Stockholm School of Economics
Master Thesis in Finance

Pre-Bid Run-Ups and Insider Trading

- Evidence from the Swedish stock market

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Abstract

We have studied a data sample of 191 cases of public takeover bids on Swedish listed companies. The goal of this study was to, by firstly studying the price volume dynamics of the target firm, try to determine if a potential price run-up in the target company stock price prior to the announcement was caused by illegal insider trading, or by sophisticated investors carrying out careful analysis of public information. In a second step we also examined the relationship between several factors that potentially could cause an information leakage and the amount of abnormal return generated prior to the announcement, relative to the abnormal return generated upon the announcement. Our main findings are that although we can see a significant price run-up ahead of the announcement date, we cannot find any signs of illegal insider trading, but rather conclude that the observed run-ups are caused by sophisticated investors trading on public information.

Key Words: Run-Ups, Insider Trading, Event Studies, Abnormal Returns, Abnormal Volume

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1. Introduction

The aim of this paper is to firstly study the returns and traded volumes of Swedish listed firm's stocks in the period running up to announcements of takeovers of said firms, in order to determine whether or not the observed patterns are an effect of illegal insider trading, or legal market anticipation. Secondly we will try to determine whether or not several factors surrounding a takeover announcement increase the likelihood that a portion of the abnormal return associated with the takeover will be generated prior to the announcement date.

We examine data of 191 takeovers on the Stockholm Stock Exchange (henceforth abbreviated SSE) that occurred between 1998 and 2008. International studies have in many cases acknowledged the pre-bid reaction of stock prices, implying that people knowledgeable of the coming takeover try to profit from this knowledge by trading upon it (Kyle (1985), Admati & Pfleiderer (1988), Llorente et al. (2002), He & Wang (1995), King & Padalko (2005)).The pivotal question is thus whether or not this knowledge stems from possession of insider information, or if it stems from sophisticated analysis of public information. The illegality of insider trading in Sweden is usually motivated with that, it is hurtful to the trust needed in the capital markets for them to function properly and evolve in a favourable manner (prop. 1990/91:42 p.38). This is because as financial markets are characterised by large informational asymmetries (Leland & Pyle (1977), the fact that some participants are known to be more well informed, will lead other participants that know themselves to be less informed to shun the market, or at least demand a higher return, King & Padalko (2005)). This will in turn lead to higher costs of capital for firms (Bhattacharya and Daouk (2002)).

Cornell and Sirri (2002) study Anheuser-Busch's tender offer for NYSE listed Campbell Taggart in 1982, with data based on court records from the consequent prosecution, i.e. a known case of insider trading surrounding a takeover. They can easily identify the trades made by people who were later recognized as insiders that drove up the share price. However, they also conclude that traders that were not regarded as insiders made profits by trading the same stock at the same time, which is not illegal. Thus two groups of investors make generic trades in the same stock, but only one can be proven to be illegal ex post. This shows that it is very difficult for authorities to differentiate between what is illegal insider trading, even after a takeover has been announced and the share price and traded volume have both experienced run-ups prior to the announcement, and what is legal trading.

This is the reason why this is interesting to study. The simple fact that the stock price moves before the announcement does not imply that traders who act during this run-up are involved in illegal activities. King and Padalko (2005) analyze price run-ups and define insider trading as periods of abnormal trading volume coinciding with abnormal returns, to be able to distinguish

insider trading from "normal" trading. We will base much of the analytical methodology in the first phase of this paper on their research. Their study is done on the Canadian market, whereas our study will focus entirely on the Swedish market.

Furthermore, we will in a second phase examine the data to see if we can find any correlation between a number of factors that could possibly increase the likelihood of a "leak",[1] and the risk that a portion of the abnormal return associated with the takeover will be generated ahead of the takeover announcement. The factors that will be considered are: i) the number of firms that are involved in the takeover transaction, and that therefore are in possession of the insider information; ii) Whether or not the transaction is cross border or between two domestic firms; iii) Whether or not the transaction is financed through stock or cash, or if it is a mixed deal; and finally iv) if there has been any media speculation prior to the announcement of the takeover. To our knowledge this has not been studied before on the Swedish market.

1.1. Definition of Insider

Illegal insider trading, and who is to be regarded as an insider, is in Sweden governed by Lag (2005:377), also known as *Marknadsmissbrukslagen (MmL)*. This is however in Swedish and we will not attempt to translate it due to the inherent risk. For the purpose of this paper we therefore choose to use the following definition of an insider:

- *A person in possession of non-public information that can significantly affect the price of financial instruments.*

An insider can be a person involved in the day-to-day activity of a firm, for instance a CEO or CFO, but in the context of a takeover, it also extends to advisory firms (for instance investment banks, consultancy firms), law firms etc.

An insider trade is defined as follows:

- *Trading by an insider whilst the information remains non-public.*

1.2. How to understand our Paper

The first phase of the paper will be structured as follows. In order to be able to identify illegal insider trading, we will examine two different rationales, or hypotheses for trading. The two hypotheses differ in their interpretation of the notion "private information", and therefore also their predictions of the market's reaction to said information.

[1] A "leak" will in this context be defined as having occurred if we can find a relationship between the portion of the cumulative abnormal return that occurs before the announcement date (known as run-up index) and the number of firms in possession of insider information.

The first rationale- or hypotheses for trading that is reviewed is the strategic trading hypothesis, which was developed by (Kyle (1985) and Admati and Pfleiderer (1988)). This hypothesis distinguishes two or more kinds of traders. Common to all studies on the strategic trading hypotheses is that they contain an informed- or insider trader who is in possession of insider information, and also at least one other type of trader, the "noise"- or "liquidity" trader.

The second rationale- or hypothesis for trading that will be used in our analysis is the competitive trading hypothesis (Wang (1994), He and Wang (1995) and Llorente et al. (2002)). The competitive trading hypothesis assumes heterogeneity between market participants, and although traders can be more or less well informed, no one is assumed to be in possession of insider information. This is the key difference to the strategic trading hypothesis.

At this point it is worth to highlight that the two different rationales- or hypotheses for trading, the strategic- and the competitive trading hypothesis, are based on conclusions drawn in studies on data gathered in markets other than the Swedish market. Nonetheless, we will still apply these rationales- or hypotheses for trading as a theoretical framework in our study which is conducted on data of the Swedish market. This is based on the assumption that the observed characteristics are valid for the Swedish stock market as well, and are as such not confined to the specific market in which each respective study was conducted.

1.3. Value addition of our study

This is where we believe that our study adds value since, 1) the hypothesis based study to determine whether or not illegal insider trading has occurred, has to our knowledge never been carried out on Swedish data, and 2) we add another dimension by examining whether or not there is a relationship between a number of factors that could potentially contribute to the likelihood of a "leak" of insider information ahead of a takeover, and the portion of the cumulative abnormal return that occurs ahead of the announcement of the public takeover. This is useful since, as documented in the study by Cornell and Sirri (2002), even with cases of ex-post know cases of insider trading it is hard to, with existing models, differentiate between what is legal and what is illegal trading. Therefore, by two different methodologies, we feel that we decrease the risk of drawing false conclusions based on errors or shortfalls in the theoretical framework used. However, we realize that such risks are not eliminated.

1.4. Findings and Conclusions

The main conclusion that we reach in our paper is that although we can see a significant price run-up ahead of the announcement date, we do not find the data to be supportive of illegal insider trading, nor can we establish that any of the factors that we tested for, significantly

affects the likelihood that a portion of the return associated with a takeover will occur before the announcement. Therefore we conclude that the observed run-ups are caused by sophisticated investors trading as opposed to insider traders.

1.5. Structure of the Paper

The paper will be structured in the following manner. First we will briefly touch upon the regulatory climate surrounding insider information and illegal trading in Sweden. This section will be kept as short as possible and presented facts will only be included to the extent that they are deemed vital to the settings of the analysis.

Secondly, we will develop the possible theoretical explanations for the potential pre-bid run-ups. Under this heading both the strategic and the competitive trading models will be outlined in detail, in order to be able to construct a theoretical framework with which we can interpret the results we arrive at. We will in a second phase develop the economical rationale for a number of factors that increase the risk of a leak of insider information. The aim is to examine whether or not these factors contribute to a significant portion of the pre-bid run-up occurring before the announcement day.

In the following section we will present the data sample that we have used to base our analysis on. We will also outline how we arrived at our data sample.

Section five will, on the basis of the theoretical background all ready developed, present the model that we will use to test our pre-bid run-ups for evidence of illegal insider trading. In this section we will also regress the so called run-up index of a company subject to a public takeover offer, to the factors outlined above that may contribute to an increased risk of a leak of insider information. The goal is to be able to determine if there is any relationship between the run-up index and the factors.

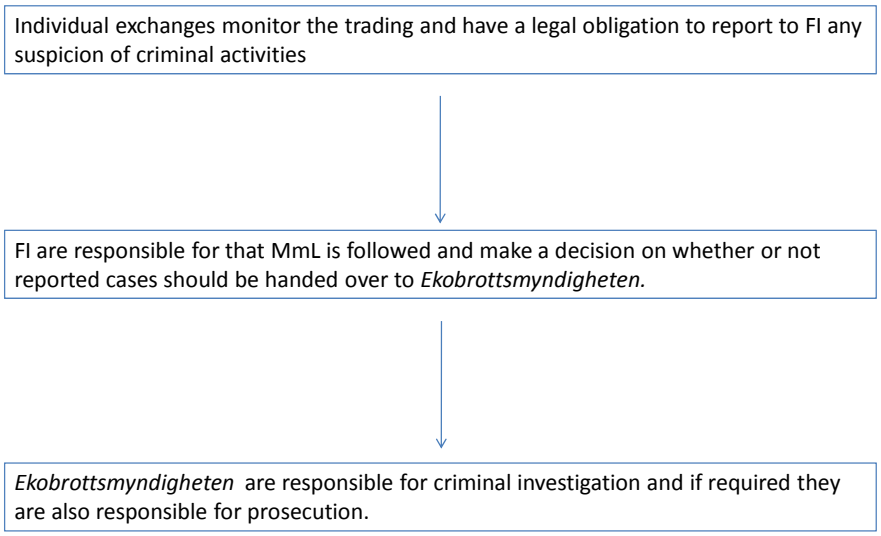
In the sixth and second-to-last section, we will summarize the results of the study and also try to draw conclusions from the results. Finally, in the seventh and last section, we will try to stress test the reasonability of our conclusions and the assumptions that these conclusions are based on, and also try to suggest possible areas of further research.

2. Legal Framework

The law prohibiting insider trading in Sweden is as of 2005 *Marknadsmissbrukslagen (MmL)*, also known as lag (2005:377) *om straff vid handel med finansiella instrument*. MmL defines what is regarded as insider information, and consequently who is regarded as an insider, and therefore also what is to be regarded as insider trading. The process of enforcing MmL is in Sweden split into three steps. Firstly, the different exchanges have a legal obligation to monitor the trading and report all suspicious activities to the Swedish SEC called *Finansinspektionen* (henceforth abbreviated FI).

Figure 2

The legal process of dealing with suspected insider trading in Sweden.



FI is the institution that has the responsibility for making sure that the MmL is followed (MmL 16§), by issuing licenses and formulating rules and also enforcing MmL. Investigation and prosecution of suspected acts of insider trading is in turn performed by Ekobrottsmyndigheten which is the section of the police and the prosecutor's office that is responsible for economic crimes (Borg (2006)). For further clarification please see figure 2 above which outlines the different offices and their responsibilities.

In order for legislation to be effective, there must exist a legal framework to enforce it (Borg (2006)). This brief description of the legal entities enforcing the prohibition against insider trading is meant to outline the legal framework in Sweden. For the purpose of this study we will assume that the Swedish legal framework is functioning ex ante. This is an important assumption since if the regulatory framework where to be considered impotent by the traders in the market, the question of what is legal and illegal insider trading would become mote.

3. Theoretical Framework

3.1. Theoretical rationale for run-ups

Looking into studies of known insider cases, insider trading is shown to cause several different effects. For instance, trades based on insider information can lead to "price discovery", i.e. that private information is spread in the market when insiders trade. This is in some cases used as an argument against too extensive market regulation, since, in this context, insider trading will lead to more informed prices (Meulbroek (1992)). This has however been argued against, on the grounds that in later studies using the same data but more advanced methodology (inclusion of a new variable that captures the effect of volume from buying of non-insiders), the trading by insiders and non-insiders have been found to have undistinguishable effects on the stock price (Chakravarty & McConnel (1999)). This implies that insider trading, compared to "normal trading", does in fact not lead to more informed prices, and therefore the argument falls.

Also, insider trading has been shown to have ambiguous effects on the volume of traded shares as well. For instance, certain studies have shown that when insiders trade, this increases the number of orders in the market, and does not affect liquidity, in the context that it does not lead to increased bid-ask spreads (Cornell & Sirri (2002)). However other studies have provided evidence of the opposite i.e. that in certain markets, insider trading can be detected by market makers, who therefore adjust their bid and ask prices to this new information. The adjustment of offered prices starts with a withdrawal of existing orders when the market maker realizes that he or she is missing something. Then, the new orders are placed. However they are not placed instantaneously, but require a short period of reflection on behalf of the market maker. This means that just after the realization by the market maker that there is insider trading going on, liquidity is reduced temporarily (Fishe & Robe (2004)). In this context, insider trading in fact decreases liquidity in the market. Thus even when studying relatively uniform data (cases of known insider trading), the effects on price and volume from insider trading are not completely clear.

More generally speaking however, the price run-up can be triggered by one of two factors. The first possible factor is that there is an actual "leak" of inside information into the market. Price run-ups triggered by "leaks" of insider trading are analytically represented by the strategic trading hypothesis. The other rationale- or hypothesis for trading that will be examined in this paper is the competitive trading hypothesis, a theoretization of the market anticipation hypothesis (both of these two hypothesises will be described in more detail the following two sections). In essence, the competitive trading hypothesis claims that sophisticated market

players are able to correctly predict pending takeovers through analysis of public information. Thereby it closely aligns itself with the semi-strong form of efficient market hypothesis; that is that prices fully reflect all available public information (King & Padalko (2005)).

The reason why we will go through both of these hypotheses is that they are both representing the same thing, namely informed trading. However the pivotal difference is that whereas one is illegal informed trading the other is legal informed trading. To be able to distinguish between the legal and illegal trading, we therefore need a theoretical context that allows us to do so with a satisfying level of objectivity.

