Implications of Insider Trading for Market Efficiency: Empirical Evidence from the Swedish Stock Market

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Abstract

Although a large research body pertains to abnormal returns in insider trading and market efficiency, little research has looked into the actual directional impact of insider trading on market efficiency. This study sets out to examine if insider trading activity promotes or impairs market efficiency. As market efficiency is not directly observable, the level of autocorrelation in share pricing has been introduced as a proxy in line with the Random Walk Hypothesis. The proxy is quantified as the multiple variance ratio test statistic and constitutes the dependent variable, insider trading being the main independent variable. The variables, computed for a sample of 149 companies listed on the OMX Stockholm exchange in the period 2004-2014, are regressed using a GLS framework. The regression output supports that insider trading activity results in more prevalent share price autocorrelation implying that market efficiency is impaired. It is also concluded that insider buy transactions have a stronger negative impact on market efficiency than insider selling. These findings contribute to the understanding of insider trading dynamics and has interesting implications for market efficiency theory.

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Contents

1 Introduction

"Markets thrive on transparency, but insider trading thrives on opacity"
– James Surowiecki, Staff Writer, October 2005 *The New Yorker*, "Capitol Gains"

"Insider trading serves as a means of communicating market information, which makes markets more efficient"
– Robert W. McGee, Professor of Accounting at Barry University, January 2008 *Journal of Business Ethics*, "Applying Ethics to Insider Trading"

The diffusion and incorporation of information are integral parts of the Efficient Market Hypothesis (hereinafter abbreviated EMH). Interestingly, this very nexus of the EMH has become much politicized by both advocates and adversaries of regulating insider trading. Yet, the otherwise well-documented and rather conclusive insider trading niche in finance research appears scattered on the issue of insider trading and market efficiency. Hence, this study sets out to examine how insider trading activity relates to market efficiency levels. In other words, does the insider trading activity in itself promote or impair market efficiency? This effect is examined by measuring the prevalence of autocorrelation in stock pricing in concurrence with different levels of insider trading.

Initially, more context should be provided as to why this seemingly niche topic has a more widespread application in finance research. Insider trading scandals have long plagued financial systems and its effect on social utility is much debated. Moreover, insider trading is not only a source of controversy in politics but has proven to have puzzling implications on finance research.

Numerous researchers including Pratt and DeVere (1970) and Finnerty (1976) have concluded that insiders consistently earn abnormal returns thus contradicting the strong form efficiency. More interestingly, however, Seyhun (1986) among others have concluded that outsiders simply by imitating insiders can make abnormal profits. This revelation and that it is publicized constitutes a violation to the more widely accepted semi-strong form stating that historical as well as public information is reflected in security prices.

Yet, despite a large body of research evidencing anomalies in two forms of the EMH little insider trading research has investigated how it relates to the weak-form hypothesis. More importantly, little research has looked into the actual effect of insider trading to market efficiency. Actually determining the directional impact of insider trading ought to have a much wider application than many existing studies that simply establish the absolute level and abnormal returns in a given market. In light of this, the study sets out to examine the impact of insider trading on market efficiency, i.e. if insider trading increases or decreases share price efficiency? As market efficiency is not readily observable it is proxied by the level of autocorrelation in line with the

Random Walk Hypothesis (hereinafter abbreviated RWH).

For the RWH and weak-form efficiency to hold true there should be no autocorrelation between stock prices, instead prices should follow a random walk. The alternative would be that insider trading creates predictable patterns in share prices meaning that past prices are not fully incorporated in present prices. Identifying more prevalent autocorrelation in concurrence with higher levels of insider trading would imply that markets become less efficient as a result of insider activity. In testing the RWH, the widely accepted multiple variance ratio test is applied to OMX Stockholm share price data collected from Thomson Reuters Datastream. The test examines the correlation between past and present prices.

