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Asymmetric Information and the Bid-Ask Spread:

The Case of Sweden's Order Driven Exchanges

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ABSTRACT

This thesis considers if asymmetric information in general has a permanent impact on adverse selection in Sweden's order-driven exchanges, and if selected occurrences of asymmetric information have an immediate but temporary impact on adverse selection. In all cases, insider trading proxies for asymmetric information, and the bid-ask spread proxies for the risk of adverse selection, which is considered from the perspective of the limit order trader. There is support for the proposition that the risk of adverse selection following trading by insiders is significantly different from the normal case. There is also evidence that the degree of insider trading is a significant variable in explaining the bid-ask spread.

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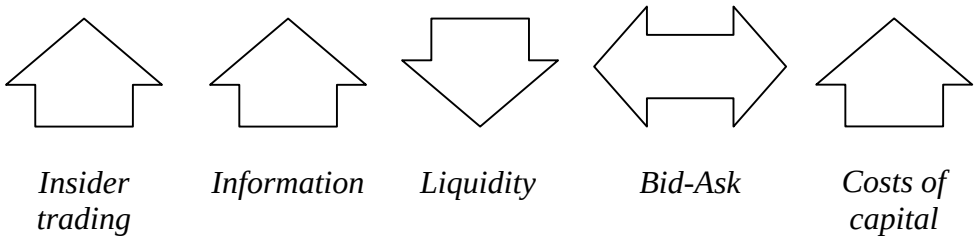
1 INTRODUCTION

1.1 What is an Insider and why do insiders trade?

Insider trading is normally defined as trading in a company by individuals with information superior to that possessed by the market in general. Such individuals are generally considered to be members of that company's board of directors, senior management and large shareholders. These insiders are generally required to disclose their trades to the market in order to resolve any concerns the market may have regarding information asymmetry. The disclosure of trading activity by insiders is a topic of academic contention. Opponents of easing restrictions imposed on trading by insiders argue that such trading results in additional costs to the market via wider bid-ask spreads and increased costs of capital in general (Bhattacharya & Daouk, 2002). Those who advocate fewer restrictions on trading by insiders claim that unfettered trading would enhance the price discovery process (Muelbroek, 1992).

Figure1.1. The case against insider trading, as outlined by Bhattacharya & Daouk (2002)



Insiders may trade to diversify their portfolios, to obtain cash, or to profit. Insiders who trade to diversify their portfolios or to address cash and/or budget constraints do not reveal any private information. Therefore, one would expect these trades to provide no insight into the fundamental value of a security, or into the level of asymmetric information faced by other investors in the marketplace. However, insiders who trade in order to profit from a fundamental mispricing of their firm do reveal valuable information to the market. This mispricing implies that the degree of information asymmetry faced by other less informed agents is larger, and the risk of adverse selection is greater.

Insiders may sell because they wish to diversify, because they require cash or because they believe that the market has overvalued their stock and they wish to realise their profits. In practice, insider selling that is motivated by private information is dominated by selling motivated by other reasons. This trading reveals little or no new information to the market. In contrast, rational insiders will only purchase if they believe that the market has undervalued their stock and that they can therefore profit. Insider purchases are consequently more informative as indicators of fundamental valuations than are sells, a point well documented by Lakonishok & Lee (2001), among others. They note that there are "a variety of reasons for insiders to sell a stock, but the main reason to buy a stock has to be to make money".

1.2 Spreads, Information Asymmetry and Market Microstructure

The variation in the bid-ask spread is one measure of the degree of information asymmetry. In this argument, the risk of adverse selection is a cost that is priced. Chung & Charoenwong (2001) find that information asymmetry spreads are increasing with the number of insiders operating in a particular market and decreasing in liquidity. From the former finding, one infers that the extent of information asymmetry – and necessarily, the risk of adverse selection – is wider for those stocks which experience relatively higher proportions of insiders trading. The latter result is one supported at least since Demsetz noted in 1968 that "the cost of exchanging a security declines as trading activity in that security increases.[1]" Hence, one notes that trading in less liquid stocks carries an additional cost for investors. This cost reveals itself through a wider bid-ask spread.

Market microstructure is essential in determining how the market reacts to insider trading, and how one reads the degree of information asymmetry. Research suggests that costs arising due to insider trading are higher on electronic order driven markets such as the Stockholm Stock Exchange (SSE) than on quote-driven markets such as the New York Stock Exchange (NYSE – see Madhavan, 1992 and Garfinkel &

[1] Demsetz, The Cost of Transacting, 50

Nimalendran, 2003). This is partly due to the fact that order driven markets may operate as periodic auctions as well as continuous auctions, depending on the time of day and on the trades submitted. Additionally, the existence of a market maker on quote driven exchanges provides continuous liquidity and is able to draw additional information regarding the identity of traders submitting orders to the market. This reduces the cost of adverse selection to other market participants. Thus, when faced with an informed trader, the risk of adverse selection encourages the market maker to post wider bid-ask spreads than would normally be the case. Accordingly, market observers of a quote driven exchange may consider the width of the bid-ask spread to be an appropriate measure of the degree of information asymmetry prevalent in the market. In comparison, investors on order driven markets may infer that insiders are active on those days when volume traded is abnormally high (see Chung & Charoenwong), but must wait until trades are reported to the relevant authority to have those suspicions confirmed. Bid and ask prices can only be used to infer the supply of liquidity following insider trading. Without a market maker able to observe the source of the order flow, adverse selection is a greater risk for liquidity suppliers on order driven exchanges.

1.3 Purpose

This thesis is concerned with the effect of asymmetric information upon the limit order traders of Sweden's order driven exchanges. Firstly, we explore whether stocks exhibiting consistently higher degrees of information asymmetry display consistently higher costs of trading. Secondly, again using insider trading as a proxy for "new levels" of information asymmetry in the market, we explore whether this asymmetry is manifest in temporarily increased costs to non-informed traders supplying liquidity.

The purpose of this thesis is to address the following questions:

1. *Do general patterns of insider trading have a permanent impact on adverse selection in the market, as experienced by limit order traders?*
2. *Do selected instances of insider trading have an immediate (and negative?) impact on adverse selection in the market, as experienced by limit order traders?*

1.4 Contribution

This thesis is the first attempt we know of to explicitly explore the relationship between insider trading and asymmetric information upon an order driven market. There is, however, a heavy debt due to existing theories of asymmetric information applied to quote-driven markets, and to existing research of the costs associated with order driven markets. Like Chung & Charoenwong (2001) we combine cross-sectional and event study analysis, but in addition to this we construct a panel dataset that allows us to control for time-varying effects in our cross-sectional analysis.

1.5 Outline

Section 2 explores the differences between the two main market microstructures, and outlines and embellishes existing applications of asymmetric information to these market microstructures. *Section 3* describes the data set used to analyse how asymmetric information impacts costs upon order driven markets. *Section 4* lists the hypotheses explored, along with predictions and their explanations. *Section 5* outlines the methodology applied. *Section 6* analyses results. *Section 7* attempts to draw conclusions from these results, while *Section 8* provides suggestions for future research.

2 ASYMMETRIC INFORMATION AND MARKET MICROSTRUCTURE

Problems of adverse selection and asymmetric information were popularised by George Akerlof in the seminal piece from 1970, "The Market for Lemons". In Akerlof's model, which focussed on the second hand market for automobiles, adverse selection affects buyers only – sellers are fully informed about the real value of the vehicle. In the market for second-hand automobiles, signalling strategies based on prices and guarantees are of the utmost importance in advising potential buyers of the quality of the product offered. In securities trading, the strength of using insider trades as a proxy for information asymmetry comes from the signalling value inherent in these trades: "Company executives and directors know their business more intimately than any Wall Street analyst ever would" [2].

The 1980's witnessed a significant expansion in the available literature addressing problems of information asymmetry and adverse selection. This literature primarily addressed market structures where a dealer or market maker is the source of liquidity, and those employing a Walrasian auction method. Glosten & Milgrom (1985) developed a model of sequential trading where private information moves and is absorbed into the market price. Hellwig (1980) offers a model where investors with private information submit demand schedules to an auctioneer who sets a single market-clearing price *post factum.* Kyle (1985) proposed a simultaneous model with its roots in a quote driven market, but with applications to the limit order traders of an order driven market. Here, he describes strategies of limit order submission where insiders with private information may trade more than once, utilise limit orders and strategically select trade size in order to discourage market prices from moving against them.

[2] Sourced from Lakonishok and Lee, 2001 – referenced from "Individual Investor", Feb 1998

2.1 Asymmetric Information and Adverse Selection on a Quote Driven Market

Analysis of asymmetric information in the case of the quote driven market is most simply considered through the adverse selection problem faced by a market maker. In a market where information is symmetric, the market maker does not face risks associated with adverse selection. In a market where information is asymmetric, adverse selection costs are borne by the market maker and are ultimately passed on to other traders. Once applied to quote driven exchanges, the problem of adverse selection faced by agents trading on an order driven exchange may be more easily understood.