Figure 3

Rationale for trading and respective hypothesis

Illegal Insider Trading	Sophisticated Investors
Strategic Trading Hypothesis	Competitive Trading Hypothesis

3.1.1. Illegal Insider Trading

As earlier mentioned, illegal insider trading is formally modeled by the strategic trading hypothesis. Two papers on the strategic trading hypothesis are Kyle (1985) and Admati & Pfleiderer (1988). Both studies develop a hypothesis with three different types of traders, and two different motives for trading. The first kind of trader is the insider who is singlehandedly in possession of private information and who tries to earn maximal returns by exploiting this information. The second kind of trader is the noise- or liquidity trader who is uninformed and trades for reasons not directly related to potential return of an asset, such as portfolio rebalancing, etc. (Admati & Pfleiderer (1988)). Finally, there is also a market maker who sets prices based on order flows such that the market clears, where the clearing price implies market price discovery (Kyle (1985), King & Padalko (2005)). According to Admati & Pfleiderer (1988) the two different motives for trading that are "widely recognized as important: information and liquidity", divide traders into two groups; on the one hand the insider trader, and on the other hand the liquidity trader and the market maker. It is important to distinguish between the two.

A common attribute that is the same for both the insider trader and the liquidity trader is that both prefer to trade when the market is "thick" ("thick" in this context refers to the order flow and signifies periods when liquidity is such that individual trades do not move prices) (Admati & Pfleiderer (1988)). The rationale for this is that if traders trade in periods of high liquidity, they minimize their impact the order flow, and therefore also on the quoted prices set by the market maker. For the insider trader this delays price discovery and thus protects their information advantage from spilling into the market (King & Padalko (2005)). For liquidity

traders, whose trades are generally reactive in nature (such as hedging, rebalancing etc. following price movements), this is probably best described through an example.

Say for instance that stock A has gone down in price, and is therefore an attractive hedge. Thus the liquidity trader decides to buy the stock. However, if he or she has a great impact on the quoted price due to poor liquidity (the opposite of a "thick" market) this will mean that the hedge will not work, since the price at which the stock will be obtained will be higher than it was at the time that the decision to buy the stock because of its low price was taken. For this reason, liquidity traders prefer to trade in periods when the market is thick as well.

Furthermore, looking into the kinds of people that are defined as insiders (corporate leadership, financial intermediaries involved in the transaction), these are not people who trade stock on a regular basis (in many cases, such as corporate finance personnel within investment banks, they are prohibited from trading stocks). Thus when insiders try to exploit their private information by trading, this will be incremental volume in the market (i.e. extra volume on top of the "normal" traded volume). The conclusion is therefore that insider trading will take place in periods of high volume, and will lead to abnormal volume (Admati & Pfleiderer (1988)).

An insider who seeks to exploit his or her private information ahead of a takeover will be a buyer of a stock in order to gain a return from the premium between the prevailing market price and the takeover price (we assume here that the insider does not place any sell orders to cover his or her actions). Thus contrary to the liquidity trader, the insider's trades will always be positively correlated between periods (Kyle (1985)). This is key, since if traders change from being buyers to being sellers between periods ambiguously like the liquidity trader (remember the case of the hedge), this means that the stock price will fluctuate up and down between different days, but over time, it will remain relatively unchanged. If on the other hand, the traders are consecutively buyers, such as the insider traders, this will drive up the market price because of the trades being positively auto correlated, leading to price discovery and abnormal returns over time. The conclusion is therefore that insider trading will lead to abnormal returns in the period ahead of the announcement (King & Padalko (2005)).

Since insiders will only trade in periods of high volume (when the market is "thick" in order to protect information), and since their volume is incremental to that of the "normal" market volume (since they insiders do not usually trade stock), this means that insider trading will lead to abnormal volume. Furthermore, since the insider's trades are positively correlated between periods, which in turn leads to price discovery and abnormal returns, this implies the following: Insider trades are characterised by abnormal volume coinciding with abnormal returns. "Abnormal returns that are not accompanied by abnormal volume (or vice versa) would constitute a rejection of this hypothesis" (King and Padalko (2005)).

It is fair to assume that insiders trading illegally on private information will implement a scheme for trading that minimizes the risk of being caught, and at the same time it maximizes returns (King and Padalko (2005)). Therefore we expect insiders to try and space their trades through time. The argument for doing so is the same as the one for trading when the market is "thick", i.e. since their trades are positively correlated through time, this will limit their impact on the quoted price, and thus help protect their information. For this reason, we expect the trading (when characterized by insider trading) in the stock to exhibit spurious cases of abnormal returns that occur simultaneously as abnormal volumes, in the period ahead of the takeover.

An important point here is that the exact time frame in which these trades are expected to occur for it to be deemed illegal insider trading is not clearly defined (King and Padalko (2005)). For this reason we will examine several time frames. As this will be consistent for all tests, we will return to this in further detail under a separate heading. Formally however, the pattern of trading that we expect is spurious cases of abnormal volume coinciding with abnormal returns a long time prior to the announcement, and little or no cases just prior to the announcement, since the risk of exposure is considered the greatest during this period.

As insiders are assumed to be profit maximizing, this implies that they will continue to trade until the marginal utility from further trade is equal to zero. In the setting of a takeover this implies that insiders will continue to trade until the market price more or less matches the expected takeover price, and thereby all of the insider's private information is incorporated into the quoted price. This way the insider ends up setting the quoted price (referred to previously as price discover). This also implies that there should not be any large reaction to the stock price upon announcement of the takeover, since this is not new information that needs to be incorporated.

The conclusion is therefore that insider trading leads to abnormal returns, due to positively autocorrelated trades, coinciding with abnormal volume, in the period far ahead of the announcement, and little activity just prior to the announcement as the risk of getting caught is the largest. Finally, upon announcement at the end of trading, no large impact in the share price should be seen since this information is already fully incorporated in the price.

3.1.2. Market Anticipation

The competitive trading hypothesis is the theoretization of the market anticipation hypothesis. This hypothesis involves two different types of traders, sophisticated and

unsophisticated traders.[2] All traders regardless of category are considered to posses' heterogeneous views on the market based on different information. This is also assumed to be a pre-requisite for trading to occur (Wang (1994)).

Under the competitive trading hypothesis, investors trade for one of two reasons: either for risk sharing, i.e. hedging (rebalancing portfolios), or to speculate on proprietary information.[3] The proprietary information differs from the illegal insider information in the sense that is based on analysis of public information, for instance speaking to equity research analysts, reading company announcements etc (King & Padalko (2005)).

The different reasons for trading lead to different patterns in the return of the stock. "Hedging trades generate negatively autocorrelated returns and speculative trades, based on proprietary information, generate positively autocorrelated returns." (Llorente et al. (2002)). The rationale for this is that when investors for instance buy a stock for speculative reasons, this drives up the price, leading to positive returns, which in turn reflects the positive proprietary information held by said investors. However, this proprietary information is not instantaneously fully reflected in the price (analogous with the notation used in the strategic trading model, this implies that there is not an immediate price discovery), but rather a small return is seen in several consecutive periods as the information becomes incrementally more and more impounded in the price (Llorente et al. (2002)). The reason that the information is not fully implemented in the price right away is that the observed prices are assumed to contain some unknown amount of residual uncertainty (we will come back to this shortly in more detail), and therefore do not solely portray the proprietary information held by informed investors. For this reason, there are incentives for investors to carry on trading several periods after the information was first received (this is a difference compared to traders who trade based on non-public insider information since they have no uncertainty about what the offer price will be in the coming takeover). Thus "speculative trades based on proprietary information (...) positively autocorrelated returns and serially correlated volume over a number of days (...) as the proprietary information about the stock becomes incorporated into the price" (King & Padalko (2005)).

Conversely, when a group of investors sell a stock as a hedge in one period, this does not reflect any proprietary information. In other words it does not imply anything about the expected future pay-off of the stock. Nonetheless it still drives down the price slightly. This in

[2] In the previous literature that we have studied, the two types of traders are known as informed and uninformed. However we choose here to use the same phrasing as King & Padalko (2005) in order to avoid confusion with the strategic trading hypothesis.
[3] In the context of the hypothesis this is denoted private information, but in order to avoid confusion with the strategic trading hypothesis we choose to call it proprietary.

turn causes investors who were happy to simply hold the stock at the prevailing price before the hedging occurred, to become buyers at this lower level. Therefore they buy in the subsequent period, which pushes the price back up, and thus leads to negatively autocorrelated returns (Llorente et al. (2002)).

The competitive trading hypothesis decomposes the value of a company's shares prior to a takeover announcement, into two parts. One part is a "fundamental" value and then there is also a residual uncertainty factor (He & Wang (1995)). The fundamental portion of the value is the part that becomes visible to investors through sophisticated analysis. The uncertainty factor is simply the residual part of the value, over which investors have no overview. This uncertainty is not revealed until the announcement day of the takeover, when the exact takeover price is announced (King & Padalko (2005)).

Obviously, the relative weights of these two portions in the stock value govern the conviction of the investors, and therefore also the aggressiveness of their trading. If there is little perceived uncertainty surrounding the bid, investors will speculate aggressively, and vice versa.

This pattern is clearly extrapolated in periods of high traded volume. "In periods of high volume, stocks with a high degree of speculative trading tend to exhibit positive return autocorrelation and stocks with a low degree of speculative trading tend to exhibit negative return autocorrelation" (Llorente et al. (2002)). Thus, the perceived uncertainty, or "low degree of speculative trading" is analogous with trading for risk balancing reasons, as opposed to trading on proprietary information (speculating). In other words if you have a relatively little amount of uncertainty in your stock value you will speculate on your fundamental value.

The key to understanding the volume/return dynamics of the competitive trading hypothesis lies in the heterogeneity between investors. As investors have different portions of fundamental value and residual uncertainty in their respective views on a company, there will exist a rationale for trading as long as there is no complete consensus as to the true value of the company. Remember though, a complete consensus will only exist upon announcement when the residual uncertainty portion disappears and fundamental values are aligned.

The last piece of the puzzle to understanding the volume/return dynamics of the competitive trading model lies in the information flow across time. When there is a long time left before the announcement date, investors have only their own fundamental value to rely on (i.e. they have no idea what fundamental value other investors are assigning a particular company). The prevailing uncertainty at this time is relatively large. Then as more and more trading occurs, this will act as a signalling factor to investors about the fundamental value of other investors,

which will serve to reaffirm their case and thus take a bite out of the residual uncertainty portion of the stock value (Llorente et al. (2002)).

We expect the following patterns in abnormal volume and abnormal returns from trading according to the competitive trading hypothesis. When there is a long time left till announcement, different investors will take different bets on the same stock, either to speculate or the re-balance/hedge their portfolios. Therefore, in the period far ahead of the takeover we expect no significant cases, and no clear pattern in abnormal returns and abnormal volumes due to the heterogeneous views on the "right" value of the company. This is in line with the reasoning about high degree of speculation leading to positive autocorrelation and low degree of speculation leading to negative autocorrelation. Then, as more and more information is revealed through trading, the uncertainty portion in the stock decreases leading to more and more aggressive trading. Therefore, just ahead of the announcement we expect to see both serially correlated abnormal volumes and positively autocorrelated abnormal returns as more and more people come to the same conclusion, thus both abnormal volumes and returns coincide just prior to the announcement.

But remember, although the residual uncertainty decreases just before the announcement, it never fully disappears until the actual announcement. This implies that all investors carry a residual uncertainty in their firm value until the announcement, when it disappears in an instant. Therefore, according to the competitive trading model, we should also expect significant abnormal returns (either negative or positive) and abnormal volumes upon announcement.

3.1.3. Summary of Hypothesises and Differences In-between

Thus to summarize the two theories we will present a number of hypothesises below, and the conclusions that we draw from accepting or rejecting a hypothesis. The hypothesis will be split into three different time frames: 1) Far ahead of the announcement, 2) Just prior to the announcement, and 3) At the announcement date. The hypothesises are displayed in table 3.1.3.

Table 3.1.3

Summary of the return & volume dynamics under the different hypothesis

Time to Announcement	#	Hypothesis	Insider Trading	Sophisticated Investors
Far Ahead	1	Abnormal Returns	Coinciding w/ Abnormal Volume	No significant cases
	2	Pattern of Abnormal Returns	Positively Autocorrelated	No Clear Pattern *
	3	Abnormal Volumes	Coinciding w/ Abnormal Returns	No significant cases
	4	Pattern of Abnormal Volumes	No Clear Pattern	No Clear Pattern
Just Prior	5	Abnormal Returns	No significant cases	Coinciding w/ Abnormal Volume
	6	Pattern of Abnormal Returns	No Clear Pattern	Positively Autocorrelated
	7	Abnormal Volumes	No significant cases	Coinciding w/ Abnormal Returns
	8	Pattern of Abnormal Volumes	No Clear Pattern	Positively Autocorrelated
Upon Announcement	9	Abnormal Returns	Insignificant Reaction	Significant Reaction
	10	Abnormal Volumes	Insignificant Reaction	Significant Reaction

** Assuming abnormal volumes are insignificant, otherwise we would expect negatively autocorrelated returns here.*

From table 3.1.3 we can see that the major differences between the two hypothesises lie in the reaction to the announcement, the relationship between abnormal returns and abnormal volumes, and the patterns and timings of the abnormal returns and abnormal volumes (King & Padalko (2005)).

3.1.4. Far Ahead and Just Prior

Since the time period in which the return/volume patterns are seen is important, we will, when examining the data for autocorrelation in returns and volumes, split the window into several periods. The way we split the window is slightly arbitrary, since none of the studies we have looked at (ex. Kyle (1985), Admati & Pfleiderer (1988), Llorente et al. (2002), He & Wang (1995), King & Padalko (2005)), have stated clearly what the exact time frame should be. Therefore, to be prudent, we have chosen several in an ad-hoc fashion. See the table 3.1.4 below for the exact dates we have chosen.

Table 3.1.4

Different cut-off points for how we choose to define what is to be considered as Far ahead, and what is to be considered as Just prior.

Over entire window	Far Ahead	Just Prior
[-60, 30]	[-60, -30]	[-30, 1]
[-60, -5]	[-60, -20]	[-20, 1]
[-60, 0]	[-60, -5]	[-20, 20]
[-60, 1]		[-20, 0]
		[-5, 5]
		[-5, 1]
		[-5, 0]
		[0, 1]

3.2. Regression of Factors Contributing to an Increased Likelihood of a "Leak"

Under this heading we will develop a number of factors that increase the risk of a leak of illegal insider trading. This methodology is based on the study by Jarrel and Poulsen (1989). We will here seek to explain the percent of abnormal return that takes place before the announcement of the takeover, the run-up index,[4] with a number of factors that increase the risk of a leakage of insider information.