This measure of time-varying level of informational efficiency then constitutes the dependent variable. The insider trading variable, computed from Finansinspektionen data, comprise the main independent variable. In said variable a distinction has also been made between buy and sell orders. This is deemed appropriate as the respective activity is likely to stem from differing underlying reasoning and as such have different information content. In terms of statistical framework, the Generalized Least Squares regression using random effects is applied. This model has proven suitable for other studies with similar panel data sets containing multiple variables observed a number of times for numerous companies. Whereas the application can be considered new for this particular research question all the individual components of the method have been tested and proven in related research.

In addition, a set of factors which could potentially influence market efficiency, namely company size and state of the economy, are also introduced in the regression. These are measured by market capitalization respectively GDP and categorized as independent variables alongside insider trading in the regression. Including these independent variables allows for benchmarking of the weight of the insider trading variable. In other words, it not only allows for the directional impact to be determined but also the actual magnitude of the effect. Running the regression will map out the relationship between the independent and dependent variables, i.e. the impact insider trading has on market efficiency. The research questions looking to be answered are thus:

i. What is the net impact of insider trading on market efficiency?
   - In other words, is there a link between the insider trading frequency and market efficiency levels as proxied by share price autocorrelation?

ii. Is there a distinction between insider buy and sell orders in terms of efficiency contribution?

iii. Is the impact on market efficiency related to company market capitalization or the state of the economy?

In the study it is hypothesized that insider trading has negligible net impact on market efficiency as the different effects of the activity is likely to cancel each other out. This implies that the autocorrelation in share prices is anticipated to remain at a similar level regardless of insider trading

frequency. The reasoning mainly revolves around the ambiguous implications of insider signaling. On the one hand using an analogue application of Grossman & Stiglitz (1980), well-informed insiders are likely to feed uninformed investors with proprietary information. This signaling takes the form of purchase orders on stocks with expectations of strong future performance and vice versa. Consequently stock prices would move to more accurately reflect the intrinsic values allowing for less autocorrelation. As such, more information would be incorporated into stock prices which would follow more of a random walk.

Meanwhile, with Seyhun's (1986) findings in mind the insider signaling also ought to have the adverse effect. The study concluded that outsiders consistently can earn abnormal returns by simply imitating the trades of insiders. Consequently, following the publication of insider activity external investors are likely to replicate the trades. This implies that the market reaction is predictable which in its turn creates patterns in the pricing. As such, the stock price would show increased autocorrelation and to a lesser extent follow a random walk. These opposing signaling effects are anticipated to coincide but the impairing effect is likely stronger in magnitude. This implies that insider trading activity increases autocorrelation in share pricing resulting in less efficient markets.

It is also hypothesized that there is distinction between insider buying and selling in terms of impact on informational efficiency. An insider net purchase is believed to have a stronger signaling effect as it is more likely to stem from an active action. Contrastingly, selling is often associated with diversification and liquidity reasons. As a result insider buying is likely to be more frequently concurring when there is a spread between market and intrinsic value whereas selling theoretically should occur more randomly. This means that insider buying is likely to create patterns in stock pricing whilst selling probably has less of an effect on market efficiency.

In regards to company size and state of the economy, proxied by market capitalization respectively GDP, these are predicted to somewhat positively correlate with informational efficiency. This implies that shares are marginally more efficiently priced for larger companies and also when the economy is performing well. This relationship with state of the economy is believed to stem from increased price volatility and limitations in resources in times of crises. The rationale in regards to company size is that largely companies are more frequently traded and have greater analyst coverage. As such, evaluations in regards to the intrinsic value is performed more frequently presumably resulting in more efficient pricing.

The initial regression for all companies yielded an insignificant insider trading coefficient meaning that it is neither possible to reject nor confirm an effect of insider trading. In contrast, subsequent regressions using a selection criteria firstly relating to ownership concentration and secondly to proportion of insider-traded shares produced conclusive results. Regressing all companies except for the most sparsely insider-traded companies revealed that insider trading activity impairs market efficiency as it bolsters autocorrelation levels. Meanwhile, the size variable though significant proved more or less negligible. The consistently insignificant GDP on

coefficient on the other hand, proved it having little correlation with market efficiency. Moreover, both insider sell and buy transactions were found to negatively impact share price efficiency, the latter of which proved to have a stronger magnitude.