2.1.1 Cost Components in the Bid-Ask Spread on a Quote Driven Market

In the quote driven market, prices are determined by quotes published by designated "market makers" or dealers. When an investor executes a trade at one side of the market quoted by the market maker, this quote becomes the prevailing market price – until the next trade is executed. Dealers profit from the spread, ie by buying at the "bid" and selling at the "ask". Huang and Stoll (1997) argue that the width of the bid-ask spread is explained by three cost components: order processing costs, inventory holding costs, and adverse information costs. In the absence of some structural change, order processing costs are constant across a security and a particular exchange. Inventory holding costs vary according to the current position of the market maker and his or her view of the market. Adverse information costs vary according to the proportion of informed traders operating in the market, how readily they may be identified, and the value of the private information that they hold. It is with adverse information costs that this thesis is concerned.

2.1.2 Adverse Selection According to the Glosten-Milgrom Theorem

The Glosten-Milgrom Theorem elegantly models adverse selection from the perspective of a specialist market maker operating on an exchange such as the NYSE over a single period. Note that in this simplified example, the only variable factor affecting spreads is information asymmetry. The following additional constraints hold:

i. The liquidation value of a security is V
ii. The next trader is equally likely to be a buyer or a seller
iii. The probability that the next trader is informed is P, and therefore the probability that the next trader is uninformed is $(1-P)$
iv. Where E represents half the bid-ask spread, the security is worth $V+E$ if an informed trader wants to buy it and $V-E$ if an informed trader wants to sell it

The market maker is unable to conclude if the counterparty is informed or uninformed. If the next trader is a buyer, his best estimate of the "fundamental" value of the security is the probability-weighted average of the market price under both outcomes. The same applies if the next trader is a seller. The difference between these two values is the spread. This can be derived to be $2PE$[3].

The Glosten-Milgrom Theorem illustrates how a larger proportion of informed traders will increase the problem of adverse selection for the market maker, and hence the quoted spread. As this proportion of informed traders' increase, P must increase. Consequently, the bid-ask spread will increase. This, in turn, increases the costs of trading for uninformed traders. In reality, trading sessions extend over many periods. A market maker that is able to learn from previous trading experience will therefore be able to punish traders who extract additional profits from him or her – the flip side to the market makers adverse selection costs. This is important as an explanation of how a quote driven market results in a tighter bid-ask spread than alternative market structures.

2.2 Asymmetric Information and Adverse Selection on an Order Driven Market

In order driven markets, the observed spread is not quoted by any one market maker, but is a function of the individual spreads of all market participants. The observed spread relevant to the order driven market is referred to as the "inside spread", and is the best bid and offer available. The inside spread at any point in time may include

[3] For full proof refer to Larry Harris, "Trading and Exchanges", 320-321

individual limit orders for agents who are either informed or uninformed, insiders or utilitarian traders – ie, traders who are motivated by factors other than pure profit. This trader type may include hedgers, gamblers, or asset swappers, among others. Deriving that component of the spread attributable to the cost of information asymmetry is more complex in an order driven market than in the example of the quote driven market. This is primarily because of the fact that market participants – liquidity suppliers in particular – may each have different liquidation values for the security, and that informed traders on such an exchange are able to trade anonymously.

2.2.1 Anonymous Trading and Insiders on an Order Driven Market

Market participants trade anonymously on order driven markets. This means that informed trading will only be revealed to the market when the relevant authority releases this information. There is no reason to expect that an insider will be required to advise the regulatory authorities immediately following a trade. If this was the case, there is no reason to expect that the regulatory authorities would immediately advise the public that insiders have been trading a particular stock.

In a quote-driven market, a central market maker may immediately infer he is trading with an insider and react by widening his quoted spreads. All market participants observe the spread widening and may draw their own conclusions accordingly. In contrast, on an order-driven exchange, the inside spread is a product of the behaviour of independent market agents – and agents will probably remain unaware of insider trading when the relevant regulatory authority releases this information. As such, it is only at the time of the announcement that uninformed traders become aware that insiders have been trading in their market, and they then must consider the implications of this upon their own individual liquidation values. Additionally, all market participants will not become aware of insider trading activity at the same time. This problem affects limit order traders, and in particular, those among them who do not update their orders regularly. This point is of paramount importance to what follows in sections outlining the data and the methodology.

2.2.2 Trading on an Order Driven Market by Uninformed and Informed Traders

In order driven markets, traders may place either market orders or limit orders. Market order traders demand immediacy or liquidity – described as "buying time" – and they may be certain that their trades will be executed. Limit order traders supply immediacy at a given depth – this strategy is often described as "selling time". A market order to buy (sell) will result in execution at the lowest (highest) current ask (bid). Cohen, Maier, Schwartz and Whitcomb (1981) describe how limit orders "create" the order book, while market orders "clear" the limit orders. In a market where some traders are more informed than others, both market order traders and limit order traders trade hampered by information asymmetries. Adverse selection is an inevitable consequence of asymmetric information. For limit order traders who do not continuously manage their orders to reflect new information, the problem is still more severe. Harris notes that "limit orders execute quickly if they are on the wrong side of the market, but they do not execute if they are on the informed side of the market.[4]" To protect against this, Foucault (1999) observes that limit order traders are more likely to post a wider spread in more volatile asset. Nevertheless, limit order traders – liquidity suppliers – face adverse selection against both informed traders (insiders) and non-informed but quickly moving market order traders.

The fact that abnormal returns are earned by insiders has been well documented in academic literature, by Jaffe (1974) and Seyhun (1992), among others. Kyle demonstrates the effect of superior private information upon prices. He illustrates that profits of a trader with superior private information (in our case assumed to be an insider) are determined by:

i. The prevailing market price *(P)*, which is in turn a function of
ii. The order flow for a given security
iii. A given liquidity constraint
iv. A mean value
v. The liquidation value, determined by the insiders' private information *(V)*
vi. The insiders' demand for the security, *(X)*
vii. And the demand for the security by uninformed trader

[4] Harris, Trading & Exchanges, 310

The profits of the insider will then be defined as:

$$\Pi = X(V-P)$$

Let us assume that the personal valuation of the insider is to the upside, so that $V > P$, and that the insider trades through market orders. In this case, he may place orders from P to V. These bids at above market valuation will presumably draw sellers, dragging the market price closer to V as sellers continue to hit the bids. This order flow will encourage holders of the security to ask for still higher prices. Meanwhile, assuming that prices are semi-strong form efficient, bids by all other traders will remain at their prior levels until the explanation for the higher-priced limit orders are revealed. Alternatively, we can consider the impact of the insider trading via market orders, given that the constraints of the limit order example continue to be valid. In this case, the insider can continue to trade at P until only transactions costs are able to explain the difference between P and V. In both examples, the bid-ask spread has widened as a result of the insiders actions.

Furthermore, Cohen et al demonstrate that transaction costs will always ensure that limit orders are placed in an order driven market. They thereby justify that a bid-ask spread will be a persistent feature of a market of this kind, and are a feature of markets that have cleared temporarily. They argue that this equilibrium spread ensures that traders are, in general, indifferent between using market orders and limit orders when trading. They contend that at this equilibrium spread, the probability of the spread widening is equal to the probability of the spread tightening. However, Cohen et al base their abstraction on the strong form version of the efficient markets hypothesis. Any relaxation of this assumption necessarily implies that there are varying degrees to which one may be informed about the true value of the security. Accordingly, deviations from Cohen et al's equilibrium spread are to be expected. Among other things, this deviation will include a cost indicative of the adverse information afflicting most (uninformed) traders of the asset. Because of this Luez & Verrecchia (2000) contend that using order driven data to identify information

asymmetry is "conceptually appealing[5]". They assert that spread components unrelated to information asymmetry are less important in an environment where all traders can post limit orders.

2.3 Regulation of Insider Trading in Sweden

The regulatory authority overseeing Sweden's financial system is *Finansinspektionen*. Amongst its operations is the publication of legal insider trading announcements; what in Swedish is labeled "insynshandel".

The legal framework surrounding legal insider trading is concentrated to the *Reporting Duty for Certain Holdings of Financial Instruments Act (2000:1087)*[6]. Where the legislation has changed during the 1991-2006 period, *Section 2.3.4* below outlines the relevant changes. With this in mind, the key parts of the current legislation are outlined below.

2.3.1 Trade disclosure requirements

Swedish law considers the following physical persons to have insider positions in a listed company:

1. *Directors or deputy directors on the Board of Directors*
2. *Managing directors or deputy managing directors*
3. *Auditors or deputy auditors at the company*
4. *Partners in a partnership that is the company's parent company, though not limited partners,*
5. *Holders of other senior management posts or other qualified functions of a permanent nature, if the post or function can normally be considered to involve access to unpublished information on circumstances that may affect the company's share price,*
6. *Persons who own shares in the company corresponding to at least ten percent of the share capital or of the number of votes for all shares in the company or who own that proportion of shares jointly with physical or juridical persons who are closely-related to the shareholders as stated in the first subsection of section 5.*

[5] Luez & Verrecchia, "The Economic Consequences of Increased Disclosure", page 108
[6] Availiable in English through
Http://www.fi.se/upload/90_English/50_Insider_trading/Reporting/2000_1087_eng.pdf

Reporting duty applies also to corporate officers of parent companies, and in some cases senior executives of subsidiaries, are also considers. A key recurring phrase is *"if they can normally be considered to have access to unpublished information on circumstances that may affect the company's share price"*. To resolve potential uncertainties, Finansinspektionen is obliged to assess whether an agent is to be considered an insider if a company requests it to do so.