3.2.1. Number of involved firms

The first factor that we will develop is the number of firms in possession of the insider information surrounding a takeover. The rationale is simple from a game theoretical perspective We start out by denoting the probability that you were the one who leaked the information as *prob.(leak)*. This probability is visible by everyone in the game. Assume the number of people in

[4] The price run-up index per firm I is defined as→ $Price\ run\ up\ index_i = CAR_i^{-60,-1} / CAR_i^{-60,1}$

the game who know a secret is $n = 2$. Then, if the secret leaks everyone will know who leaked it since there is a $prob.(leak) = 50\% = \frac{1}{n} = \frac{1}{2}$ chance that you spoke (either you leaked it, or you did not, which means that the other person did). However as the number of people increases $n \to \infty$ then the likelihood that you spoke grows very small $\frac{1}{n} = \frac{1}{\infty} = prob.(leak) \to 0$. Remember here, we assume insiders who trade illegally on insider information develop a scheme that minimizes the risk of getting caught. Therefore, as $prob.(leak) \to 0$, the risk also decreases. (Torun Lindholm, Interview). Thus we should expect to find more insider trading when there are a large number of firms involved in the takeover transaction. Although the following quote by Benjamin Franklin has no economical bearing, it summarizes why we think this is interesting to examine: "Three may keep a secret, if two of them are dead". We expect the sign of this factor to be positive.

3.2.2. Domestic or Foreign bidder

The next factor that we will look into is whether the transaction is between two companies from the same country, i.e. if it is a domestic transaction, or if it is between two companies from different countries, i.e. cross border. The rationale for looking into this is that cross border transactions involve certain variables that domestic transactions do not need to pay any attention to. For instance, Rossi and Volpin (2004) examine how firms acquire foreign governance when they conduct cross border M&A. Slemrod (1990) and Hines (1996) focus on international double taxation associated with cross border M&A. Therefore, we hypothesize that cross border M&A will be more complex than domestic transactions, and as such require a greater effort on behalf of the people involved in the transaction. This will either cause the transaction to require more manpower, i.e. a greater number of involved firms, or to simply take longer time to execute. The first effect is obviously captured by the number of firms involved in the transaction but the second is not. Our rationale is the longer the information sits with the involved firms (the target, the buyer and the advisory firms etc.) the greater is the risk that it will leak. We expect the sign of this factor to be positive.

3.2.3. Cash or Share Transaction

The third factor that we look into is whether the transaction is financed through cash, through shares, or through a combination of both. The theory in this case is that share based transactions are associated with a greater risk of a leak, than cash based transactions. This is simply because a company with a cash position can at any point in time decide to use this cash position for M&A transactions. However, in order to be able to pay for a transaction with own shares, a company must first repurchase these shares in the market, or issue them, or have them already on their own books. To have them already on their books is a potentially limiting factor,

since for instance Swedish companies can generally carry only a maximum of 10% of the share capital on their own books (Aktiebolagslagen 15 Kap.). Thus, share based transactions are assumed to be more complex, and therefore, analogous with the reasoning above, carry with them a greater risk of leakage. We expect the sign of this factor to be positive.

3.2.4. Media Speculation

The fourth and final factor that we will examine is if there has been any media speculation referring to the takeover, ahead of the announcement date. We perform news runs on both the global site www.factiva.com and the Swedish site www.affärsdata.com for the time period announcement date -1 year. We search for any articles mentioning the bid. At risk of stating the obvious, but if the bid has been mentioned in the press ahead of the official takeover announcement, this is likely to contribute to a potential run-up. It is nonetheless a case of leakage, and has for this reason, contrary to some prior studies, not been adjusted for in the first phase of the essay (see explanation under heading 4). We expect the sign of this factor to be positive.

3.2.5. Summary of theories and formal hypotheses

The prediction is thus as follows: We expect all of the factors to have a positive impact on the price run-up index of a firm. i.e. we expect there to be a positive relationship between the included factors, and the risk of a leakage, as measured by the run-up index. This will be tested through the following hypothesises:

H0: There exists a positive correlation between the number of involved firms in a deal, if the deal is cross border, if the deal involves stock and if there has been any media speculation regarding the deal prior to the announcement, and the risk of illegal insider trading.

H1: There is no correlation between the number of involved firms in a deal, if the deal is cross border, if the deal involves stock and if there has been any media speculation regarding the deal prior to the announcement, and the risk of illegal insider trading

4. Data and Methodology

4.1. Data

The Data Sample that we have used consists of 191 cases of public takeover bids, with cash- and stock- as well as mixed offers for listed Swedish firms. The deals have been collected from several databases (OMX, MergerMarket, Trust Platinum), and span the period January 1998 to December 2008. All in all, the sample consisted of 368 cases originally. The data we have used comes from Thomson DataStream, and is for price, volume and number of shares for the target

companies. However, the original sample consisted not only of public bids on the entire equity of a firm, but also of bids on specific divisions within firms as well as private placing cases, recapitalizations, reversed takeovers and so forth. Counter to the standard takeover bids on the listed share capital of a firm, these transactions are not always associated with unambiguous stock price reactions. This is because for instance sell side research might be negative to the disposal of a division, feeling that the firm might have undersold a value added division at to low a value for instance. Obviously, investors might feel that a bid for an entire company does not reflect the true value of a firm and thus choose to decline to sell, but generally speaking, most bids are made at a premium, with an average of 30% above market value (Burkart (1995)). For this reason we have excluded all cases other then public takeovers of entire listed firms. This has narrowed the sample by -177 cases, from 368 to 191 cases.

As such, it should however be pointed out that as the conclusions drawn in this paper are based on data of takeover bids on listed companies, one should be careful when applying these conclusions to different situations.

Table 4.1

Descriptive statistics of our data sample

Category	Number	Percentage (%)
Total	191	
Number of Firms Involved	182	95.29
Press Speculation	44	23.04
No Press Speculation	147	76.96
Domestic	118	61.78
Foreign	73	38.22
Cash	118	61.78
No Cash	73	38.22

For these 191 cases we added additional data on the deals by cross checking against press releases, as well as further data searches on Merger Market and Trust Platinum in order to obtain information such as type of deal (if it is domestic or cross border), payment structure (cash, shares or both), and the number of firms involved in the deal. In the cases were the same firm acted as debt provider as well as advisor to either the buyer or the seller (most often the buyer) we counted this firm only once. This is because, although advisory- and debt providing departments are two different divisions within for instance a bank, it was the most stringent course of action since for most participating firms we had only the firm name and not the exact number of participating individuals. This data was obtained by cross referencing press releases from the public offer against sources from Merger Market and also Trust Platinum. In our opinion, the cross referencing added value to the study since in most cases the data concerning,

for instance the number of advisory firms was not always available in the press release, but could be found on Merger Market and/or Trust Platinum.

Furthermore, an important point in any study of this nature is the exact announcement date of a public takeover bid. Previous studies (Asquith (1983), Jarrel and Poulsen (1989), and King & Padalko (2005)) have stressed the importance of finding the correct announcement date (day 0). For instance, King & Padalko (2005) performed news runs on the included deals in order to find what they denote as the "news adjusted" announcement date. The "news adjusted" date is the date when the information first leaked into the market, as measured by a press article mentioning the takeover bid. We have chosen for the first phase of our essay to use the official press release date because of two reasons: 1) just because one cannot find any press articles mentioning a coming takeover bid, it does not with certainty mean that no such information has leaked out into the market; and 2) a statement in a newspaper is just as much an illegal leakage as anything else. For these two reasons, and to ensure comparability across all cases we have thus chosen the press release date, in phase one of this paper. We do not feel that this compromises our results vis-à-vis previous studies, a view that is confirmed when looking into the results of our study, and comparing these to the results of other studies (this will be developed further under section 6). Furthermore, we have in phase 2 included a factor which we choose to call media speculation, which is in essence the exact same thing as the "news adjusted" takeover date used by King & Padalko (2005).

Finally, to be able to calculate what abnormal return is, and what abnormal volume is, we have downloaded the market index OMXSPI. We have used an equal weighted index, analogously with previous studies. Appendix 1 shows our data sample.

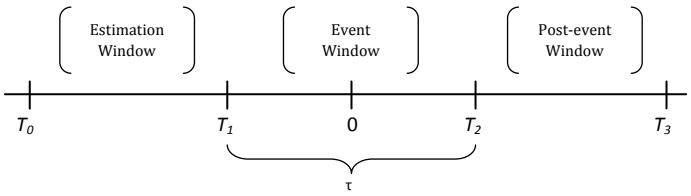
4.2. Methodology

In order to examine the existence of abnormal returns and/or abnormal trading volume for the purpose of determining whether any illegal insider trading has occured we perform an event study broadly following the methodology presented in MacKinlay (1997). An event study is an econometrical way of measuring the impact of a specific event on the value of a firm.

Our test window (event window), the period tested for abnormal returns and abnormal trading volume, spans across 91 days beginning 60 days prior to the event date and ending 30 days after, [-60,30]. The estimation window, over which the models described below are calculated, begins 250 days prior to the announcement and ends as the event window starts 61 days prior to the event date, [-250,-61]. The event window itself is not included, as can be noticed, in order to prevent the event from influencing the market model estimates.

Figure 4.2

Descriptive picture of the time period utilized in event studies



4.2.1. Abnormal Returns

By estimating expected returns using a market model we are able to predict abnormal returns over our event window. The abnormal return for firm *i* and event date *t* are specified as follows

$$AR_{it} = R_{it} - E(R_{it}|\mathrm{X}_t) \qquad (1)$$

where AR_{it}, R_{it}, and $E(R_{it}|\mathrm{X}_t)$ are abnormal, actual and normal returns given the market model used for the time period *t*. The market model uses a market portfolio to estimate the normal return of a given security *i,* at a given point in time by the following linear model

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (2)$$

$$E(\varepsilon_{it} = 0) \qquad Var(\varepsilon_{it}) = \sigma_{\varepsilon_i}^2$$

where R_{it}, R_{mt} are the period t returns for security i and the market portfolio respectively and ε_{it} is the zero mean and constant variance error term. α_i and β_i are the parameters used to calculate the normal return within our event window. As market index we have chosen to use the Swedish benchmark index OMXSPI since we believe that it provides us with a good proxy for the overall performance of the Swedish market in line with the market model assumptions. Furthermore, as this paper is, as stated earlier, based on previous studies of pre-bid run ups, we choose to use a methodology that is as similar to theirs as possible, for comparability reasons.

Using the market model results abnormal return is calculated as the following:

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \qquad (3)$$

Finally both average abnormal return (AAR) for each day of the event window and cumulative abnormal return (CAR) for each company is calculated in order to analyse the data (for closer descriptions of CAR and AAR see Appendix 2).

Table 4.2.1

Description of AAR, CAR and CAAR and how they are calculated

Measure	Explanation
AAR_t	$= \sum AR_{it}$ (across i) / Number of firms
CAR_i	$= \sum AR_{it}$ (across t)
CAAR	$= \sum AAR_t$ (across i) $= \sum CAR_i$ (across t) / Number of firms

Using the student *t*-tests, we try the null hypotheses that the CARs and the AARs are not different from zero. The t-tests statistic is as follows (Guajarati (2003)):

$$t = \frac{\bar{x} - \mu_0}{S/\sqrt{n}} \qquad (4)$$

4.2.2. Abnormal Volume

In order to test for informed trading we look for abnormal trading volume. The approach is similar to that used when calculating the abnormal returns. We broadly follow the methodology used in King and Padalko (2005). As suggested by Lo and Wang (2000) we take the natural logarithm of volume since its distribution by definition is skewed – it cannot be negative. This helps to mitigate trends that exist in the data (time varied trends). Furthermore, this is yet again in line with previous research, which in turn makes our results comparable.

The abnormal trading volume is calculated in two different ways. The difference lies within the calculation of the expected trading volume. We first follow the methodology used in Chae (2005) where abnormal volume (AV) is calculated according to the mean model as follows:

$$AV_{it} = V_{it} - \frac{\sum_{n=-250}^{-61} V_{in}}{n} \qquad (5)$$

where V_{it} is the log of turnover of firm i at time t. A positive number indicates that the trading volume at that particular day was larger than the average trading volume during the estimation window [-250,-61]. Next we also calculate the abnormal volume using a regression analogous to the market model used for returns. The following market model is calculated for firm i at time t:

$$V_{it} = \alpha_i + \beta_i V_{mt} + \varepsilon_{it} \qquad (6)$$

where V_{it} is the log turnover of a particular firm i at time t and $V_{mt}$is the log mean turnover of all shares trading on the Stockholm stock exchange (OMXS). ε_{it} is the zero mean and constant variance error term. $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the estimated parameters used to calculate the normal volume within our event window. The estimated abnormal volume using the market model is:

$$AV_{it} = V_{it} - \hat{\alpha}_i - \hat{\beta}_i V_{mt} \qquad (7)$$

As with AARs the average abnormal volume (AAV) is calculated for all firms per every trading day within the event window and the cumulative abnormal volume (CAV) is calculated for each company.

Using *t*-tests, we try the null hypotheses that the CAVs and the AAVs are not different from zero.

4.2.3. Panel Regression of Abnormal Volumes vs. Abnormal Returns

Finally, to capture both the cross-sectional aspects of the data, as well as the time-series aspects, we will run a panel regression. The cross sectional dimension is added to test the possible relationship between abnormal volumes and abnormal returns both across time, and across firms. This is to further examine whether the price run-up is based on illegal insider trading, or not. It is possible to choose a panel data regression with either random effects structure, or fixed effects structure for the residuals. Generally, a fixed effects structure for the residuals is more restrictive, since it assumes the takeover-specific residual to be constant over time. Furthermore, as the previous studies have chosen a random effects model, we have too, in order to secure comparability (King & Padalko (2005)). Formally, the model is:

$$AR_{it} = \gamma_i + \delta_i AV_{it} + u_{it} \qquad (8)$$

$$E(u_{it} = 0) \qquad Var(u_{it}) = \sigma_{u_i}^2$$

As can be seen from the model above, it is very much similar to the market model, however, in this case the we regress average return of firm *i* at time *t*, against average volume of firm *i* at time *t*. Then we test the hypotheses that there is a positive relationship between the dependent and explanatory variable, i.e. that:

$$\delta_i > 0$$

This is in turn tested with a *t*-test.

4.2.4. Autocorrelation

As stated under section 3 “Theoretical Frameworks” serial correlation in the data will help us determine whether there is pattern in the data that points towards either insider trading or sophisticated traders.

Serial correlation or autocorrelation is the correlation of a variable with a time-lagged version of itself and defined as:

$$R_{(t,t+i)} = \frac{E[(X_t - \mu_t)(X_{t+i} - \mu_{t+i})]}{\sigma_t \sigma_{t+i}} \quad (9)$$

In our case, *i*=1, which implies that *t=(t+1)-1*, i.e. the same as *(t+1)* lagged one period. We then test the hypotheses that there is $R_{(t,t+i)} \neq 0$. This is done with a *t*-test. Analogous with 4.2.1 and 4.2.2 this will be done for both returns and volumes. Also we will split the analysis into the time frames shown in table 3.1.4 for theoretical reasons.