When contrasting these results with the findings of related papers, they are not surprisingly contradictory to some papers and in line with others. This is in part explained by the use of different proxies for market efficiency as the measure is not readily available. Aktas et al. (2008) conclude that the price sensitivity to order imbalance increases in concurrence with insider trading. This implies that price discovery is hastened. Thus insider trading increases market efficiency as the intrinsic values are more accurately reflected.

Fishman and Hagerty (1992) on the other hand, contend that insiders drive out outside investors and that alternative information-seeking is crowded out. This stems from the reluctance to trade against an informed party. This allows for stock prices to deviate more from intrinsic values as less frequently traded have their market value less commonly evaluated. This in its turn is said to decrease the information efficiency of stocks that are frequently traded by insiders. These papers indicate some of the alternative explanations e.g. the eventuality that there is a reverse causality in which less efficiently priced shares instead spur higher levels of insider trading. This cannot be refuted with certainty but existing papers evidencing a causal link has been used as assurance. There could also be other variables outside the study that the effect in fact should be attributed to, or perhaps better proxies for market efficiency.

Nonetheless, that the study was able to reject the null hypothesis stating that insider trading has no effect on market efficiency contributes to the understanding of insider trading dynamics. It also has interesting implications for the EMH. Granted that the study did not set out to test the weak-form efficiency, it still implies that insider trading creates pattern in share pricing. In related theory, this would be interpreted as it being possible to earn abnormal returns simply by technical analysis. Moreover, it stands in contrast to studies contending that the Swedish market is weak form-efficient. This in its turn can be said to highlight the limitations of the EMH in that it uses a rather blunt binary approach in describing complex markets. Of course the EMH has merits as a theoretical representation, but markets seldom prove to be efficient or inefficient across proxies and over time.

The contribution of the study in mapping out the effects of insider trading on market efficiency also extends well beyond the finance research community. It also has value as theoretical foundation on which to design the insider trading legal framework so that it promotes market efficiency and restores public confidence. Moreover, the study develops investor understanding of insider trading dynamics. This should in theory trigger investors to exploit existing inefficiencies thus driving the market to higher levels of efficiency. The study also serves as a benchmark for, and trigger of, future research testing other samples and markets. Ideally, said research would also examine the effect of insider trading on market efficiency across proxies for added conclusiveness.

2 Literature Review

2.1 Efficient Market Hypothesis

The Efficient Market Hypothesis developed by Fama (1965) states that markets are efficient if prices fully reflect all available information. The concept of information in this case not only includes what is known at present but also future expectations in regards to e.g. earnings and dividends. Prices should also promptly adjust to incorporate new information. The theory argues that as a result of efficient markets where prices reflect all information, it is not possible to consistently outperform the market. As such, one cannot earn excess returns by stock picking or market timing. The only way to obtain higher returns is instead to take on more risk. The EMH takes on three different forms namely weak, semi-strong and strong form addressing differences in which information is included.

According to the weak-form efficiency it is not possible to earn abnormal returns by analysing past prices. In other words, investment strategies relating to historical prices does not systematically earn excess returns. Stock prices changes are said not to be autocorrelated, i.e. there are no patterns in asset pricing. Instead price changes are determined by information which is not contained in the price series. By looking at the serial dependence in share price changes one can test for the level of weak-form efficiency. The weak form concludes that excess returns cannot be achieved using technical analysis.

The semi-strong form incorporates the historical pricing components and adds another layer relating to public information. The form assumes that stock prices promptly and unbiasedly adjust to reflect any new public information. Hence, excess returns cannot be achieved by either technical or fundamental analysis. In testing the form, the price development is studied when previously unknown news are made publicly available. The semi-strong form implies that by simply employing an investment strategy using public information one cannot reliably earn abnormal returns.