Legally, persons who have insider positions in a stock market company must report in writing any holdings of shares in the company and any changes in those holdings to Finansinspektionen. In practice, many choose to report through the Finansinspektionen website. Reports on shareholdings or changes in holdings must reach Finansinspektionen no later than five working days. The reporting duty also covers certain shareholdings by closely related persons, such as partners and minors in the insider's custody.

There are certain cases when the reporting duty does not apply, for instance if changes in the insiders holding come about through bonus issues or share splits. Whilst this study focuses solely on trade announcements regarding shares, the regulatory framework concerns also related financial contracts such as subscription rights, interim certificates, and option certificates.

2.3.2 Prohibited trading

Certain insiders may not trade in shares in the company for a period of thirty days prior to the publication of an ordinary interim report, including the date of publication. This applies primarily (but not exclusively) to directors or deputy directors on the Board of Directors, to managing directors or deputy managing directors and to auditors or deputy auditors at the company.

2.3.3 Fines and Sanctions

Insiders who fail to report trading, or who submit incorrect or misleading information, may be subject to fines. These amount to 10 percent of the consideration for the shares or, if no consideration has been paid, SEK 15 000. The maximum fee is SEK 350 000. Finansinspektionen may lower the fines in special circumstances.

2.3.4 Legislative developments

Between 1991 and 2000, insider trading was regulated through the law *Insiderlag (1990:1342)*. The law underwent several minor revisions during the 1990s[7], and was eventually replaced by two separate laws where reporting duties and market manipulation are treated separately. The reasons for to the 2000 legal overhaul concerned the inability of the existing regulatory bodies to cooperate and reach prosecution when insiders traded in during prohibited periods or failed to report their trades to Finansinspektionen[8]. As a consequence of the new legislation, the allowed reporting period was also shortened from 14 days to 5.

The current, official law regarding reporting duties is the *"Lag (2000:1087) om anmälningsskyldighet för vissa innehav av finansiella instrument"*. Since its inception it has since undergone minor revisions[9]. The previous prohibition of short-term trading has been replaced by a ban on trading in the month running preceding interim reports (as discussed in *Section* 2.3.2, above). Furthermore, the definition of related parties from children and spouses has been broadened to include also cohabitants.

The current law treating market manipulation is the *Lag (2005:377) om straff för marknadsmissbruk vid handel med finansiella instrument*.

[7] For a full list of changes, consult http://www.notisum.se/rnp/sls/fakta/a9901342.htm (Swedish)
[8] Wesser, "har du varit ute och shoppat, Jacob?"
[9] For a full list of changes, consult http://www.notisum.se/rnp/sls/fakta/a0001087.htm (Swedish)

3 THE DATA SET

3.1 Data sources

Our dataset has two primary sources, insider trading data and market data. Market data involves daily closing prices, the closing bid and ask prices, the daily volume (in number of shares) and the highest and lowest transaction prices for each trading day. This data was acquired from the SIX Trust database. Insider trading data was retrieved from Finansinspektionen, the regulatory authority overseeing the financial markets in Sweden. The data set from Finansinspektionen originally included all reported trades by insiders from 1991 to March 2006.

3.2 Exchanges

Our study treats insider trading in companies on all Sweden's approved Stock Exchanges and Approved Marketplaces. OMX Stockholmsbörsen is the leading Swedish stock exchange, where companies are listed either on the A-list or O-list. Nya Marknaden is a separate marketplace for smaller companies, although this too is managed by OMX. Nordic Growth Market (NGM) is a rival exchange also listing smaller companies.

All the exchanges are order-driven, though NGM explicitly states that firms may employ a market maker to improve liquidity if they choose.

A significant weakness of the Trust database is its poor detailing of the exchanges on which firms are listed. This data is treated as static, which means that only the latest exchange where a company was listed is recorded. The Exchange Listing data will hence clearly be erroneous in situatations where a company's share has moved between exchanges (or between the Stockholmsbörsen A and O lists).

3.3 Date Considerations

The Finansinspektionen database stores two dates for each insider trade: the date of the actual insider trade and the date when Finansinspektionen announces that insider

trading has occurred. For the purposes of our analysis, and for reasons outlined in Section 2.2 *"Asymmetric Information and Adverse Selection on an Order Driven Market"*, we consistently focus on the latter: the date when the market is notified that one or more company insiders have recently been trading. Given the anonymous nature of order-driven exchanges, we believe that the announcement time is likely to yield a greater impact on the bid-ask spread than the actual time of the trade.

3.4 Cross-sectional Panel Data Set

Cross-sectional regression analysis is undertaken to analyse the permanent effects of insider trading on the bid-ask spread. The data is structured around group and time axes, in our case "firm" and "year", respectively. Aggregate statistics are calculated for each such firm/year combination from 1991 to 2005. The mean closing price, mean spread, standard deviation of the closing price and mean volume are calculated using data from the Trust database. For each firm, the yearly amount of insider trades, buys, sells and president/vice president/large owner trading amounts are calculated using data from Finansinspektionen. Three criteria were required for a firm/year observation to be included in the final panel data set:

i. There must be trading in both January and December
ii. There must exist data for at least 200 trading days
iii. The amount of missing closing prices must not exceed 100.

These restrictions were put in place to ensure a minimum amount of recorded trades, not just quoted bid and ask prices. Together, these three criteria reduced the data set to 3,132 firm/year observations.

3.5 Event Study Data Set

We employ the standard event study methodology to analyse the temporary effects of insider trading on the bid-ask spread. Extensive pruning of the trading data set was required to facilitate this analysis. Cutting away all trades not labelled "shares" reduced the data set to 42,588 events. Keeping only trades related to presidents, vice presidents and large shareowners further reduced the data set to 13,584 events. We then netted all trades related to one insider if they were announced on the same day. We removed cases where such trades netted to zero. Together, these steps reduced the

data set to 9,605 events. We then collapsed the trades relating to different insiders in the same company on the same day. This reduced the data set to 9,204 events. Setting a 30-day event window reduced the data set further, as we excluded those events where the event window was contaminated by insider trades. Some events were discarded as we matched our events to Trust data, and found missing data points in the event window. In total, imposing these restrictions upon the data set resulted in 2,827 events across 501 companies.

4 HYPOTHESES

Our formal hypotheses will allow us to determine if there is evidence of adverse selection on Sweden's order driven exchanges. The hypotheses are summarised in *"Section 4.3: Summary of Hypotheses"* below.

4.1 Permanent Asymmetries

In this section, we wish to explore the argument that adverse selection is a greater problem in markets where insiders are relatively active than in markets where insiders are relatively inactive. If so, in line Chung & Charoenwong, we propose that spreads in these markets will be wider *in general*. In order analyse this question, we begin by considering possible measures of insider activity. There are two possible measures of activity available to us, which will collectively be referred to as *instances* of insider trading:

1. *Number of Trades Made by Insiders*
2. *Amount of Shares Traded by Insiders*

Furthermore, we will define insider trading as all trades by presidents, vice presidents and large shareholders, in keeping with expectations outlined earlier. Trades may refer to all trades, or buy trades or sell trades in particular. In order to determine that insider trading is a factor in explaining bid-ask spreads and therefore, the degree of information asymmetry endemic to a market, we propose testing the following hypotheses:

Hypothesis 1:

H_0: Instances of insider trading do not contribute positively and significantly to bid-ask spreads

H_1: Instances of insider trading contribute positively and significantly to bid-ask spreads

Hypothesis 2:

H_0: The amount of shares traded by insiders does not contribute positively and significantly to bid-ask spreads

H_1: The amount of shares traded by insiders contributes positively and significantly to bid-ask spreads

Rejecting the null hypothesis of either Hypothesis 1 or Hypothesis 2 will be interpreted as support for our original concern, the broader hypothesis that the activity of insiders in the trading of their own stock will widen the mean spread of that stock. We expect to reject the null hypothesis tabled in both hypotheses. Therefore, we expect to reject also the null presented in Hypothesis 3 in favour of its alternative hypothesis:

Hypothesis 3:

H_0: The bid-ask spread is not wider in stocks where insiders are more active traders than in stocks where insiders are less active traders

H_1: The bid-ask spread is wider in stocks where insiders are more active traders than in stocks where insiders are less active traders

Turning our attention to the possibility that certain types of trading indicate a greater degree of information asymmetry than others, we wish to explore whether buy trades widen bid-ask spreads more than do sell trades. When insider trades are segmented into two explanatory variables, buys and sells, we expect the buy variable to have a larger (positive) and more significant coefficient. As such, we expect to reject the below null hypothesis in favour of the alternative hypothesis.

Hypothesis 4:

H_0: Buy trades by insiders do not contribute more to wider bid-ask spreads than do sell trades by insiders.