4.2.5. Regression of Run-up Index vs. Contributing Factor

In the first section (4.2.1-4.2.3) we set out to determine whether or not we, given the hypothesises that we use (strategic- vs. competitive trading hypothesis), can find any prevalence of illegal insider trading in our data. However, as stated in the introduction, the study by Cornell and Sirri (2002) pointed out that even given cases of known insider trading, it is still very difficult to differentiate between legal and illegal trades by analyzing the data with existing theoretical framework.

Therefore, in this section, we use a slightly different approach to possibly be able to find signs of insider trading, other than those that existing models are able to show us. This methodology will be based on the paper by Jarrel and Poulsen (1989). However we only include their variable *Press Speculation* and instead further try to explain the pre-bid run-up with our variables number of involved firms, domestic or foreign bidder and whether the bid is placed using cash or stock (or a combination of the two). We regress the price run-up index per firm, against: i) the number of involved firms; ii) the geographic nature of the takeover (cross border or not); iii) whether the transaction is financed through stock or not; and iv) whether there has been any media speculation, in order to determine if the included factors have any significant impact on the risk that a portion of the cumulative abnormal return will be generated ahead of the announcement date. By using regression analysis we are able to extend our analysis to looking we try to explain the pre bid-run ups at a firm level instead of at an aggregate level. The following regression is performed:

$$Price\ run\ up\ index_i = \mu + \hat{\theta}(number\ of\ involved\ players_i) + \hat{\varphi}(Cross\ Border) + \hat{\tau}(Stock\ offer) + \hat{\omega}(Media\ Speculation) + error\ term_i \quad (10)$$

Where $\hat{\varphi}$, $\hat{\tau}$, and $\hat{\omega}$ are dummy variables that assume the value 1 if either is true, and 0 if not. We test the hypotheses that the coefficients are different from zero, i.e. that

$$\hat{\theta} = \hat{\varphi} = \hat{\tau} = \hat{\omega} = 0$$

This is in turn tested with an *F*-test.

5. Empirical Results

5.1. Price run-ups

In this first section we will examine the results for the abnormal returns and abnormal volume regressions, as well as the panel data regressions, in order to be able to conclude if any possible price run-up is caused by illegal insider trading, as modelled by the strategic trading model, or if they are caused by informed investors trading on proprietary information according to the competitive trading model.

5.1.1. Average Abnormal Returns & Average Abnormal Volumes

In appendix 2, both the average abnormal returns (AAR) and the cumulative average abnormal returns (CAARs) are reported. Although both are calculated for the entire estimation window [-60, 30], AARs are reported on a single day basis, whereas CAARs are aggregated from the first day of the estimation window. Therefore the first observation of $CAAR_{-30} = \sum_{-30}^{-60} AAR$. Significant values are denoted in with a *.

Also in appendix 2, we have compiled data for the abnormal average volume as well (AAV) as well as the cumulative abnormal average volume (CAAV). These are constructed analogously to AAR and CAAR (i.e. that AAV is for each day in the window [-30, 1] on a stand-alone basis, and CAAV is cumulative for the period [-60, 30]). As stated under heading 4.2.2 we have used two different models for generating the expected volume in order to calculate abnormal volume, the market model and a mean model. Both are reported below in appendix 2. As both generate similar results, we will focus on the market model, since this is what we have used for generating abnormal returns.

Referring back to table 3.1.3, we start by examining if we can find any cases of AARs that coincide with AAVs. From appendix 2 we can see that this occurs as of day -4. Except for day -2, when AAR is insignificant at the 1% level, this pattern is consistent up until day +1. For the interval [2, 30] there are no more significant AARs. If we therefore choose to treat day -2 as an anomaly for a short moment, we can see a significant run-up in returns starting -4 days prior to the announcement. Furthermore, we can see a pattern of significant AARs coinciding with significant abnormal average volume. This is similar to the findings of both King and Padalko (2005) and Gao and Oler (2008), as well as Chae (2005), who all document abnormal volume at the same time as abnormal returns just shortly before the takeover announcement. However, in contrast to the aforementioned studies, we do not find any evidence of AAVs leading AARs in time.

Looking back to table 3.1.3, it is important to determine whether or not this is deemed to be "Far Ahead" of the announcement, or if we feel that this is to be regarded as "Just Prior". We have chosen to interpret this as being "Just Prior". Therefore, we choose to reject hypothesises 1 and 3, and accept hypothesises 5 and 7. So far, the data seems to point towards the competitive trading hypothesis, where the observed price run-up is caused by sophisticated investors, and not insider traders.

But what does it mean that the average abnormal return on day -2 is not significant. Obviously this is somewhat unexpected. As average abnormal volume is still significant the conclusion becomes that there still exists uncertainty amongst investors as to whether or not the run-up is justified. Some investors therefore choose to sell, which drives down AAR, but keeps AAV significant. As for how this affects the conclusion we have reached, we would argue that the impact is very limited. The observed case is if anything, an example of the heterogeneity between investors. Therefore we do not see this anomaly as adverse to the conclusion that the run-up seems rather to be caused by sophisticated investors, than by insider traders.

Upon the announcement day (day 0), the AAR is 16.3% the first day, followed by 5.5% the next day. This is a lot higher than the values reported by King and Padalko (2005) of 9.8%, and the 5.9% reported by Jabbour, Jalilvand and Switzer (2000). As earlier mentioned, there are no more significant AARs after this. The AAVs is also highly significant upon the announcement day, jumping up to 273%. This trend of significant positive AAVs continues up until day +21. This significant reaction to the announcement suggests that there still existed some amount of residual uncertainty in the value of the stock. Investors therefore have to adjust their positions to the disappeared uncertainty upon announcement, causing intense trading and leading to both AAR and AAV following the announcement. Referring back to table 3.1.3 we can see that we would accept hypothesises 9 and 10. This is therefore indicative of the competitive trading model as well.

Looking into the cumulative abnormal returns and cumulative abnormal volumes we can see the following. CAARs follow more or less the same pattern as AARs, although possibly more strongly so, being as they are all significant at the 1% level[5], and positive as of -5 days prior to the announcement. On day 1 the CAARs peak at 30.5%, before declining until day 17, and then climbing back up to reach a new high at 31.2% on day 30. After day -5, all CAAR values are significant at the 1% level.

CAAV on the other hand only becomes significant according to the market model on the announcement date, day 0 (it continues to be significantly positive throughout the event window

[5] The significance of for instance $CAAR_{-30}$ is: $significance(CAAR_{-30}) = \sum_{-30}^{-60} singnificance(AAR)$

[0, 30]). This is strange since there are 4 days of significant AAVs before day 0. This implies that there is if anything cumulative subnormal average volume up to this date. For the market model this might be caused by either the choice of index (which we do not believe since we have used an equal weighted index) or that we have a sample of many relatively small firms. Also, the conclusion is the same for the mean model, although less so, as CAAV becomes significant on day -2. The mean model thus produces better, but still not good results. It should here be pointed out that these patterns are not significant. We do not see significantly negative AAVs in the period [-60, -4], but the fact that CAAVs become significant after the AAVs seems to suggest that the AAVs are subnormal prior to this, although not significantly so. This conclusion is also reinforced by looking at appendix 3.

We fail to find anything in our theoretical framework that should explain a cumulative subnormal average volume up to just prior to the announcement date. Why do investors trade less in stocks to be taken over, in the interval [-60, -4], compared to the period [-250, -61]? We are here tempted to draw the conclusion that investors have all ready taken positions far ahead of the announcement date, i.e. further ahead than -60 days. That means that there are potentially cases of AARs coinciding with AAVs earlier then our window can measure. Therefore there might be signs of illegal insider trading as predicted by the theoretical framework that our study, and prior studies, miss due to poor methodology (too small window). The explanation would be that the estimation window itself is affected by abnormal volume from insider trading, as compared to what is "normal volume", excluding the incremental insider trades. However, this is not a theoretically valid conclusion, since in this case we would expect the same dynamics in the AAR vs. CAAR relationship. Remember what is stated under heading 3.1.1: "Abnormal returns that are not accompanied by abnormal volume (or vice versa) would constitute a rejection of this hypothesis (insider trading)". From the data in appendix 2 we can see that this is not the case. Admittedly the day -10 AAR is significant, whereas the CAAR is not. The CAAR just barely fails to be significant at the 1% level, but is significant at the 5% level. Also the fact that it is just one observation leads us to conclude that the pattern in AARs is not as pronounced as the pattern in AAVs, and therefore we stand fast by our conclusion. Thus the conclusion is that the observed AARs and AAVs are indicative of the competitive trading hypothesis, whereby sophisticated investors trade on proprietary information, as opposed to the strategic trading model where insiders trade on illegal insider information.

Table 5.1.1

This shows the results of the first phase of our study

Time to Announcement	#	Hypothesis	Insider Trading	Sophisticated Investors
Far Ahead	1	Abnormal Returns	Coinciding w/ Abnormal Volume	No significant cases
	2	Pattern of Abnormal Returns	Positively Autocorrelated	No Clear Pattern *
	3	Abnormal Volumes	Coinciding w/ Abnormal Returns	No significant cases
	4	Pattern of Abnormal Volumes	No Clear Pattern	No Clear Pattern
Just Prior	5	Abnormal Returns	No significant cases	Coinciding w/ Abnormal Volume
	6	Pattern of Abnormal Returns	No Clear Pattern	Positively Autocorrelated
	7	Abnormal Volumes	No significant cases	Coinciding w/ Abnormal Returns
	8	Pattern of Abnormal Volumes	No Clear Pattern	Positively Autocorrelated
Upon Announcement	9	Abnormal Returns	Insignificant Reaction	Significant Reaction
	10	Abnormal Volumes	Insignificant Reaction	Significant Reaction

** Assuming abnormal volumes are insignificant, otherwise we would expect negatively autocorrelated returns here.*

5.1.2. Patterns of AARs and AAVs

So far we have examined the hypothesises # 1, 3,5,7,9 and 10, which leaves us with hypothesises # 2, 4, 6 and 8. These are all focused on the pattern of AARs and AAVs. Both the strategic trading hypothesis (insider trading) and the competitive trading hypothesis (sophisticated investors) expect to find positively autocorrelated abnormal returns, but whereas the competitive trading hypothesis also expects to find positively autocorrelated abnormal volumes, the strategic trading model makes no clear prediction in terms serial correlation of volumes. The pivotal difference between the two hypothesises lies in whether we see these patterns "Far Ahead" of the announcement, of if they occur "Just prior" to the announcement. Since, as stated earlier there is no clear definition as to what is to be regarded as "Far ahead" and what is "Just prior" we have measured the autocorrelation for a number of different periods(see appendix 5). We have also tested for 1st, 2nd and 3rd order autocorrelation.

From appendix 5 we can see that the only significant autocorrelation are seen in the periods [-60, 30], [-60, -30], [-60, 0] and [-60, 1]. Thus, there is a significant autocorrelation for the period as a whole, but this gives us no guidance, since we need to look at how this pattern changes over time. We can see no significant autocorrelations for the periods not including [-60], i.e. the periods starting -30 days, -20 days and -5 days prior to the announcement do not display any significant autocorrelation. Thus significant autocorrelation seems to occur in the early stage of the window, closer towards -60 days, than towards the announcement date, i.e. just prior to the announcement date. Looking at the autocorrelation that is significant for the period that can be denoted as being far ahead, [-60, -30], it is negative -0.5704. This implies that with a probability that is slightly larger than 50%, returns will change between periods from being positive to negative in the period "Far Ahead" of the announcement. For the period just prior to the announcement, there is no significant autocorrelation. Thus we can reject hypothesis #2 of positive autocorrelation far ahead of the announcement. If there would have been significant abnormal volumes during this period (not coinciding with abnormal returns) this would have

been indicative of the competitive trading model i.e. that sophisticated investors trade on proprietary information. This far ahead of the announcement the level of residual uncertainty in the price, and thus low level of speculative trading, leads to a negatively correlated pattern of returns, since recall from heading 3.1.2: "stocks with a high degree of speculative trading tend to exhibit positive return autocorrelation and stocks with a low degree of speculative trading tend to exhibit negative return autocorrelation". Thus, this would on a stand-alone basis have been supportive of the competitive trading hypothesis. However closer to the announcement we would expect the residual uncertainty to diminish leading to more speculative trading and therefore positively autocorrelated returns. As we do not see this, the conclusion from this section is unclear.

Looking at the patterns of autocorrelation in volumes, these are significantly positively autocorrelated except for the periods [-60, -30], [-5, 5], [-5, 1]. The results are close to identical for both models, and the conclusions are the same for both the market model and the mean model (appendix 5). Therefore we will base our reasoning solely on the market model. From the table we can see that volumes are consistently positively autocorrelated and significant except for just prior to the announcement date and at the early end of the sample [-60, -30], i.e. as "Far ahead" of the announcement as possible. This means that in the "middle" of the sample there is a clear pattern of positively autocorrelated volumes, but "Just prior" to the announcement and "Far ahead" of the announcement there is no clear pattern. The interpretation is that investors trade most intensely in the stocks when there is not too long and not too short time to announcement left.

If it were a clear cut competitive trading hypothesis (sophisticated investors) we would have expected the volume to display an unclear pattern before being positively autocorrelated shortly ahead of the announcement. Thus, these results seem to be more indicative of the strategic trading model, whereby insiders trade in the stock far prior to the announcement, but space their trades through time, leaving volume autocorrelation untouched. However this does not explain the positively autocorrelated volume in the "middle" of the window. Therefore, the conclusions from this heading are ambiguous as well (compare to returns autocorrelation above).

Table 5.1.2

This table shows new conclusions drawn from the autocorrelation pattern analysis

Time to Announcement	#	Hypothesis	Insider Trading	Sophisticated Investors
Far Ahead	1	Abnormal Returns	Coinciding w/ Abnormal Volume	No significant cases
	2	Pattern of Abnormal Returns	Positively Autocorrelated	No Clear Pattern *
	3	Abnormal Volumes	Coinciding w/ Abnormal Returns	No significant cases
	4	Pattern of Abnormal Volumes	No Clear Pattern	No Clear Pattern
Just Prior	5	Abnormal Returns	No significant cases	Coinciding w/ Abnormal Volume
	6	Pattern of Abnormal Returns	No Clear Pattern	Positively Autocorrelated
	7	Abnormal Volumes	No significant cases	Coinciding w/ Abnormal Returns
	8	Pattern of Abnormal Volumes	No Clear Pattern	Positively Autocorrelated
Upon Announcement	9	Abnormal Returns	Insignificant Reaction	Significant Reaction
	10	Abnormal Volumes	Insignificant Reaction	Significant Reaction

** Assuming abnormal volumes are insignificant, otherwise we would expect negatively autocorrelated returns here.*

From the analysis of the pattern of AARs and AAVs we cannot draw any clear conclusions as to whether or not the observed patterns are indicative of the strategic trading hypothesis (insider trading) or of the competitive trading hypothesis (sophisticated investors). Therefore we rely on the conclusions already reached in the previous sections.