H_1: Buy trades by insiders contribute more to wider bid-ask spreads than do sell trades by insiders.

Thirdly, we wish to support the tenet that trades made by a certain class of insider is more informative than another. This is theoretically and intuitively a reasonable proposition: an insider such as a president or a vice president has access to more firm specific information than an insider such as a large shareholder. Additionally, the former has access to this information almost continuously. To test this, we segment the insider trades according to the category of insider that is trading. We expect to reject the null hypothesis, and for coefficients for these variables to be significant and positive. Therefore:

Hypothesis 5:

H_0: Trades by presidents and vice presidents do not contribute more to wider bid-ask spreads than do trades by large shareholders.

H_1: Trades by presidents and vice presidents contribute more to wider bid-ask spreads than do trades by large shareholders.

4.2 Temporary Asymmetries

Hitherto our focus has been with permanent asymmetries – the proposition that a high level of informed trading has a lasting and permanent impact on the bid-ask spread of a given security. To complement this analysis, we investigate also the incidence of temporary effects on the bid-ask spread following announcements of recent insider trading. Firstly, we begin with a generalised case across all securities and all types of insider trading. We aim to determine if trading by insiders indicates that relatively less informed traders are at greater risk of adverse selection. If so, we suggest that the bid-ask spread will widen as informed traders exploit liquidity supplied by uninformed traders. Given findings from previous research, we would not expect to find significant results that are strong enough to reject our null hypotheses had we used a raw database containing all recorded announcements of insider trading. However, as outlined in *Section 3*, the data set has been culled by the authors to only include the most informative trades. For this reason we expect nonetheless to reject the null hypotheses posed below. Our event study lets us phrase the following formal hypotheses:

Hypothesis 6:

H_0: The bid-ask spread after the announcement of recent insider trading is not significantly different from what could be expected had there been no announcement of recent insider trading.

H_1: The bid-ask spread after the announcement of recent insider trading is significantly different from what could be expected had there been no announcement of recent insider trading.

We also wish to consider the possibility that certain insiders are better informed than others. While we do not consider that there will be a large difference in how well informed presidents are relative to their vice presidents, we do consider there to be an argument that both of these insiders will be more informed than large shareholders. This is justified by the observation that the former group are more involved in the day-to-day operations of their business. If this is the case, we could infer that adverse selection is a greater problem if the insider trading is a company president or vice-president. Therefore:

Hypothesis 7:

H_0: The bid-ask spread after the announcement of recent trades by a company president or vice-president is not more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent trades by a large shareholder

H_1: The bid-ask spread after the announcement of recent trades by a company president or vice-president is more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent trades by a large shareholder

Secondly, as per Lakonishok & Lee, and for those reasons outlined earlier, we wish to investigate and determine if purchases by insiders result in a greater likelihood of adverse selection than do sells by insiders. If this is the case, we argue that the bid-ask spread will widen relatively more following a purchase by an insider than it would after a sell by an insider. The null hypothesis we expect to reject is:

Hypothesis 8:

H_0: The bid-ask spread after the announcement of recent buy trades is not more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent sell trades

H_1: The bid-ask spread after the announcement of recent buy trades is more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent sell trades

Fourthly, as per Kyle's assertion that spreads are a function of liquidity, we wish to investigate if insider trading by insiders results in greater risks of adverse selection in relatively illiquid stocks than in relatively liquid stocks. We expect to find support for the assertion that insider trading widens the bid-ask spread further on illiquid stocks than on liquid stocks. The formal hypothesis we expect to reject is hence:

Hypothesis 9:

H_0: The bid-ask spread after the announcement of recent insider trades in an illiquid stock is not more significantly different than is the bid-ask spread following the announcement of recent insider trades in a liquid stock

H_1: The bid-ask spread after the announcement of recent insider trades in an illiquid stock is more significantly different than is the bid-ask spread following the announcement of recent insider trades in a liquid stock

4.3 Summary of Hypotheses

Tabulated below is a summary of the hypotheses in our two studies. We have also indicated the expected outcomes, though interpreting these may demand familiarity with *"Section 5: Methodology"*.

4.3.1 Cross-sectional study

	Hypothesis	Expected outcome (to reject null hypothesis)
1	Instances of trading → wider spread	Positive and significant coefficient of variable no_trades
2	Quantities of shares traded → wider spread	Positive and significant coefficient of variable qu_trades
3	More active insiders → wider spread	Rejection of null hypothesis in Hypothesis 1 and/or 2
4	Buys → wider spread than sells	Greater (positive) coefficients of variables no_buys than of variable no_sells; and/or greater (positive) coefficients of variables qu_buys than of variable qu_sells
5	Trading by presidents & vice-presidents → wider spreads than trading by large owners	Greater (positive) coefficients of variables no_pres and no_vp than of variable no_owner; and/or greater (positive) coefficients of variables qu_pres and qu_vp than of variable qu_owner

4.3.2 Event study:

	Hypothesis	Expected outcome (to reject null hypothesis)
6	Trading → significantly different spread	Overall *p*-value < 0.05
7	Trading by presidents & vice-presidents → more significantly different spreads than trading by large owners	*p*-values for sub-samples Presidents and Vice-Presidents below 0.05, and smaller than the *p*-value for sub-sample Owners
8	Buys → more significantly different spreads than sells	*p*-value for sub-sample Buys below 0.05 and smaller than the *p*-value for sub-sample Sells
9	Trades in illiquid stocks → more significantly different spreads than trades in liquid stocks	*p*-value for sub-sample O-list below 0.05 and smaller than the *p*-value for sub-sample A-list

5 METHODOLOGY

The methodology involved in the cross-sectional study differs markedly from that of the event study, even though the source data share the same origin. Our ambition is that the combined application of differing techniques will shed more light on our subject than would the use of one method on its own.

5.1 Cross-sectional Study using Panel Data

The cross-sectional study employs unbalanced panel data, as described in *"Section 3: The Data Set"*. The intent is to assess the relationship between "Permanent Asymmetries" in information and levels of insider trading in Swedish listed companies. Throughout this analysis, the dependent variable used to proxy for asymmetric information is the mean bid-ask spread across a full year.

5.1.1 Hausman test

We employ Hausman's specification test[10] choose between a fixed effects and random effects model. The chi^2 returned is 72.03, corresponding to a highly significant *p*-value near 0.0000. We thus conclude that fixed effects modelling is preferable over random effects.

5.1.2 Models used for cross-sectional estimation

Listed below are the (fixed effects) model fitted in our cross-sectional analysis. Of the many variables, it is worth pointing out that *sd_close* proxies for risk and that *mean_volume* is related to liquidity. A full specification of the variables used is listed in Appendix II.

[10] The results originate from the model labelled Model 2 in *Section 5.1.2*

Model 1 (overall test, terms of instances):

$$mean\_spread_{it} = \beta\ no\_trades_{it} + \beta\ mean\_close_{it} + \beta\ sd\_close_{it} + \beta\ mean\_volume_{it} + \alpha_i + u_{it}$$

Model 2 (overall test, quantity terms):

$$mean\_spread_{it} = \beta\ qu\_trades_{it} + \beta\ mean\_close_{it} + \beta\ sd\_close_{it} + \beta\ mean\_volume_{it} + \alpha_i + u_{it}$$

Model 3 (buys/sells, terms of quantities):

$$mean\_spread_{it} = \beta\ qu\_buys_{it} + \beta\ qu\_sells_{it} + \beta\ mean\_close_{it} + \beta\ sd\_close_{it} + \beta\ mean\_volume_{it} + \alpha_i + u_{it}$$

Model 4 (type of insider, terms of quantities):

$$mean\_spread_{it} = \beta\ qu\_pres_{it} + \beta\ qu\_vpt + \beta\ qu\_ownert + \beta\ mean\_close_{it} + \beta\ sd\_close_{it} + \beta\ mean\_volume_{it} + \alpha_i + u_{it}$$

5.2 Event Study

We employ a multifactor event study methodology where we attempt to reject our null hypotheses and gain insights into the "Temporary Asymmetry". When doing so, we use the regular parametric testing procedure[11].

We believe that the probability of adverse selection will rapidly diminish as the market quickly absorbs the information revealed by the actions of the insider. Hence, we define our event window as the day of publication and the day after (*t* and *t+1*). Since we use daily data we have Trust records of closing bid and ask prices. This means that for the first day in the event window we measure the spread 3 hours after the Finansinspektionen announcement. For our estimation window, we use 30 trading days *(t-30)* running up to (but not including) the event window. From the basis of these regressions, "normal-case" spreads are predicted during the event window. An

[11] We base our analysis on the methodology set forth in "Event Studies with Stata"; Data and Statistical Services, Princeton University

abnormal spread is then calculated during the event window by subtracting the normal spread from the actual spread, so that:

$$Abnormal\ Spread = Actual\ Spread - Normal\ Spread$$

The sum of the abnormal spreads over the two days in the event windows is summed to form the cumulative abnormal spread:

$$\Sigma_1^2 Abnormal\ Spread = \Sigma_1^2 Actual\ Spread - \Sigma_1^2 Normal\ Spread$$

Applying a *t* test to this figure allows us to determine if – under given circumstances – the publication of insider trading data yields a change in the bid-ask spread that is significantly different from zero. A *p*-value is then obtained to measure the significance of abnormality within this sample or sub-sample.

When calculating our dependent variable, the normal spreads, for the purpose of our multifactor event study analysis, we use three explanatory variables. These will now be outlined.

5.2.1 The Dependent Variable

Previous studies analysing issues of insider trading and asymmetric information have variously utilised "*effective spreads*", "*proportional effective spreads*[12]", time-weighted percentage spreads of stock[13]. These studies rely on the availability of continuous data or on variables such as average trade size. Lack of such data forced the use of a cruder spread measure.

The quoted spread throughout the estimation window will be considered to represent the "normal spread", and can be expressed:

$$\frac{P_A - P_B}{2}$$

[12] See Garfinkel & Nimalendran, "Market Structure and Trader Anonymity", 595
[13] Chung & Charoenwong, "Insider Trading and the Bid-Ask Spread", 4

5.2.2 The Explanatory Variables

Consistent with most studies that attempt to explain the effects of information asymmetry upon spreads, we use variables that are intended to proxy for liquidity, volatility, common information and transaction costs (tick size). Theoretically, these factors should explain most predictable components of the spread. Other explanatory factors mentioned in *Section 2* include the relative probabilities of incoming traders being buyers or sellers, and the order flow for any given security. We consider such factors to be indeterminable, relatively stable and we expect them to be captured in the regression constant.

`turnover_amount:`

Defined as the share's daily turnover in number of shares, the turnover amount is included in our regression as a proxy for the liquidity of a security and as a proxy for the demand for the security by both informed and uninformed traders. In line with Kyle, a more liquid security should have a tighter bid-ask spread as the ease of trading in and out of that security improves.

`close:`

Defined as the share's closing share price, the closing price is included in our regression as a measure of the effect of the tick size on the costs of trading a security and as a measure of the "common-information market price". Securities trading at lower prices have lower tick sizes, while securities trading at higher prices have higher tick sizes. However, as tick sizes are applied to a band of prices, they will have larger proportional affects on the trading costs – and therefore the spread – of relatively lower priced securities than relatively higher priced securities. This variable matches with Kyle's liquidation value of the asset and mean value.

`hilo:`

Defined as the highest transaction price minus the lowest transaction price on the same trading day, this variable is intended to serve as a proxy for volatility. Much previous research uses a measure of idiosyncratic risk (e.g. intraday volatility) to construct normal spreads. On an order driven market, limit order traders would

intuitively post wider spreads on more volatile assets. The Trust database lacks this information, which is why we include the *hilo* variable defined above. Lacking a measure for intraday volatility, *hilo* is the best available alternative.

Before deploying our model, we will ensure there are no grave problems of correlation, autocorrelation or multicollinearity. Given that these checks do not raise doubts regarding our explanatory variables, our complete event study regression therefore becomes:

$$(P_A - P_B)_{it} = \alpha_{it} + \beta_1 TURN\_AM_{it} + \beta_2 CLOSE_{it} + \beta_3 HILO_{it} + u_{it}$$

5.2.3 Treatment of Outliers

Following our initial estimations, we calculate Studentized residuals and Cooks D statistics to identify outliers. Manual inspection is ruled out through the large number of observations, and therefore we remove all observations (days) where the Cooks D > 4/N. After this removal, outliers, the effects of some events still appear to be exaggerated due to missing data points. This leads us to restrict the sample to events with a complete sample, N≥20. These revisions decrease the dataset by 202 events, explaining why the results described below stem from a sample of 2625 events across 415 companies.

Lastly, the distribution of regression residuals is known to often be non-normal when working with financial data. Upon completion of each regression in the event study, we therefore apply Shapiro-Wilk's testing to assess whether the residuals from the regression can be considered normally distributed.

6 RESULTS & ANALYSIS

6.1 Cross-sectional Results

Tabulated below are the results from our cross-sectional study using panel data. In order to provide for a more robust analysis, the cross-section data aims to answer the same question using both insider trades defined in terms of the *instances* or *numbers* of trades by insiders, and in terms of the *quantities* of stock traded by insiders.

6.1.1 The Model

The R^2 returned by our cross-sectional models are in the order of 0.40-0.45. This is clearly lower than expected, and is likely to stem mainly from our relatively poor proxy for idiosyncratic risk.

6.1.2 Hypothesis testing

Firstly, in accordance with Hypothesis 3, we aim to determine that insider trading does in fact contribute to a wider bid-ask spread. This will be done by examining the tenets of both Hypothesis 1 and Hypothesis 2; ie, that both the number of trades made by insiders and the quantity of shares traded by insiders are informative. The analysis of both hypotheses is tabled in Table 6.1.

Hypothesis 1:

H_0: Instances of insider trading do not contribute positively and significantly to bid-ask spreads

H_1: Instances of insider trading contribute positively and significantly to bid-ask spreads

Hypothesis 2:

H_0: The amount of shares traded by insiders does not contribute positively and significantly to bid-ask spreads

H_1: The amount of shares traded by insiders contributes positively and significantly to bid-ask spreads

Table 6.1. Cross-sectional results: overall significance testing

Instances					
	no_trades	mean_close	sd_close	mean_volume	constant
Coeffiecient	-0.005	0.023	-0.023	3.02e-09	-0.520
p-value	0.171	0.000	0.000	0.795	0.000
R2 within	0.452				
R2 between	0.348				
R2 overall	0.378				

Quantities					
	qu_trades	mean_close	sd_close	mean_volume	constant
Coeffiecient	-1.50e-08	0.023	-0.023	2.04e-09	-0.556
p-value	0.019	0.000	0.000	0.858	0.000
R2 within	0.453				
R2 between	0.337				
R2 overall	0.375				

Dependent: mean_spread

Due to the low significance level, we cannot reject the null hypothesis of Hypothesis 1. What's more, and in violation of the hypothesis, the sign of the coefficient suggests insider trading causes the spread to contract. In Hypothesis 2, the quantity of trades proved to be a statistically significant explanatory variable. However, the coefficient is too small to be economically meaningful in determining the mean bid-ask spread. By assessing the first two hypotheses we can hence not reject the null hypothesis of Hypothesis 3.

Hypothesis 3:

H_0: The bid-ask spread is not wider in stocks where insiders are more active traders than in stocks where insiders are less active traders

H_1: The bid-ask spread is wider in stocks where insiders are more active traders than in stocks where insiders are less active traders

These results do not support the phenomenon we projected, that information asymmetries due to insider trading have a permanent impact on bid-ask spreads. This implies that a limit order trader with open orders faces no greater risk of adverse selection in those markets where the selected insiders are relatively more active. We nonetheless continue to assess also Hypotheses 4 and 5, focusing on *Quantities of trading* rather than *Instances of trading* due to the greater significance of that variable.

Our second aim was to replicate the findings of Chung & Cheroenwong by confirming that buy trades are indeed more significant in explaining the bid-ask spread than are sell trades. This result would indicate that buy trades are more informative to the market, and thus of more value. Results are presented in Table 6.2.

Hypothesis 4:

H_0: Buy trades by insiders do not contribute more to wider bid-ask spreads than do sell trades by insiders.

H_1: Buy trades by insiders contribute more to wider bid-ask spreads than do sell trades by insiders.

Table 6.2. Cross-sectional results: Buys versus Sells

Quantities					
	qu_buys	qu_sells	mean_close	sd_close	constant
Coefficient	1.40e-08	7.05e-08	0.023	-0.022	-0.525
p-value	0.146	0.000	0.000	0.000	0.000
R2 within	0.457				
R2 between	0.315				
R2 overall	0.370				

Dependent: mean_spread

We are unable to reject our null hypothesis. These results run contrary to our expectations. When trading is measured in quantity terms, sell trades are again more significant although the sizes of the coefficients are negligible. This implies that the risk of adverse selection is greater in general for those limit order traders that post buy orders, than for those limit order traders who have posted sell orders. Such results have no theoretical grounding and should be interpreted with caution.

As per Hypothesis 5, we explore the proposition that trading by certain types of insiders has a more significant impact upon the formation of bid-ask spreads than trading by other types. Results are presented below in Table 6.3.

Hypothesis 5:

H_0: Trades by presidents and vice presidents do not contribute more to wider bid-ask spreads than do trades by large shareholders.

H_1: Trades by presidents and vice presidents contribute more to wider bid-ask spreads than do trades by large shareholders.

Table 6.3. Panel study: Presidents/Vice-Presidents/Large owners

Quantities						
	qu_pres	qu_vp	qu_owner	mean_close	sd_close	constant
Coefficient	1.36e-08	5.88e-08	-1.61e-08	0.023	-0.023	-0.578
p-value	0.788	0.947	0.388	0.000	0.000	0.000
R2 within	0.452					
R2 between	0.346					
R2 overall	0.377					

Dependent: mean_spread

Again, our study will not allow us to reject our null hypothesis. The coefficients are again economically meaningless, too small and in the case of trading by presidents, the opposite of sign from what had been expected. The coefficients are not statistically significant. This implies that individual limit order traders do not face a larger risk of adverse selection when presidents, vice presidents or large shareholders are trading than in markets when other insiders are trading. Although we cannot reject the null hypothesis, the alternative H_1 hypothesis is not applicable either. Rather than shed light on relative importance of different insiders, our results here again question the existence of permanent asymmetries due to insider trading altogether. For this reason, our additional breakdowns of these results are presented in Appendix III.