5.1.3. Panel Data Regression

Table 4 shows the results of the panel data regression of abnormal volume on abnormal returns. It has been performed over 3 different periods, the pre-announcement window [-30, -1], the announcement window [0, 1], and also the pre- and announcement window [-30, 1].

From the regression we can see that the correlations between AARs and AAVs is only 16,7% for the pre-event window [-30, -1]. It is the strongest for the period [0, 1] at 26%. These values are more or less in line with the findings of King and Padalko (2005) who find the correlations to be 12% and 35% for the periods [-30, -1] and [0, 1] respectively. However, although the coefficients for abnormal volume on abnormal returns are significantly positive, the size of the coefficient along with the poor fit of the regression (very low R-square values across all periods, which can also be confirmed by looking at scatter plot in appendix 4), leads us to conclude that the relationship is not relevant from an economical point of view. This conclusion is analogous with King & Padalko (2005) p.24. For instance if abnormal volumes were to increase 100% in the pre-event window [-30, -1], abnormal returns would only increase by 0.57% (King & Padalko find the equivalent value to be 0.47%). This test indicates there is no evidence in the data of a relationship between abnormal returns and abnormal volumes, which in turn indicates that insiders are not responsible for the price run-up prior to the announcement (since this would have in such a case have been in conjunction with abnormal returns). This supports the competitive trading model.

Table 5.1.3

Table5.1.3 shows the result from the panel data regression with abnormal return as the dependent variable, and abnormal volume as the explanatory variable. The regression has been split into 3 sub-samples. One ranging from [-30,-1], one covering the period [0, -1] and finally one for the period [-30, 1]. Although the regressions for sub-sample one and two show significant parameters, the size of the parameters along with the poor fit leads us to conclude that there is no economical relationship between AAR and AAV

Regression of AAR on AAV			
	(1)	(2)	(3)
	[-30,-1]	[0,1]	[-30,1]
Abnormal Volume	0.00572	0.01151	0.01647
p-value	(0.000)	(0.000)	(0.000)
Constant	0.00192	0.03485	0.00509
p-value	(0.002)	(0.229)	(0.000)
Observations	5174	362	5536
R-squared	0.0278	0.0677	0.0585
P-value	(0.000)	(0.000)	(0.000)
Correlation	0.1667	0.2601	0.2419

5.1.4. Conclusions from price run-ups

Based on the conclusions under heading 5.1.1-5.1.3 we conclude that there exist significant price run-ups in the Swedish market, but that these are not caused by illegal insider trading, but rather by sophisticated investors trading on proprietary information gained through different forms of market analysis. Obviously the results vary depending on which parameter we choose to examine, but the conclusion drawn from the conclusion as a whole feels robust. The results are summarised in table 5.1.4 below.

Table 5.1.4

Table 5.1.4 summarizes the results from the first phase of our study. This table is identical to 5.1.1 since no conclusions could be drawn in table 5.1.2

Time to Announcement	**#**	**Hypothesis**	**Insider Trading**	**Sophisticated Investors**
Far Ahead	1	Abnormal Returns	Coinciding w/ Abnormal Volume	No significant cases
	2	Pattern of Abnormal Returns	Positively Autocorrelated	No Clear Pattern *
	3	Abnormal Volumes	Coinciding w/ Abnormal Returns	No significant cases
	4	Pattern of Abnormal Volumes	No Clear Pattern	No Clear Pattern
Just Prior	5	Abnormal Returns	No significant cases	Coinciding w/ Abnormal Volume
	6	Pattern of Abnormal Returns	No Clear Pattern	Positively Autocorrelated
	7	Abnormal Volumes	No significant cases	Coinciding w/ Abnormal Returns
	8	Pattern of Abnormal Volumes	No Clear Pattern	Positively Autocorrelated
Upon Announcement	9	Abnormal Returns	Insignificant Reaction	Significant Reaction
	10	Abnormal Volumes	Insignificant Reaction	Significant Reaction

** Assuming abnormal volumes are insignificant, otherwise we would expect negatively autocorrelated returns here.*

5.2. Run-up Index Regression Results

Table 5.2.1

Descriptive statistics of Cumulative Abnormal Returns and Run-up Index for the 191 firms of our sample

	Run up Ind [-1,1]	CAR[-60,1]
Max	16.69	6.34
Min	-25.83	-1.10
Mean	0.36	0.30
Median	0.46	0.25

Table 5.2 describes the Run-up Index and cumulative abnormal return statistics of our 191 firms. As seen the mean and median CAR for our sample is close to the total CAAR across the entire sample (0.3047) over the same window [-60, 1]. The maximum and minimum spans show us that the span of abnormal returns across our data is large. The reason for the large span is difficult to generalize about, as each case would need to be examined on a stand-alone basis. However large negative run-up indexes are generally caused by $CAR_i^{-60,-1}$ being negative, and $CAR_i^{-60,1}$ being small (which implies that $CAR_i^{0,1}$, i.e. the reaction to the takeover, is positive as expected, since $CAR_i^{-60,1} = CAR_i^{-60,-1} + CAR_i^{0,1}$). Therefore since the numerator is negative, and the denominator is very small, a large negative number is produced. As to what is causing the large positive run-up indices, the explanation is identical to the negative case, except for that $CAR_i^{0,1}$ is not sufficiently large (alternatively $CAR_i^{-60,-1}$ is too negative) to cause $CAR_i^{-60,1}$ to become positive. Therefore since both the numerator and the denominator are negative, the run-up index becomes positive. Notable is also that the minimum CAR across the period [-60, 1], (-1.10) indicates that the particular takeover has decreased 110% more than predicted by the market model (not meaning that the stock price decline 100% however).

The Run-up index across firms for the entire sample was 28.8% a bit less than the mean and median of the individual firms. The maximum and mean run-up indices exhibit very large values, but this is due to the mathematical properties of the run-up calculation, i.e. as described earlier, if the denominator is close to zero, the value will be disproportionally distorted up- or downwards.

Table 5.2.2

Descriptive statistics of Regression of Run-up Indices vs. Explanatory Factors

Regression: Dependent Variable = Run-Up Index						
	Panel A			Panel B		
	Incl. Negative Cases			Excl. Negative Cases		
	Day(-1)	**Day(-5)**	**Day(-10)**	**Day(-1)**	**Day(-5)**	**Day(-10)**
Intercept	0.167	-0.122	1.229	1.208	1.578	2.858
t-val	0.26	-0.17	1.66	2.33	3.25	3.13
Number Involved	0.016	0.053	-0.014	-0.043	-0.042	-0.092
t-val	0.26	0.77	-0.19	-0.91	-0.97	-1.13
Press Speculation	0.325	0.401	-0.140	0.010	-0.164	-0.612
t-val	0.58	0.64	-0.22	0.02	-0.40	-0.78
Domestic/Foreign	0.040	-0.494	-0.988	0.422	0.004	-0.781
t-val	0.08	-0.89	-1.73	1.06	0.01	-1.12
Cash/Stock	0.069	0.267	-0.403	-0.280	-0.525	-1.082
t-val	0.15	0.50	-0.73	-0.72	-1.45	-1.59
R-squared	0.003	0.016	0.019	0.025	0.024	0.036
F-value	0.11	0.71	0.86	0.49	0.54	0.36
Number Firms	182	182	182	141	130	122

We have used regression analysis to analyze the effect that our chosen factors have on the run-up index. The run-up index measures, as previously stated, the amount of run-up that occur close to the event compared to the rest of the event window. We believe that this is the most appropriate measure since it is a relative measure, and as such is not dependent on the absolute amount of abnormal return generated by each takeover, but rather how much of said abnormal return is generated ahead of the takeover. Table 5.2.2 reports the outcome of our regression. Panel A of table 5.2.2 displays the results from the regression performed on our entire sample. For Panel B we have, analogous to Jarrel and Poulsen (1989), excluded negative run-up indices. Their rationale for doing so is that the negative numbers will distort the regression. We have, on the other hand, predominantly included the "clean" sample for comparability reasons.

The dependent variable in our regressions is the run-up index. The variable number of involved players is a positive integer corresponding to the number of firms involved with both bidder and target. The variable press speculation is assigned either a one or a zero, the number one signifying that media speculation has occurred prior to the announcement. Conversely the variable domestic/foreign assigns a one to a domestic bidder and cash/stock assigns the number one to a cash bid. Both regressions including negative run-up indices and excluding negative run-up indices exhibit low R-square values, implying that our explanatory variables are ill fitted to explain the run-up index. The fit of our regression to the data is improved when excluding the cases of negative run-up indices, and although the significances of our factors increase slightly, none become significant.

The first factor we looked at was number of involved firms. The factor exhibit the correct sign (positive) for the first two regressions including the negative cases of the run-up index. However the remaining cases the sign is instead negative meaning that the more firms involved the less run up prior to the announcement. Further all cases are insignificant.

The second factor is press speculation, which Jarrel and Poulsen (1989) found to be significant, and of the correct sign. In our regressions it exhibits the correct sign in three out of six cases; however it is insignificant in all cases.

The two remaining factors, cash/stock and media speculation, also exhibit ambiguous results, where the signs are un-consistent across the regressions and furthermore all values are insignificant, making us wary to draw any conclusions as regards to these factor, apart from that they do not seem to be doing a great job in terms explaining the run-up index.

Finally, as none of the F-values are anywhere near the critical values for any of the samples, we fail to reject the hypothesis that all factors are jointly not different from zero.

Thus, as none of the factors are significant on a stand-alone basis, and as they are jointly not different from zero, and as the R-squared values are all low, we conclude that there is no meaningful relationship between any of the factors included in our study, and the run-up indices. The reason this extra stage was added to our analysis was to be able to avoid false conclusions based on shortcomings in the theoretical framework of stage one. However, after having performed this regression analysis, we are forced to admit that section two added very little value. Therefore, the conclusion from the first stage of our study still stands, that is that we are unable to find solid evidence of insider trading in our data.

6. Comparison to other studies

Appendix 4 shows the results from our study, and compares them to the results seen in previous studies of the same nature. The most notable fact is that we have the second lowest run-up index (28.8%) of all studies. This is interesting, taking into account the facts that: i) we have the highest total CAAR (31.2%); and ii) as opposed to some other studies, we did not adjust the announcement date following news runs (as written under heading 4). As earlier stated we chose to use the press release date as the official announcement date. This means that the only possible impact would have been setting day 0 at an earlier, which in turn would have resulted in an even lower price run-up index. Regardless of the method for determining the exact day 0, the conclusion seems to be that Swedish price run-ups are similar in terms of total CAAR, but that a relatively larger part seems to be generated post the announcement date. This also supports the case that we fail to find solid evidence of illegal insider trading in Sweden.

7. Conclusions

We have studied 191 cases of public takeovers on the Swedish stock exchange, in order to determine if we can see any signs of illegal insider trading. This is done in two stages. First we start by analyzing the price and volume data of the target firms at the time before, at, and after the announcement date. With the help of two different types of models, the strategic trading model and the competitive trading model, we try to ascertain whether or not a potential price run-up is caused by illegal insider trading or not.

Next, we examine the relationship between the number of factors that we feel could potentially increase the leak of insider information ahead of the official takeover announcement namely: i) the number of firms that are involved in the takeover transaction, and that therefore are in possession of the insider information; ii) whether or not the transaction is cross border or between two domestic firms; iii) whether or not the transaction is financed through stock or cash, or if it is a mixed deal; and finally iv) if there has been any media speculation prior to the announcement of the takeover; and the portion of the abnormal return associated with the bid that is generated before the public announcement.

Our main conclusions in stage one are the following: Although we find a significant price run-up in the stock price of the target firm, this does not coincide with abnormal volumes until just prior to the announcement (-4 days). However, patterns of abnormal volumes and abnormal returns are hard to interpret, and therefore we are not able to categorize them according to our theoretical framework. Finally, both abnormal returns and volumes display large, significant reactions to the announcement of the actual takeover. All of these findings support the theories of the competitive trading model, i.e. that investors trade on heterogeneous beliefs based on public information, as opposed to illegal insider information.

Our main conclusions in stage two are the following: We can find no evidence that any of the factors that we tested: : i) the number of firms that are involved in the takeover transaction, and that therefore are in possession of the insider information; ii) whether or not the transaction is cross border or between two domestic firms; iii) whether or not the transaction is financed through stock or cash, or if it is a mixed deal; and finally iv) if there has been any media speculation prior to the announcement of the takeover: have a significant impact on the risk of illegal insider activities, as measured by a run-up index.

Overall, our results indicate that the Swedish market is better characterised by sophisticated investors trading legally on careful analysis of public information, than by insiders trading illegally on non-public information.

The study that we have conducted is based on a pattern in an aggregated sample. The models used fail to distinguish individual cases of insider trading, but rather draw conclusions based on the market as a whole. Furthermore, all conclusions drawn are sensitive to the time frames used. Taking into account the vital importance of time to the different conclusions reached, at least in stage one, we find it slightly strange that we can find no research on this specific area. This is therefore a field that we feel should be explored further to be able to add an extra layer of robustness to studies such as ours. Also, as mentioned above, models sensitive to individual cases is also an area in need of further development.

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9. Appendices

Appendix I: Complete Sample (191 firms) and Descriptive Statistics

The Data Sample that we have based this study on. It consists of 191 takeover bids for public Swedish companies, listed on the Swedish stock exchange. The bids all occurred between 1998 and 2008. Sample is limited to bids for share capital of entire companies, i.e. private placings, bids on single divisions etc. are excluded. The data shown below is sorted according to the order in which we gathered it, which is the way we have worked with it. As earlier mentioned, the sources that we have used are the OMX webpage, Merger Market and Trust Platinum.

Target	Ann. Date	Number of Involved Firms	Domecile of Bidder (1 = Domestic, 0 = Foreign)	Press Speculation (1 = Yes, 0 = No)	Deal Structure (Cash = 1)	CAR [-60,1]	Run Up Index [-1, 1]
Academedia	2007-10-22	2	1	0	1	-0.2719	0.9554
Acando	2003-05-15	3	1	0	0	0.2484	0.9688
ACSC	2007-09-24	1	1	0	0	0.1275	-0.1171
Aga	1999-08-17	6	0	0	1	0.2160	0.9749
Allgon	2000-08-22	5	1	0	0	-0.3863	1.5520
Allgon	2000-09-28	8	0	0	0	0.4751	0.8445
Allgon	2003-01-21	4	1	0	0	0.9345	0.6459
Althin Medical	1999-12-22	5	0	0	0	1.1288	0.6195
Anders Dios	2000-09-26	3	1	0	1	0.4088	0.2705
Arete	2000-09-13	6	1	1	0	0.3456	0.4823
Ark Travel	2007-10-22	4	0	0	1	0.2843	0.9230
Arla	1999-11-30	1	0	1	0	-0.2824	0.9625
Artema Medical	2001-01-10	5	0	0	0	0.6209	0.3023
ASG	1999-04-27	2	0	0	1	0.3142	0.9711
Aspiro	2005-11-03	2	0	1	1	0.2532	1.3053
AssiDomän	2001-10-10	7	1	1	0	0.0705	1.3733
Asticus	1999-03-09	8	0	0	0	0.5296	0.9931
Astra	1998-12-09	8	0	1	0	0.1406	0.2703
Atle Industri	2001-02-19	7	1	0	0	0.1393	-0.3914
AU-System	2001-12-10	6	1	0	0	0.5156	0.6245
Avanza	2001-06-08	-	1	1	0	-0.4762	1.2031
Avesta Sheffield	2000-09-29	11	0	1	0	0.0474	1.6868
Balder	2000-02-09	4	1	0	1	0.1489	-1.0708
Ballingslöv International	2008-05-16	4	1	0	1	0.2163	-0.0125
Benima Ferator Engineering	1998-09-21	0	1	0	1	0.4782	-0.2121
Biacore International	2006-06-20	9	0	0	1	0.4786	0.6657
Biora	2003-04-07	5	0	0	1	0.1852	-0.8988
Boss Media	2008-02-01	7	0	0	1	0.5091	0.3609
BPA	1999-04-29	2	1	1	1	0.3185	0.2426
Broström	2008-08-27	5	0	0	1	0.4359	0.8227
BT Industries	2000-04-04	6	0	0	1	0.4388	0.3724
Bulten	2000-09-21	2	1	1	1	0.5939	0.1427
Capio	2006-09-01	13	1	0	1	0.4440	0.1387
Caran	1998-12-14	1	1	0	1	0.2165	-2.2691
Cashguard	2008-04-16	4	0	1	0	-0.0145	-2.6074
Cell Network	2000-02-08	5	1	0	0	-0.0792	7.0506
Celsius	1999-11-16	6	1	0	1	0.6149	0.5779
Celtica	2003-06-13	2	1	0	1	0.2802	0.5288
Cision AB	2008-04-30	11	1	0	1	0.5209	-0.2462
Custos	2006-11-08	5	0	0	1	0.2057	0.4554
Custos	2004-04-26	3	1	0	0	-0.0570	1.0006
Dahl International	1999-02-11	2	1	0	1	0.3429	0.1066
Diffchamb	2003-02-13	3	0	0	1	0.4723	0.0617
Digital Illusions CE	2006-03-17	4	0	1	1	0.1394	-1.1165
Digital Illusions CE	2004-11-15	5	0	0	1	0.0583	-2.7087
Diligentia	2000-01-18	2	1	0	0	0.1281	-0.0346
Diligentia	2000-02-14	3	1	0	0	0.1520	0.4071
Diligentia	2000-03-20	5	1	0	1	0.2260	0.1293

Appendix I continued

Target	Ann. Date	Number of Involved Firms	Domecile of Bidder (1 = Domestic, 0 = Foreign)	Press Speculation (1 = Yes, 0 = No)	Deal Structure (Cash = 1)	CAR [-60,1]	Run Up Index [-1, 1]
Dimension	2003-11-24	1	1	0	0	1.0249	0.1377
El & Industrimontage Svenska	2007-06-14	-	1	0	1	0.0215	-6.1670
Thule	1999-08-10	2	1	0	1	0.1800	-0.2156
Elverket i Vallentuna	2007-09-25	1	0	0	1	0.2985	-0.0246
Enator	1999-03-03	3	0	0	0	0.0934	0.1600
Entra Data	2000-05-15	3	0	0	0	-0.0027	-2.6130
Epsilon	2003-01-09	2	1	0	1	0.1480	-0.5859
Esselte	2002-05-24	6	0	0	1	0.4245	0.7823
Evidentia	2000-02-17	1	1	0	1	-0.1073	1.9714
Fabege	2004-07-19	6	1	1	0	0.0567	1.1637
Tornet	2003-10-20	10	1	0	1	0.1036	0.1628
FB Industri Holding	2000-10-06	1	1	0	1	0.4101	0.0127
Finnveden	2004-11-15	7	1	0	1	0.0437	-7.0794
Focal Point	2005-04-13	4	1	0	0	-0.0193	-2.4099
Folkebolagen	2000-05-09	1	1	0	1	0.7458	0.8823
Frango	2004-08-24	6	0	0	1	0.5079	-0.1979
Friluftsbolaget Ekelund & Sagner	2001-05-31	3	1	1	0	0.2037	0.6966
Gambro	2006-04-03	17	1	1	1	0.1966	0.1024
Gamers Paradise Holding	2005-10-17	-	1	0	0	0.2961	0.1760
Gant	2007-12-11	5	0	0	1	0.3586	0.0907
Gibeck	1999-05-12	1	0	0	1	0.7395	0.6016
Glocalnet	2006-02-08	5	0	0	1	0.0956	-0.3744
Gorthon Lines	2004-10-07	3	1	0	0	0.1077	0.0572
Guide Konsult	1999-12-03	3	1	0	0	0.9174	0.0784
Gunnebo Industrier	2008-07-22	15	1	0	1	0.6695	0.2296
Gylling Optima Batteries	2000-08-29	1	1	0	1	0.8104	0.0854
Gymgrossisten Nordic	2007-12-14	3	1	0	1	0.1174	-1.5958
Handskmakaren	1999-10-05	1	1	0	0	0.0060	10.2270
HQ Fonder	2005-06-30	2	1	0	0	0.0837	0.8065
Human Care	2008-01-14	3	1	0	1	0.1100	-0.5710
Humlegaarden Fastigheter	1999-11-06	0	1	1	1	0.5497	0.9982
IBS	2008-06-30	4	0	1	1	-0.2608	1.3069
Kinnevik	2004-02-16	6	1	0	0	-0.2071	1.2288
Intelligent Micro Systems Data	2002-02-18	1	1	0	1	0.9558	0.2512
Intentia	2005-06-02	9	0	0	0	-0.1058	1.6960
Intra	2000-12-01	-	0	1	1	-1.1017	1.1430
Inwarehouse	2007-03-26	4	1	0	1	0.3554	0.1131
Invik	2007-04-26	10	0	0	1	0.4355	0.4555
IRO	2000-08-21	1	0	1	1	0.3479	0.8948
JC	2006-05-09	5	1	0	0	0.2985	0.4010
JP Bank	1999-01-19	1	1	0	0	0.0207	-4.1692
JP Nordiska	2002-08-29	7	0	0	0	0.5649	0.5070
Karlshamns	2005-07-12	5	1	0	0	0.1504	1.0490
Karolin Machine Tool	2007-10-29	3	1	0	1	-0.0252	16.6883
Kipling Holding	2001-12-17	1	1	0	0	0.4780	0.7052
Kjessler & Mannerstråle	2000-02-14	-	1	0	0	-0.2685	1.7819
Kontakt East Holding	2008-05-26	6	1	0	1	0.2416	-0.6859
LBI	2006-03-21	5	1	1	0	0.0094	7.6850

Appendix I continued

Target	Ann. Date	Number of Involved Firms	Domecile of Bidder (1 = Domestic, 0 = Foreign)	Press Speculation (1 = Yes, 0 = No)	Deal Structure (Cash = 1)	CAR [-60,1]	Run Up Index [-1, 1]
Ledstiernan	2000-02-29	2	1	0	0	6.3394	0.1325
LGP Allgon Holding	2003-12-01	7	0	0	0	0.5735	0.4948
LGP Telecom Holding	1999-09-24	1	1	0	0	0.0246	3.9248
Lifco AB	2000-06-15	2	1	0	1	-0.0126	15.8485
Liljeholmens	1999-04-09	2	1	0	1	0.0172	-7.8785
Lindab	2001-05-14	9	1	0	1	0.2387	0.3202
Lindex	2007-08-13	7	1	0	1	0.2783	0.4893
Lindex	2007-10-01	5	0	0	1	0.2865	0.7612
Logica	2006-08-21	13	0	0	0	0.1842	0.5476
Lundin Oil	2001-06-21	8	0	1	0	0.6305	0.9223
Måldata	1999-12-17	1	1	1	0	0.3081	1.5804
Mandamus	2003-03-20	6	1	0	1	0.1621	0.0026
Mandator	2007-10-08	6	0	0	0	0.2384	-0.0822
Mandator	2000-03-22	3	0	0	0	0.1095	2.0506
Marieberg	1998-03-31	2	1	1	0	0.1971	-0.0278
Martinsson	1999-09-16	2	1	0	1	0.6137	0.6099
Matteus	2001-04-10	1	1	0	0	0.1703	0.1674
Matteus	2001-05-16	-	1	1	1	0.3090	0.8064
Monark Stiga	1999-11-19	5	1	0	1	0.4777	0.0288
Munksjoe	2002-01-29	6	0	0	1	0.2912	0.0077
N&T Argonaut	1999-11-16	2	1	0	1	0.2841	0.9905
Narkes Elektriska	2006-09-11	4	1	0	1	0.2008	0.5186
Naturkompaniet	2000-03-20	-	1	1	0	0.5878	0.1270
Nefab	2007-08-27	6	1	0	1	0.2441	0.1118
Netwise	2001-10-25	0	1	0	0	0.3080	-0.4993
Netwise	2006-06-05	2	1	0	1	0.0510	-3.1005
NK Cityfastigheter	1998-03-30	1	1	1	0	0.1729	0.5454
Norrporten	2000-08-21	2	1	0	1	0.3145	0.4901
Näckebro	1998-09-08	2	1	1	1	0.0321	-4.8995
OptiMail	2005-11-22	2	0	0	1	0.3402	-0.0586
Pandox	2003-11-04	4	0	0	1	0.2733	0.6600
Peab Industri	2008-10-15	4	1	0	0	-0.1268	0.8267
Peak Performance	1998-03-16	1	0	0	1	0.0741	0.4379
Perbio Science	2003-06-26	13	0	0	1	0.4017	0.5696
Pergo	2007-01-15	11	0	0	1	-0.1493	1.5468
Perstorp	2000-04-10	6	1	0	1	0.4277	0.7335
Perstorp	2001-03-22	9	1	1	1	0.5388	0.8021
Piren	2000-01-27	2	0	0	1	0.1700	1.0224
Platzer	2001-04-06	4	1	1	0	0.0792	-1.7576
Platzer	2001-06-01	2	1	1	1	0.2335	1.0142
PLM	1998-11-30	3	0	0	1	0.3204	-0.1773
PriFast	1999-03-01	1	1	0	1	0.4300	0.3031
Pronyx	2002-07-05	1	1	0	0	0.0049	-25.8303
Protect Data	2006-11-20	7	0	0	1	0.2217	0.7984
Provobis	2000-04-12	2	1	1	0	0.6625	0.1614
Realia	2003-03-12	2	1	0	1	0.2187	0.3400
Realia	2002-04-23	2	1	1	0	0.1932	1.0693
Resco	2000-09-11	4	0	0	0	0.5094	1.0508

Appendix I continued

Target	Ann. Date	Number of Involved Firms	Domecile of Bidder (1 = Domestic, 0 = Foreign)	Press Speculation (1 = Yes, 0 = No)	Deal Structure (Cash = 1)	CAR [-60,1]	Run Up Index [-1, 1]
Resco	2006-01-09	3	1	0	1	0.3083	0.2911
Riddarhyttan Resources	2005-05-12	11	0	1	0	0.2627	0.3091
RKS	2004-05-06	3	1	0	0	-0.1854	1.5346
Rorvik Timber	2005-06-29	-	1	0	1	-0.0286	-0.0222
SalusAnsvar	2007-08-20	5	0	0	1	0.6469	0.2184
Sapa Group	2002-07-05	4	0	1	1	0.1769	0.8501
Sardus	2007-02-19	6	0	1	1	0.4376	0.7551
Scancem	1999-05-04	5	0	0	1	0.3474	0.9286
Scandiaconsult	2003-02-17	6	0	1	1	0.1844	1.1509
Scandic Hotels	2001-04-23	8	0	0	0	0.1036	-1.6257
Scandinavia Online	2001-11-20	9	1	0	1	2.1015	0.7992
Scandinavian PC Systems	1999-03-24	0	1	0	0	0.2584	0.7499
Scania	2006-09-18	24	0	1	0	0.2951	0.8426
Scribona	2008-03-04	5	1	1	1	0.1871	0.9641
Securitas Direct	2007-11-13	19	1	0	1	0.6318	0.5541
Segerström & Svensson	2001-01-26	11	0	0	0	0.2786	-1.3805
Sendit	1999-05-18	5	0	1	1	0.6346	1.0897
Senea	2006-07-28	3	0	1	1	0.1317	1.2668
Sigma	2008-03-27	5	1	0	1	0.4774	0.2806
Skandia	2005-09-02	25	0	1	0	-0.1581	0.9008
Song Networks	2004-09-14	7	0	1	1	0.5055	0.0487
Spendrups	2001-04-30	2	1	0	1	0.3184	0.2338
Stena Line	2000-10-31	2	1	0	1	0.3878	0.7813
Stora	1998-06-02	7	0	0	0	0.1329	0.0488
Storheden	1998-04-14	3	1	0	0	-0.0669	1.8622
Strålfors	2006-03-14	4	1	0	1	0.1444	-0.4297
Svedala Industri	2000-06-21	10	0	0	1	0.4871	0.1049
Svenska Brand	2001-02-27	4	1	0	1	0.3972	0.9279
SCA	2000-02-28	2	1	0	0	-0.3439	1.0546
Svenska Orient Linien	2003-03-25	1	1	0	1	0.7291	0.4558
Sydkraft	2001-02-21	4	1	1	1	0.5675	0.9633
Tanganyika	2008-09-25	6	0	0	1	0.1370	-0.3822
Telelogic	2007-06-11	10	0	0	1	0.5864	1.0001
TietoEnator	2008-03-20	12	1	0	1	0.3193	-0.3318
TradeDoubler	2007-01-15	7	0	0	1	0.2693	0.4322
Trio	2005-04-20	-	1	0	0	0.1179	0.4990
Trio	2006-02-08	4	1	0	0	0.1020	0.3695
TurnIT	2004-12-22	3	1	0	0	0.3019	0.6770
Verimation	1998-07-03	1	0	0	1	1.0786	0.8942
Vision Park Entertainment	2001-09-03	1	1	1	1	0.2703	0.3331
VLT	2008-08-01	2	1	0	1	0.4626	-0.2534
VLT	2004-08-31	5	1	0	1	0.2253	-0.0439
Volvo Cars	1999-01-28	7	0	1	1	0.1282	1.1192
Vostok Energo	2003-04-08	3	1	0	1	0.2088	0.6028
XPonCard Group	2008-02-19	11	0	0	1	0.4627	0.2936
Zeteco	1999-04-08	1	0	0	1	0.2616	0.8067
Zodiak Television	2008-05-26	7	1	0	1	0.5422	0.4106