6.2 Event Study Results

We begin by examining the robustness of the model that we have developed and offering explanations for perceived shortcomings. We then continue by considering the implications of the event study upon our hypotheses.

6.2.1 The Model

The R^2 returned by our model is in the order of 0.20 across all trades and for all types of insiders. This is much lower than in comparable academic research the authors are aware of, where R^2's are generally in the 0.4-0.5 range (eg, see Chung & Charoenwong). There are several factors that help explain the lower R^2 obtained. In particular, these factors include the daily data that has been used to analyse the impact of information asymmetry upon adverse selection, the variables that were used in constructing the model, the construction of the measure of the "normal spread" and the architecture particular to equity markets in Sweden.

Firstly, our daily data is much less accurate than is typically used in a study of this nature. Academic literature tends to use continuous data when analysing the impact of insider trading upon bid-ask spread. This allows the researcher to identify the impact of insider trading upon the perceived degree of information asymmetry at that precise moment when the insider's trade is revealed to the public. Continuous data was not considered in this case, as it was not available through those data sources accessible to the authors. As stated earlier, by using the inside spread at the market close over two trading days, the authors of this paper measure the degree of information asymmetry two hours and twenty six hours after the market has digested news of insider trading. At this stage, it seems reasonable to assume that most active limit order traders will have altered their liquidation values to reflect the new information, and that the market will have exploited any profitable trading opportunities presented by inactive or noise limit order traders. Consequently, we argue that much of the temporary information asymmetry will have already decayed.

Secondly, those variables that have been used in constructing our model of the bid-ask spread are imperfect proxies for those factors they are intended to represent. This is inevitable. Perhaps most significantly, the model was regressed without a factor representing idiosyncratic risk. The variable intended to proxy for this – the *hilo* variable – was dropped due to its high correlation (0.96) with the close variable. Naturally, inclusion of the *hilo* variable would have done little to add to the explanatory power of the model but done much to detract from its parsimony. Furthermore, one could reasonably argue that the *turnam* variable is an imperfect proxy for the liquidity of a security and of the demand for it by all traders. In addition

to liquidity and demand, the *turnam* variable could reflect unique events – a sharp increase in demand for the stock following a credit upgrade, or a sharp decrease in demand following a profit warning. The *close* variable was consistently the most informative in the model in terms of coefficient size and significance. Additionally, the question of whether insider trading is a valid proxy for asymmetric information is an open one. In certain cases it is, while in others it is not.

Thirdly, as has been mentioned in "*Section 5: Methodology"*, the method that has been used to construct the "normal spread" is imperfect. However, given that the nature of this problem has already been explored, there is no pressing need to discuss this issue further.

Finally, the structure of the order driven exchange itself makes it less clear as to what one should expect from the explanatory power of the specified model. This is primarily because most published research has investigated the problem of information asymmetry and adverse selection on quote driven markets in the United States. For order driven markets, while the problem has been addressed from a theoretical perspective, the issue has been researched from an empirical perspective far less thoroughly. Because of this, there is less certainty as to how the specified model matches up to a peer group applied to other order driven markets.

6.2.2 Hypothesis testing

It is worth reiterating how the methodology differs between the event study and the cross-sectional analysis treated above. The cross-sectional analysis sought to explain the variation in mean bid-ask spreads across different securities. It did so through the introduction of various explanatory variables. The set of explanatory variables was also modified depending on which hypothesis was investigated, such as the breakdown of the *no_trades* variable into *no_buys* and *no_sells*. The event study relies on a very different methodology. For each event, a regression is fitted for the time running up to the event, and a prediction is generated for the time just after the event takes place. The actual outcome – the true bid-ask spread – is then compared to the predicted values. Throughout all the events, in our case around 2600, the very same model is fitted and used for prediction. When examining our different hypothesis we hence do not modify our model, we simply examine different subsets

of events. Whilst the methodology has some clear advantages, the crude choice of subsets also means that the influence of other factors is not statistically controlled for in the regular fashion. Unlike the normal cross-sectional study we cannot introduce additional variables to isolate the effect of what we are investigating.

Hypothesis 6 treats the impact of insider trading announcements on the bid-ask spread. The results are presented below:

Hypothesis 6:

H_0: The bid-ask spread after the announcement of recent insider trading is not significantly different from what could be expected had there been no announcement of recent insider trading.

H_1: The bid-ask spread after the announcement of recent insider trading is significantly different from what could be expected had there been no announcement of recent insider trading.

Table 6.4. Event study results: Overall significance testing

Sample	Number of events	Number of firms	Overall t-test (p-value)	Number of events individually significant at 5%*	% of all events individually significant at 5%*
All trades	2625	415	0.000	303	0.12
Sample	Average R^2	Average Adjusted R^2	Number of events where Shapiro-Wilks p>0.05	% of events where Shapiro-Wilks p>0.05	
All trades	0.209	0.104	1472	0.56	

** An event is considered individually significant when for that event, analysed in isolation, the bid-ask spread after the event is significantly different (at 5 percent) from its predicted value. That is, where t-testing of the difference yields a value t>1.96*

The overall t-test allows us to reject the null hypothesis in favour of the alternative hypothesis. The *p*-value is very significant; at 0.000 it shows that bid-ask spreads are indeed different in the time period shortly after the publication of insider trading data. This suggests that the limit order trader does face a greater risk of adverse selection following trading by one of the insiders considered than would be the case had that insider not traded.

It is interesting to compare this overall result to the individual t-test results from each regression. Examined individually, only 12 percent of the trade announcements

showed a statistically significant deviation of the actual spread when compared against its prediction. This result illustrates the econometric importance of sample size – without a sufficiently sized sample, we would not have reached the results we now find.

It may be prudent to point out that "All trades" in this context includes only trades by Presidents, Vice-Presidents and large shareholders. We would not have expected to find such strong a result had we examined *all* insider announcements publicised by Finansinspektionen.

Hypothesis 7 focused specifically the impact of trades by different groups of insiders. The results of our testing are presented below:

Hypothesis 7:

H_0: The bid-ask spread after the announcement of recent trades by a company president or vice-president is not more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent trades by a large shareholder

H_1: The bid-ask spread after the announcement of recent trades by a company president or vice-president is more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent trades by a large shareholder

Table 6.4. Event study results: Presidents/Vice-Presidents/Large Owners

Sample**	Number of events	Number of firms	Overall t-test (p-value)	Number of events individually significant at 5%*	% of all events individually significant at 5%*
Presidents	930	288	0.009	121	0.13
Vice-Pres.	712	195	0.053	68	0.10
Owners	735	192	0.107	82	0.11
Sample**	Average R^2	Average Adjusted R^2	Number of events where Shapiro-Wilks p>0.05	% of events where Shapiro-Wilks p>0.05	
Presidents	0.205	0.101	470	0.51	
Vice-Pres.	0.204	0.100	392	0.55	
Owners	0.213	0.107	451	0.61	

** An event is considered individually significant when for that event, analysed in isolation, the bid-ask spread after the event is significantly different (at 5 percent) from its predicted value. That is, where t-testing of the difference yields a value t>1.96*

*** No events are included where trading by more than one of the insider types Presidents/Vice-Presidents/Larger Owners are announced simultaneously.*

We note that the abnormal spread is significant at 5 percent after presidents, almost significant at 5 percent when vice presidents trade, but not significant even at 11 percent after large shareholders trade. In line with our expectations, we can narrowly reject our null hypothesis. As such, one must infer that the limit order trader faces a greater chance of adverse selection when a President or Vice-President is trading in his/her own company's stock than when a large shareholder is trading.

The difference between President and Vice-President trades is unexpected. While one naturally expects the president to wield more authority regarding the direction of a company, it is hard to understand why a president would gain from being better informed than a vice president. One may speculate that this is nothing to do with the information held by these individuals, but rather, reflects an irrational response by the market, which places relatively too much value on an action by a president.