Appendix II: Results of the event studies calculating abnormal returns and abnormal volume

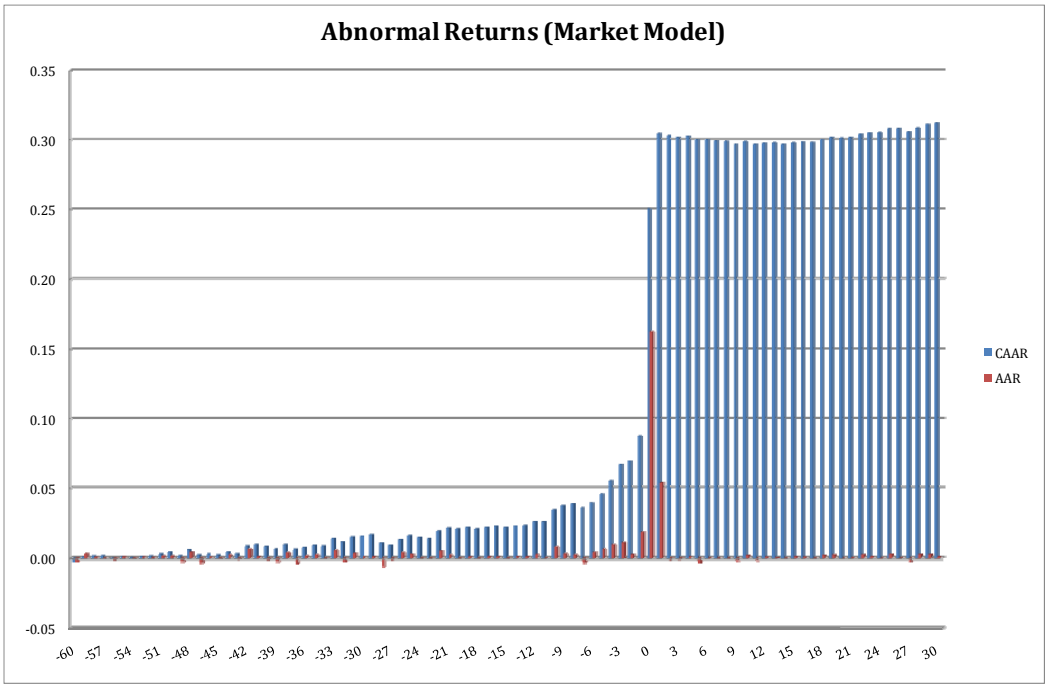
The results from the first part of our study. We have calculated Average Abnormal Return (AAR) as daily observations for the period [-60, 30], and the Cumulative Abnormal Returns (CAAR) as cumulative observations for the same period. Thus the last observation becomes $CAAR_{30} = \sum_{30}^{-60} AAR$*. Average Abnormal Volume (AAV) and Cumulative Abnormal Volume are calculated in the same way. For calculating abnormal returns we have used a market model, and for calculating abnormal volume both a market and a mean regressing model have been used.*

Trading Day	Abnormal Returns (Market Model)			Abnormal Volume (Market Model)			Abnormal Volume (Mean Model)		
	AAR	% Pos	CAAR	AAV	% Pos	CAAV	AAV	% Pos	CAAV
-30	0.0006	0.3874	0.0158	0.0641	0.5200	-2.1850	0.0465	0.5486	-1.8991
-29	0.0009	0.4188	0.0167	0.0116	0.4819	-2.1734	0.0340	0.5120	-1.8650
-28	-0.0057	0.4921	0.0109	0.0066	0.4689	-2.1667	0.0250	0.4915	-1.8401
-27	-0.0013	0.4607	0.0096	0.0100	0.5756	-2.1568	0.0267	0.5640	-1.8134
-26	0.0038	0.5183	0.0133	-0.0580	0.4855	-2.2147	-0.0656	0.5087	-1.8791
-25	0.0028	0.4817	0.0161	0.1714	0.5088	-2.0434	0.1570	0.4971	-1.7220
-24	-0.0011	0.5183	0.0150	0.0330	0.5143	-2.0104	0.0757	0.5600	-1.6463
-23	-0.0009	0.5340	0.0142	0.0406	0.5170	-1.9698	0.0621	0.5114	-1.5843
-22	0.0050	0.4660	0.0191	0.1371	0.5088	-1.8326	0.1749	0.5380	-1.4094
-21	0.0021	0.4921	0.0213	0.0762	0.5636	-1.7564	0.0891	0.5939	-1.3203
-20	-0.0005	0.4660	0.0207	0.0844	0.4800	-1.6720	0.1050	0.4686	-1.2153
-19	0.0009	0.4660	0.0216	0.1626	0.5349	-1.5095	0.2020*	0.5349	-1.0133
-18	-0.0010	0.4869	0.0206	0.0615	0.4885	-1.4479	0.0810	0.4885	-0.9324
-17	0.0010	0.4764	0.0216	0.0390	0.5393	-1.4090	0.0741	0.5449	-0.8582
-16	0.0008	0.4607	0.0224	0.0611	0.5176	-1.3479	0.0936	0.5706	-0.7646
-15	-0.0008	0.4764	0.0216	0.1178	0.5868	-1.2301	0.0985	0.5988	-0.6661
-14	0.0011	0.4555	0.0228	0.0712	0.5449	-1.1590	0.0933	0.5674	-0.5728
-13	0.0009	0.4869	0.0237	0.1165	0.5172	-1.0425	0.1401	0.5172	-0.4327
-12	0.0025	0.5288	0.0262	0.1835	0.5385	-0.8590	0.1947*	0.5385	-0.2380
-11	-0.0001	0.5497	0.0262	0.1914*	0.5311	-0.6675	0.1900	0.5254	-0.0480
-10	0.0083*	0.5131	0.0344	0.1610	0.5771	-0.5065	0.1427	0.5600	0.0947
-9	0.0029	0.4817	0.0373	0.0815	0.4889	-0.4250	0.1101	0.5444	0.2048
-8	0.0021	0.4869	0.0394	0.2435*	0.4802	-0.1815	0.2857*	0.5198	0.4905
-7	-0.0034	0.4974	0.0360	0.0250	0.5465	-0.1566	0.0644	0.5465	0.5549
-6	0.0039	0.5340	0.0399	0.0687	0.5920	-0.0878	0.0763	0.6034	0.6311
-5	0.0060*	0.5393	0.0459*	0.1599	0.5833	0.0721	0.1785	0.5893	0.8097
-4	0.0098*	0.5654	0.0557*	0.1989*	0.6205	0.2710	0.2605*	0.6265	1.0702
-3	0.0112*	0.6021	0.0670*	0.2907*	0.6392	0.5617	0.3153*	0.6772	1.3855
-2	0.0024	0.8743	0.0694*	0.3225*	0.9888	0.8842	0.3832*	0.9888	1.7687*
-1	0.0184*	0.5131	0.0878*	0.4243*	0.9402	1.3085	0.4808*	0.9348	2.2495*
0	0.1625*	0.4981	0.2503*	2.7264*	0.5132	4.0349*	2.7730*	0.5213	5.0225*
1	0.0544*	0.0000	0.3047*	2.3088*	0.0000	6.3437*	2.3602*	0.0000	7.3826*

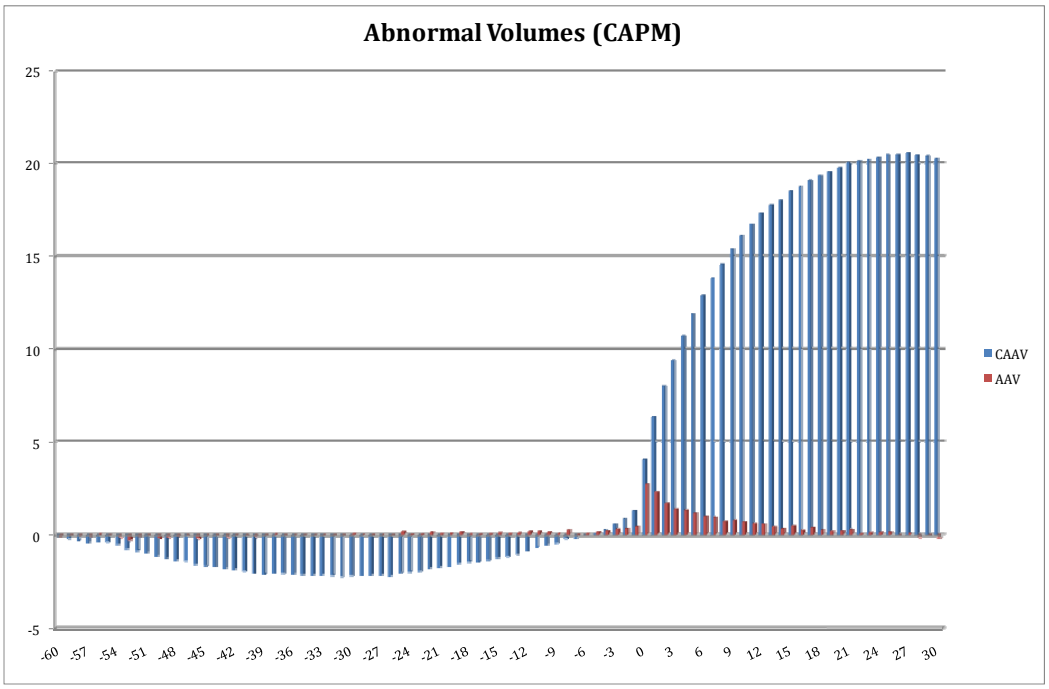
*Observations denoted with * are significant at the 1% level*

Appendix III: Graphs of CAAR, AAR, CAAV & AAV

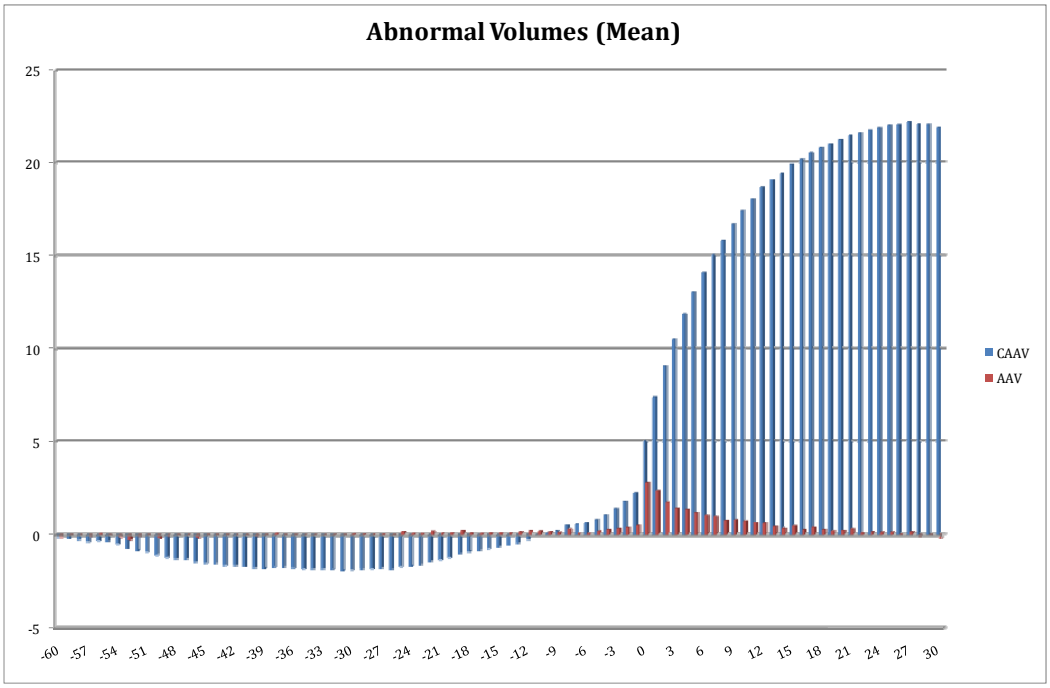
The figure shows the AAR and CAAR over the event window of [-60, 30]. As can easiest be seen by studying the CAARs in the figure, abnormal returns become significantly positive just shortly before the announcement date [-5], and cease to be significantly positive just shortly after [+1].



The figure shows the abnormal volumes (AAVs and CAAVs) calculated analogously with AARs (and CAARs). As can be seen from the figure, abnormal volumes display a pattern of serial correlation, changing just before the announcement from negative to positive.



The figure shows the abnormal volumes (AAVs and CAAVs) calculated by setting historic mean as expected volume. As can be seen from the figure, abnormal volumes display a pattern of serial correlation, changing just before the announcement from negative to positive.



Appendix IV: Comparison of Our and Previous Studies

A comparison between the findings of the first stage of our study, and equivalent previous studies. Total CAAR is calculated for the period [-20, 1], Pre-event CAAR is calculated over the window [-20, -1]. Announcement CAAR is calculated over the window [0, 1], and finally the run-up index is calculated by taking CAAR [-20, -1] / CAAR [-20, 1].

Authors (Point in time)	Keown and Pinkerton (1981)[1]	Jarrel and Poulsen (1989)[1,2]	Sanders and Zdanowicz (1992)[3]	Meulbroek (1992)[4]	Ascioglu et al. (2002)[5]	Jabbou et al. (2000)	King and Padalko (2005)	Our Study
Sample Period	1975-1978	1981-1985	1978-1986	1980-1989	1995	1985-1995	1985-2002	1998-2008
Sample Size	194	172	30	145	50	128	420	191
Country	U.S.	U.S.	U.S.	U.S.	U.S.	Canada	Canada	Sweden
Total CAAR	25.7%	28.3%	29.5%	30.6%	20.6%	12.7%	18.9%	31.2%
Pre-event CAAR	12.2%	11.0%	8.1%	13.0%	14.2%	5.5%	7.0%	8.8%
Announcement CAAR	13.5%	17.3%	21.4%	17.6%	6.4%	7.1%	11.9%	21.7%
Run-up Index	47.6%	38.9%	27.5%	42.5%	68.9%	43.8%	37.0%	28.8%

1. Successful Takeovers only.

2. Cash Offers only.

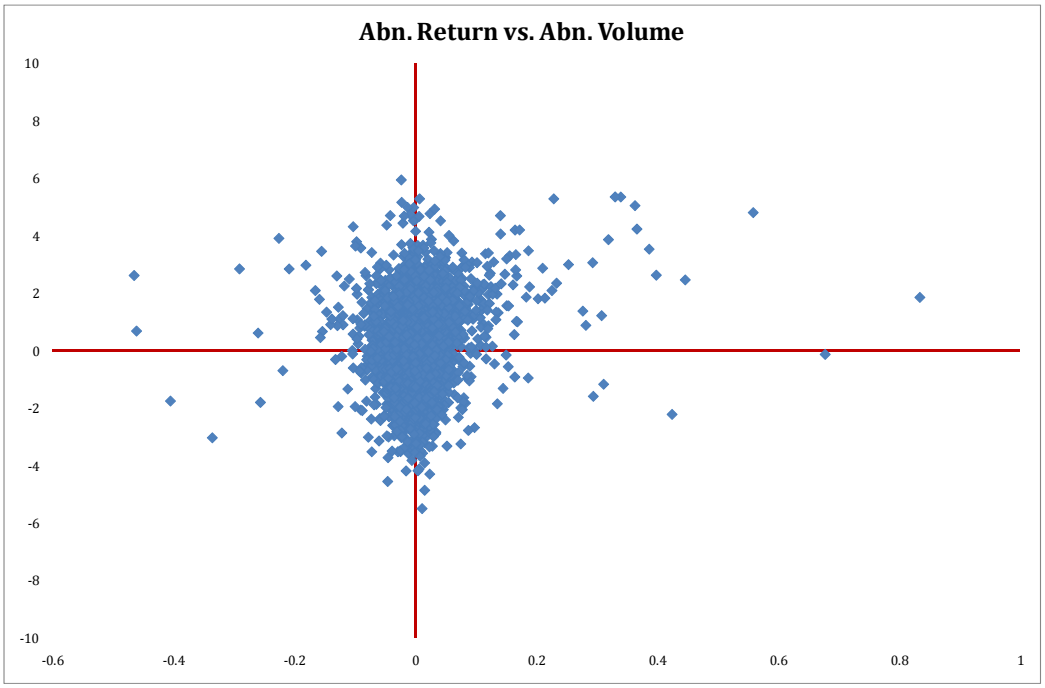
3. Deals with identifiable takeover initiation date. The total CAAR is calculated from the takeover initiation date to the announcement date (day 0), the pre-event CAAR is from the takeover initiation date to day -2, and the announcement CAAR is [-1,0].

4. Alleged cases of insider trading only. The total CAAR is calculated over the window [-20,0], the pre-event CAAR is [-20,-1], and the announcement CAAR is [-1,0].

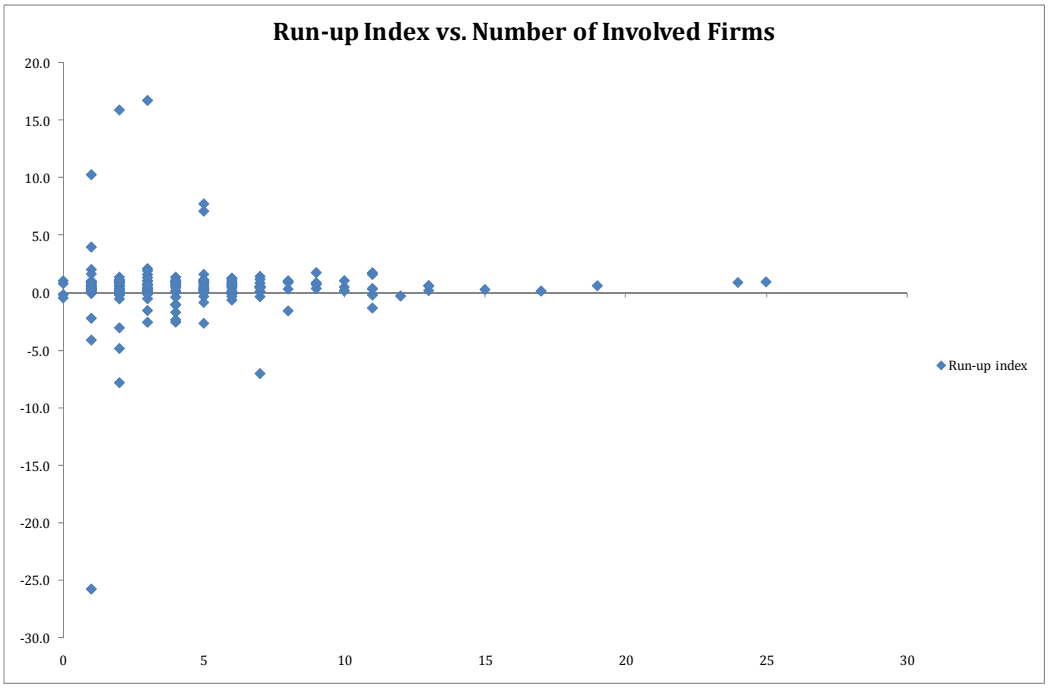
5. Takeovers of firms cross-listed on NYSE and another U.S. exchange only.

Appendix V: Scatter Plots

The scatter plot shows the panel data regression between abnormal return and abnormal volume. As can be seen from the plot, most observations are around the origo, and no clear pattern is exhibited. However, it should also be noted that there are cases of outliers that are show both positive abnormal return and volume.



The figure shows the results of the regression of the run-up index (on the vertical axis) regressed vs. the number of participating firms (on the horizontal axis). As can be seen, no clear pattern emerges.



Appendix VI: Autocorrelations for AAR and AAV

The table shows the autocorrelation coefficients for AAR under the different time frames defined under section 3.1.4.

Correlation coefficients for AAR														
	AAR [0, 1]	AAR [-60, 30]	AAR [-60, -30]	AAR [-60, -20]	AAR [-60, -5]	AAR [-60, 0]	AAR [-60, 1]	AAR [-30, 1]	AAR [-20, 1]	AAR [-20, 20]	AAR [-20, 0]	AAR [-5, 5]	AAR [-5, 1]	AAR [-5, 0]
AAR_lag1	-	0.3698*	-0.5407*	-0.3342	-0.0738	0.3903*	0.3617*	0.3419	0.3167	0.3577	0.3539	0.2497	0.1114	0.1558
AAR_lag2	-	0.0130	0.2270	-0.0053	0.1654	0.0102	-0.0008	-0.0426	-0.0817	-0.0168	-0.0612	-0.1810	-0.3856	-0.3679
AAR_lag3	-	0.0313	-0.2111	-0.1821	-0.1191	0.0250	0.0169	-0.0231	-0.0616	0.0028	-0.0435	-0.1801	-0.3330	-0.3142

* marks significance at 1% level

The table shows the autocorrelation coefficients for AAV using the mean model for calculating abnormal volume under the different time frames defined under section 3.1.4.

Correlation coefficients for AAV (Mean Model)														
	AAV [0, 1]	AAV [-60, 30]	AAV [-60, -30]	AAV [-60, -20]	AAV [-60, -5]	AAV [-60, 0]	AAV [-60, 1]	AAV [-30, 1]	AAV [-20, 1]	AAV [-20, 20]	AAV [-20, 0]	AAV [-5, 5]	AAV [-5, 1]	AAV [-5, 0]
AAV_lag1	-	0.8530*	0.3108	0.5606*	0.6969*	0.7588*	0.7928*	0.7618*	0.7459*	0.7947*	0.7103*	0.6060	0.6127	0.6061
AAV_lag2	-	0.7257*	0.0944	0.4845*	0.6444*	0.5944*	0.6313*	0.5684*	0.5338	0.6076*	0.4959	0.1943	0.2263	0.2532
AAV_lag3	-	0.6427*	0.2389	0.5962*	0.7092*	0.5199*	0.5598*	0.4765*	0.4286	0.4873*	0.3855	-0.1010	-0.0347	0.0079

* marks significance at 1% level

The table shows the autocorrelation coefficients for AAV using the market model for calculating abnormal volume under the different time frames defined under section 3.1.4.

Correlation coefficients for AAV (Market Model)														
	AAV [0, 1]	AAV [-60, 30]	AAV [-60, -30]	AAV [-60, -20]	AAV [-60, -5]	AAV [-60, 0]	AAV [-60, 1]	AAV [-30, 1]	AAV [-20, 1]	AAV [-20, 20]	AAV [-20, 0]	AAV [-5, 5]	AAV [-5, 1]	AAV [-5, 0]
AAV_lag1	-	0.8474*	0.3300	0.5319*	0.6756*	0.7470*	0.7844*	0.7537*	0.7386*	0.7886*	0.6999*	0.6039	0.6094	0.5999
AAV_lag2	-	0.7175*	0.0970	0.4473*	0.6329*	0.5770*	0.6181*	0.5561*	0.5223	0.5989*	0.4807	0.1904	0.2215	0.2451
AAV_lag3	-	0.6358*	0.2867	0.5805*	0.6982*	0.5044*	0.5482*	0.4659*	0.4196	0.4806*	0.3730	-0.0934	-0.0261	0.0136

* marks significance at 1% level

Appendix VII: Calculations of CAR, AAR, CAV, AAV

Calculation of CAR & AAR:

Step 1 (Normal returns – Market Model):

$$E(R_{it}) = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

where

$$\hat{\sigma}^2_{\varepsilon_t} = \frac{1}{L_1 - 2} \sum_{\tau=T_0+1}^{T_1} \left(R_{i\tau} - \hat{\alpha}_{it} - \hat{\beta}_i R_{m\tau} \right)^2$$

Step 2 (Abnormal returns - AR):

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt}$$

where

$$\sigma^2(AR_{i\tau}) = \sigma^2_{\varepsilon_t} + \frac{1}{L_1}\left[1 + \frac{(R_{m\tau} - \hat{\mu}_m)^2}{\hat{\sigma}^2_m}\right]$$

and

$$\hat{\mu}_m = \frac{1}{L_1} \sum_{\tau=T_0+1}^{T_1} (R_{m\tau})$$

The variance above has two components, the first is the disturbance variance from Step 1 and the second one is additional variance due to sampling errors in α_i and β_i. This sampling error, which is common for all the event window observations, also leads to serial correlation of the abnormal returns despite the fact that the true disturbances are independent through time. As the length of the estimation window *L1* becomes large, the second term approaches zero as the sampling error of the parameters vanishes.[6]

Step 3.1 (Cumulative abnormal returns - CAR):

$$CAR_i = \sum_{\tau=T_1+1}^{T_2} (AR_{i\tau})$$

where

$$\sigma^2(\mathrm{CAR_i}) = \sum_{\tau=T_1+1}^{T_2} \sigma^2(\mathrm{AR_{i\tau}})$$

[6] McKinley, 1997 p. 21

Under the assumption that $L_1 \to \infty$ the variance instead becomes

$$\sigma^2(\mathrm{CAR_i}) = (\mathrm{T_2} - \mathrm{T_1} + 1)\,\sigma^2(\mathrm{AR}_{i\tau})$$

Step 3.2 (Average abnormal returns - AAR):

$$AAR_\tau = \frac{1}{N}\sum_{i=1}^{N}(AR_{i\tau})$$

where

$$\sigma^2(AAR_\tau) = \frac{1}{N^2}\sum_{i=1}^{N}\sigma^2(AR_{i\tau})$$

Calculation of CAV & AAV – Market Model:

Step 1 (Data preparation-Log/Turnover calculation):

$$V_{i\tau} = Log(Turnover_{i\tau}) = Log\left(\frac{Volume_{i\tau}}{NOS_{i\tau}}\right)$$

We use the log-function to mitigate the trend affects that accrue from low market participation during summer months and around Christmas.

Step 2 (Normal volume - CAPM):

$$E(V_{it}) = \alpha_i + \beta_i V_{mt} + \varepsilon_{it}$$

where

$$\hat{\sigma}^2_{\varepsilon_t} = \frac{1}{L_1 - 2}\sum_{\tau=T_0+1}^{T_1}\left(V_{i\tau} - \hat{\alpha}_{it} - \hat{\beta}_i V_{m\tau}\right)^2$$

Step 3 (Abnormal volume - AV):

$$AV_{it} = V_{it} - \hat{\alpha}_i - \hat{\beta}_i V_{mt}$$

where

$$\sigma^2\left(AV_{i\tau}\right) = \sigma^2_{\varepsilon_t} + \frac{1}{L_1}\left[1 + \frac{\left(V_{m\tau} - \hat{\mu}_m\right)^2}{\hat{\sigma}^2_m}\right]$$

and

$$\hat{\mu}_m = \frac{1}{L_1}\sum_{\tau=T_0+1}^{T_1}\left(V_{m\tau}\right)$$

Step 3.1 (Cumulative abnormal volume - CAV):

$$CAV_i = \sum_{\tau=T_1+1}^{T_2}(AV_{i\tau})$$

where

$$\sigma^2(\mathrm{CAV_i}) = \sum_{\tau=T_1+1}^{T_2}\sigma^2(\mathrm{AV_{i\tau}})$$

Under the assumption that $L_1 \to \infty$ the variance instead becomes

$$\sigma^2(\mathrm{CAV_i}) = (\mathrm{T_2 - T_1 + 1})\,\sigma^2(\mathrm{AV_{i\tau}})$$

Step 3.2 (Average abnormal volume - AAV):

$$AAV_\tau = \frac{1}{N}\sum_{i=1}^{N}(AV_{i\tau})$$

where

$$\sigma^2(AAV_\tau) = \frac{1}{N^2}\sum_{i=1}^{N}\sigma^2(AV_{i\tau})$$

Calculation of CAV & AAV – Market Model:

Step 1 (Data preparation-Log/Turnover calculation):

$$V_{i\tau} = Log(Turnover_{i\tau}) = Log\left(\frac{Volume_{i\tau}}{NOS_{i\tau}}\right)$$

We use the log-function to mitigate the trend affects that accrue from low market participation during summer months and around Christmas.

Step 2 (Normal volume - Average):

$$\bar{V}_{i\tau} = \frac{1}{L_1}\sum_{\tau=T_0+1}^{T_1}(V_{i\tau})$$

where

$$\hat{\sigma}^2(V_{i\tau}) = \frac{1}{L_1}\sum_{\tau=T_0}^{T_1}\left(V_{i\tau} - \bar{V}_{i\tau}\right)^2$$

Step 3.1 (Abnormal volume -AV):

$$AV_{it} = V_{it} - \overline{V}_{it}$$

where

$$\sigma^2(AV_{i\tau}) = \hat{\sigma}^2(V_{i\tau})$$

Since no parametric estimation is performed hence no sampling error will occur and thus no correction is needed.

Step 3.2 (Cumulative abnormal volume - CAV):

$$CAV_i = \sum_{\tau=T_1+1}^{T_2}(AV_{i\tau})$$

where

$$\sigma^2(\mathrm{CAV_i}) = \sum_{\tau=T_1+1}^{T_2}\sigma^2(\mathrm{AV_{i\tau}})$$

Under the assumption that $L_1 \to \infty$ the variance instead becomes

$$\sigma^2(\mathrm{CAV_i}) = (\mathrm{T_2 - T_1 + 1})\,\sigma^2(\mathrm{AV_{i\tau}})$$

Step 3.3 (Average abnormal volume - AAV):

$$AAV_\tau = \frac{1}{N}\sum_{i=1}^{N}(AV_{i\tau})$$

where

$$\sigma^2(AAV_\tau) = \frac{1}{N^2}\sum_{i=1}^{N}\sigma^2(AV_{i\tau})$$