Turning to buys and sells, the results relating to Hypothesis 8 are tabulated below:

Hypothesis 8:

H_0: The bid-ask spread after the announcement of recent buy trades is not more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent sell trades

H_1: The bid-ask spread after the announcement of recent buy trades is more significantly different from the non-announcement scenario than is the bid-ask spread after the announcement of recent sell trades

Table 6.5. Event study results: Buys versus Sells

Sample	Number of events	Number of firms	Overall t-test (p-value)	Number of events individually significant at 5%*	% of all events individually significant at 5%*
Buys	1447	349	0.002	179	0.12
Sells	1162	333	0.048	121	0.10
Both**	16	13	0.369	3	0.19

Sample	Average R^2	Average Adjusted R^2	Number of events where Shapiro-Wilks p>0.05	% of events where Shapiro-Wilks p>0.05
Buys	0.206	0.101	771	0.53
Sells	0.213	0.109	692	0.60
Both**	0.164	0.049	9	0.56

** An event is considered individually significant when for that event, analysed in isolation, the bid-ask spread after the event is significantly different (at 5 percent) from its predicted value. That is, where t-testing of the difference yields a value t>1.96*

*** Events where there where publications of both Buy and Sell trades*

Abnormal spreads are significant for both buys and sells. However, as expected, by restricting the sample to buys and sells for separate analyses, the evidence suggests that significance is stronger in the case of buys. We can hence reject the null hypothesis of Hypothesis 8. For a limit order trader, this implies that the risk of adverse selection in the market is stronger when an insider wants to purchase stock in his/her own company, or when the limit order trader has an open sell order.

Our final hypothesis concerned liquidity. A crude proxy for liquidity is the share listing on the Stockholm OMX stock exchange, where the "A-list" includes larger and

more liquid shares than the "O-list". Trades in shares not listed on the Stockholm OMX exchange are excluded:

Hypothesis 9:

H_0: The bid-ask spread after the announcement of recent insider trades in an illiquid stock is not more significantly different than is the bid-ask spread following the announcement of recent insider trades in a liquid stock

H_1: The bid-ask spread after the announcement of recent insider trades in an illiquid stock is more significantly different than is the bid-ask spread following the announcement of recent insider trades in a liquid stock

Table 6.6. Event study results: Liquidity

Sample	Number of events	Number of firms	Overall t-test (p-value)	Number of events individually significant at 5%*	% of all events individually significant at 5%*
A-list	687	93	0.002	79	0.11
O-list	1659	244	0.027	186	0.11

Sample	Average R^2	Average Adjusted R^2	Number of events where Shapiro-Wilks p>0.05	% of events where Shapiro-Wilks p>0.05
A-list	0.188	0.083	278	0.40
O-list	0.214	0.110	1009	0.61

* An event is considered individually significant when for that event, analysed in isolation, the bid-ask spread after the event is significantly different (at 5 percent) from its predicted value. That is, where t-testing of the difference yields a value t>1.96

We note that abnormal spreads are more significant for relatively more liquid stocks. This is against expectations and not predicted by theory. Accordingly, we cannot reject the null hypothesis. This implies that, given data and constraints, the limit order trader in Sweden faces a greater risk of adverse selection when trading in more liquid markets. Again, such results should be viewed with caution.

Further to the results above, additional test results from the event study are presented in Appendix III.II. In brief, these results indicate that bid-ask spreads differ more significantly for larger insider trades and trades in firms with larger market capitalisation. Whilst the result regarding market capitalisation appears odd, it does cohere with the results relating to Hypothesis 9, above.

6.3 Comparison of Event Study and Cross-Sectional Results

Thus far, our focus has been to give a detailed analysis of the results from each study. However, a comparison of the results from our event study and cross-sectional analysis can no doubt improve the explanatory power of our study. Securing coherent results using different econometric methods would add a measure of robustness unattainable using one methodology in isolation.

6.3.1 Methodological Differences

It is worthwhile reiterating the key difference between cross-sectional and event study methodology. The event study captures the effect of an event using time-series regression to calculate "normal performance" against which observed values are measured. Any abnormality between observed values and the estimated normal performance is t-tested, first on an individual per-event basis and then on an overall level where a t-test is applied to the aggregated abnormalities of several events. In the latter case, a *p*-value is obtained to measure the significance of abnormality within that sample or sub-sample.

The cross-sectional regression analysis attacks the problem from a different angle. The focus is no longer on the individual event. Instead, the analysis attempts to explain the permanent effect on firms of observed differences. Furthermore, the use of panel data allows us to capture unobserved effects that differ between cases but are constant over time (using Fixed Effects Estimation).

The different outsets of the two techniques imply the results are not fully comparable. Instantaneous effects that are temporary in their nature should not be expected to leave a permanent impact unless events are so evenly spaced that they virtually overlap. In our study, the publication of insider trading data is unlikely to exhibit this feature. If in our case there are permanent effects, these are likely to exist as market participants adapt their general behaviour to the time-constant insider trading characteristics of the different firms.

6.3.2 Full sample significance

Both studies pose some version of the general question "Does insider trading impact the bid-ask spread"? Using the full sample in the event study, we conclude there is a

very significant (p=0.000) deviation of the bid-ask spread following the publication of insider trading information. To measure the contribution of insider trading to the mean yearly spread, we introduce the variables *no_trades* and *qu_trades* in two separate cross-sectional studies. Whether insider trading is measured in instances or quantities turns out to make no difference: we can conclude that insider trading yields a small (0.023) but highly significant (p=0.000) increase of the mean bid-ask spread. The two results hence reinforce each other: insider trading has both a temporary and permanent impact on the bid-ask spread. Formally, this is expressed in the rejection of the null hypothesis for both hypotheses 3 and 6.

It is interesting to consider the implications of these results given the market microstructure present on the Swedish exchanges. On a quote-driven exchange we could expect to see both temporary and permanent effects of insider trading as a monopoly market-maker adjusts his quoted spread to account for the risk of trading against informed counterparties. On an order-driven exchange the situation is less transparent, as the theoretical understanding of the price formation process is simply less developed. Unlike market makers, limit order traders are not required to accept both sides of a trade, or rather, post both buy and sell orders. As a consequence of this the aggregate spread may be a function of the diverse actions of many. Temporary bid-ask effects could again be explained through fear of trading against a better informed party. Permanent effects could also be explained in this fashion – but only as long as the bulk of a share's liquidity stems from traders acting as liquidity providers. We should expect to see a smaller permanent effect if the bid-ask spread is instead formed by market agents who enter the market pre-committed to buy or sell for purposes other than supplying liquidity. Further research would be required to test hypotheses related to these issues.

6.3.3 Buys versus Sells

Turning to buys and sells, we have analysed the two types of trades separately using both event study and cross-sectional methodology. Our expectation – that buys should yield more pronounced effects than sells – should apply to both studies. As it turns out, the results of the two studies conflict. The event study confirms our hypothesis; buys are indeed more significant than sells. The cross-sectional study shows indicates that instances of insider selling is a more important contributor to mean spreads than

is insider buys. When insider trading is measured in terms of quantities, however, the impact of sells is significant but virtually indistinguishable from zero (0.000).

6.3.4 Types of Insiders

Investigating trades by different types of insiders yields no significant results at all in our cross-sectional regressions. This holds true using both instances and quantity measures of insider trading, and indeed also when decomposing the analysis into buys and sells. Looking at sub-samples of the event study, we do however find noticeable differences. Publications of trades by company Presidents yield more significant deviations than do trades by company Vice-Presidents and large shareholders.

7 CONCLUSION

The set purpose of this research was twofold. Firstly, the authors wished to determine if different patterns of insider trading resulted in a permanent and significantly different bid-ask spread of a market in general. Secondly, the authors wished to explore the possibility that particular cases of insider trading would result in expected and temporary deviations to the bid-ask spread.

In the general case, the authors utilised cross sectional regression techniques and this process was rather less successful. There was evidence that insider trading is indeed a significant variable in explaining bid-ask spreads. However, this evidence was not as strong as had been expected, nor as strong as one would have liked. Additionally, the authors could not reject several of the null hypotheses that they had expected to reject. There was no evidence to suggest that buy trades are more significant in determining the bid-ask spread than are sell trades. Also, the authors were unable to verify the proposition that trades by certain kinds of insiders are more significant in determining the bid-ask spread than are others. These results are disappointing.

In the examination of specific examples, the authors employed an event study methodology and found support for several of the hypotheses that were submitted, in accordance with theory. Namely, there was support for the proposition that the spread following insider trading is significantly different to the spread in a normal scenario. There was also support for the proposition that spreads following trades by certain insiders, who are perceived to be more informed than others, are wider than spreads following trades by those less informed traders. Furthermore, there was support for the proposition that buy trades executed by insiders are more informative than sell trades executed by insiders. These results imply that the risk of adverse selection for the limit order trader is greater when informed traders, or insiders, are active in the market; but that they are at particular risk when insiders are buying or when the insider is of a certain class. In contrast, the data indicated that one hypothesis should be rejected – the hypothesis that the spreads in relatively illiquid securities following an insider trade are not wider than spreads in relatively liquid securities. As stated earlier, the possibility that spreads of more liquid securities are wider than those of less liquid securities is intuitively and theoretically incorrect and the authors expect

this result to be an anomaly. Nevertheless, the results of the event study were broadly successful.

The results of our research were partially in concert with a priori expectations. Results following events had largely been as expected, reinforcing theory. However, there seems to be little evidence that these same factors are suitable as explanations for the size bid-ask spread over a prolonged period of time.

8 SUGGESTIONS FOR FURTHER RESEARCH

There are many ways that this study may be extended and improved in order to allow for a better understanding of how asymmetric information affects the limit order traders of Sweden's order driven exchanges, and order driven exchanges in general. This may involve the use of continuous data, better measures of idiosyncratic risk, an extension of the event study in order to allow for better control of the data samples, and a larger discussion of the tendency for insiders to hide their trading on those days with heavy trading volume.

As we acknowledge, our study suffers from the possibility that all evidence of asymmetric information has dispersed by the time the market closes. This issue could be circumvented by continuous data. Such data would serve two purposes. Firstly, it would allow the construction of a more accurate "normal" spread due to the greater sample size. Secondly, it would allow the identification of the actual spread immediately following the announcement of the insider trade, and allow one to identify how quickly the abnormal spread decays.

As we also acknowledge, our measure of idiosyncratic risk is poor. A better measure would allow us to construct a more accurate bid ask spread by virtue of having accounted for a larger proportion of its composition. Again, this would allow us to more accurately identify the normal spread of each stock, and thereby more accurately measure how much the abnormal spread deviates from this at the time of the announcement.

Thirdly, it would be preferable if the current event study methodology could be extending to allow for better control of samples against each other. In this study we have selected, examined and drawn conclusions from different sets of individual event regressions. However, there is a risk that our results are misleading as subsets such as "buys" and "trade announcements by presidents" may overlap and that influences factors are not sufficiently isolated.

Finally, further investigation of the tendency of insiders to trade on those days with large volume would expand the research and add much explanatory power. This

would enable the researcher to identify if spreads are significantly different on high volume days prior to trading by insiders, and observing the difference between spreads on these days and spreads on the day of announcement that follows such days.

In all of these cases, the researcher would be able to gain a great insight into the problems of asymmetric information facing limit order traders in Sweden in particular. Additionally, such research would provide significant insight for limit order traders on other order driven markets across the globe.

APPENDIX I: GLOSSARY

Adverse selection: A situation where sellers have information that buyers don't (or vice versa), and where the informed party exploits this asymmetry in information to his own advantage.***Insider:*** A person who has knowledge of, or access to, valuable non-public information about a corporation. Legal definitions vary; the Swedish regulations are discussed in *Section 2.3* above.

Asymmetric Information: A situation where information available to some people, but not to others.

Insider information: Information about a company's activities that has not been disclosed to the public and which may potentially impact its share price. The legal definition applied in Sweden defines insider information as *"information on a non-publicised or not generally-known circumstance that is likely to significantly affect the price of financial instruments."*

Insider trading: The buying or selling of a security by an insider in that company.

Informed trading: The buying or selling of a security by someone who has access to material, non-public information about the security. Where a strict legal definition is used for "insider", informed trading may be used to refer to a situation non-insiders acquire and trade on insider information.

APPENDIX II: VARIABLE DEFINITIONS

Variables Used in the Cross-Sectional Study

mean_spread:	The yearly mean of the daily bid-ask spread, where the daily spread is defined as (closing ask-closing bid)/2
mean_close:	The yearly mean of the daily closing share price
sd_close:	The yearly standard deviation of the daily closing share prices
mean_volume:	The yearly mean of the daily share turnover, measured as the amount of shares.
no_buys:	Number of insider* buys (i.e. instances of buying)
no_sells:	Number of insider* sells
no_trades:	The number of insider* buys, plus the number of insider sells
qu_buys:	Quantity of shares purchased by insiders*
qu_sells:	Quantity of shares sold by insiders*
qu_trades:	The quantity of shares bought by insiders, plus the quantity of shares sold by insiders*
no_pres_buys:	The number of purchases by company Presidents
no_pres_sells:	The number of sells by company Presidents
no_pres_trades:	The number of buys by company Presidents, plus the number of sells by company Presidents
qu_pres_buys:	Quantity of shares purchased by company Presidents
qu_pres_sells:	Quantity of shares sold by company Presidents
qu_pres_trades:	The quantity of shares bought by company Presidents, plus the quantity of shares sold by company Presidents
no_vp_buys:	The number of purchases by company Vice-Presidents
no_vp_sells:	The number of sells by company Vice-Presidents
no_vp_trades:	The number of buys by company Vice-Presidents, plus the number of sells by company Vice-Presidents
qu_vp_buys:	Quantity of shares purchased by company Vice-Presidents
qu_vp_sells:	Quantity of shares sold by company Vice-Presidents
qu_vp_trades:	The quantity of shares bought by company Vice-Presidents, plus the quantity of shares sold by company Vice-Presidents
no_owner_buys:	The number of buys by large owners (>5%) in the company
no_owner_sells:	The number of sells by large owners (>5%) in the company
no_owner_trades:	The number of buys by large owners (>5%) in the company, plus the number of sells by large owners (>5%) in the company
qu_owner_buys:	Quantity of shares purchased by large owners (>5%) in the company
qu_owner_sells:	Quantity of shares sold by large owners (>5%) in the company
qu_owner_trades:	The quantity of shares bought by large owners (>5%) in the company plus the quantity of shares sold by large owners (>5%) in the company

* where insider is defined as a President, Vice-President or large owner

APPENDIX III: SUPPLEMENTARY TESTING

III.I Supplementary Testing of Permanent Asymmetries

Table II.I.I Cross-sectional study: Buys versus Sells in terms of instances

Instances					
	no_buys	no_sells	mean_close	sd_close	constant
Coefficient	-0.002	-0.013	0.023	-0.023	-0.502
p-value	0.696	0.084	0.000	0.000	0.000
R2 within	0.452				
R2 between	0.347				
R2 overall	0.378				

Dependent: mean_spread

Table III.I.II Cross-sectional study: Type of insider in terms of instances

Instances						
	no_pres	no_vp	no_owner	mean_close	sd_close	constant
Coefficient	-0.003	0.025	0.003	0.023	-0.023	-0.595
p-value	0.918	0.621	0.796	0.000	0.000	0.000
R2 within	0.452					
R2 between	0.347					
R2 overall	0.378					

Dependent: mean_spread

Table III.I.III Cross-sectional study: decomposing sells into Pres/VP/owners

Instances						
	Pres. sells	VP sells	Owner sells	mean_close	sd_close	constant
Coefficient	-0.001	0.019	-0.015	0.023	-0.023	-0.577
p-value	0.984	0.772	0.478	0.000	0.000	0.000
R2 within	0.452					
R2 between	0.347					
R2 overall	0.378					

Quantities						
	Pres. sells	VP sells	Owner sells	mean_close	sd_close	constant
Coefficient	1.36e-07	1.21e-07	1.86e-08	0.023	-0.023	-0.571
p-value	0.320	0.913	0.477	0.000	0.000	0.000
R2 within	0.452					
R2 between	0.452					
R2 overall	0.378					

Dependent: mean_spread

Table III.I.IV. Cross-sectional study: decomposing buys into Pres/VP/owners

Instances						
	Pres. buys	VP buys	Owner buys	mean_close	sd_close	constant
Coefficient	3.40e-05	0.053	0.019	0.023	-0.023	-0.605
p-value	0.999	0.569	0.314	0.000	0.000	0.000
R2 within	0.452					
R2 between	0.348					
R2 overall	0.378					

Quantities						
	Pres. buys	VP buys	Owner buys	Mean_close	sd_close	constant
Coefficient	2.43e-08	8.53e-07	8.53e-07	0.023	-0.023	-0.586
p-value	0.664	0.649	0.617	0.000	0.000	0.000
R2 within	0.452					
R2 between	0.347					
R2 overall	0.378					

Dependent: mean_spread

III.II Supplementary Testing of Temporary Asymmetries

Table III.II.I. Event study results: Trade size

Sample**	Number of events	Number of firms	Overall t-test (p-value)	Number of events individually significant at 5%*	% of all events individually significant at 5%*
Trade size Q1	659	255	0.616	77	0.12
Trade size Q4	656	248	0.153	85	0.13
Sample**	Average R^2	Average Adjusted R^2	Number of events where Shapiro-Wilks p>0.05	% of events where Shapiro-Wilks p>0.05	
Trade size Q1	0.213	0.109	384	0.58	
Trade size Q4	0.206	0.100	368	0.56	

** An event is considered individually significant when for that event, analysed in isolation, the bid-ask spread after the event is significantly different (at 5 percent) from its predicted value. That is, where t-testing of the difference yields a value t>1.96*

*** Trade size Q1 includes the smallest 25% of all insider trades; Q4 includes the largest 25%.*

Table III.II.II. Event study results: Firm size

Sample**	Number of events	Number of firms	Overall t-test (p-value)	Number of events individually significant at 5%*	% of all events individually significant at 5%*
Firm size Q1	651	205	0.346	95	0.15
Firm size Q4	651	134	0.066	72	0.11
Sample**	Average R^2	Average Adjusted R^2	Number of events where Shapiro-Wilks p>0.05	% of events where Shapiro-Wilks p>0.05	
Firm size Q1	0.228	0.120	444	0.68	
Firm size Q4	0.179	0.074	239	0.37	

** An event is considered individually significant when for that event, analysed in isolation, the bid-ask spread after the event is significantly different (at 5 percent) from its predicted value. That is, where t-testing of the difference yields a value t>1.96*

*** Firm size Q1 includes the trades in the smallest 25% (market cap) of the firms in the sample; Q4 includes the largest 25%.*

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