Similarly to the semi-strong form the strong form introduces another factor, though in this case building on the semi-strong form. In addition to prices reflecting historical pricing and public information the strong form also stipulates that private information is incorporated. It contends that all information, non-market, market and even inside information, is factored into security prices and that no market participant has monopolistic access to any information. The test for strong-form efficiency is if abnormal returns can be made over an extended period of time. However, even the cases where fund managers are able achieve these returns do not contradict the strong form. This stems from their returns being normally distributed where there are bound to be a few cases of high-performers. As such, the strong form still assumes a perfect market in which excess returns are not possible to achieve systematically.

2.2 Insider Trading and the Efficient Market Hypothesis

Given the standing of the EMH in the finance research community it is not surprising that there is a large body of research pertaining to each form of efficiency. In terms of literature on insider trading and how it relates to market efficiency specifically, there is also a plethora of research on the semi-strong and strong form. Meanwhile, there only appears to be one paper, or at least very few studies, in fact looking into insider trading and the weak-form efficiency.

Said research by Aktas et al. (2008) finds that the price sensitivity to relative order imbalance increases together with insider trading. This finding suggests that price discovery is hastened on insider trading days. This is then said to increase the informational efficiency as the prices move to more accurately reflect the intrinsic value. Consequently, there would be less of a built-in bias in the pricing of the stock meaning that the random walk hypothesis is more likely to hold true.

Having said that, there is naturally numerous papers examining the level of weak-form efficiency on its own which are not considering the insider trading component. Perhaps the most well-known paper by Lo and MacKinlay (1988) finds correlation in the prices in the CRSP index thus rejecting the random walk hypothesis. More recently, Chaudhuri (2001) studying ten emerging markets could also reject the random walk hypothesis at the 5% significance level. In contrast, Kam et al. (1997) tested the weak-form efficiency on 18 developed markets including Sweden finding little to no autocorrelation in the prices.

Nonetheless, there is sparse research on insider trading and the weak form unlike the strong form which is well-covered in the literature. Such tests examine insiders' ability to consistently make abnormal return. In terms of verdict, it appears that it is more or less consensus in the finance community that insiders do in fact earn excess returns. E.g. Jaffe (1974) and more recently Ziobrowski et al. (2011) concluded that insiders achieve abnormal returns. According to Jeng et al. (2003) the magnitude of the abnormal returns for insider selling amounts to 6% annually for corporate executives on NASDAQ over a 20-year period. These findings refute the strong-form efficiency stating that all information, even private, is incorporated into share prices. Having said that, there are naturally a few studies such as that of Chowdhury et al. (1993) contending contradictory findings, i.e. that insiders do not earn abnormal returns.

Though the latter studies are few and perhaps less widely recognized they still have some interesting implications. What these studies indicate is that the market efficiency as a concept is varying not only based on which market is studied but also over time. As such it might be most appropriate to consider market efficiency a dynamic measure rather than an absolute state.

In terms of research on the semi-strong form it should be pointed out that such indirectly also tests the strong form. This is the case as insider trading research relating to the semi-strong form often is structured to test for insiders' ability to achieve abnormal returns. Once this is established the usual process is to examine if outsiders simply by replicating inside trades also

are able to earn excess returns. Perhaps the most acknowledged paper in the field was performed by Seyhun (1986). The study concluded that outsider were in fact able to achieve abnormal returns by mimicking insiders. Further, it also identified a distinction in returns depending on the timing of the replicating trade. Not surprisingly, higher returns were achieved when trading on the SEC lists rather than the official summary as the first-mentioned is published closer following the inside trade.

Whilst Seyhun's (1986) research has become the go-to paper in this finance niche the study by Wahlström (2003) is perhaps more relevant given its Swedish context. Similarly the Swedish study also found that outsiders could achieve abnormal returns by imitating insiders. However interestingly, Wahlström (2003) found this to be the case for mainly the larger companies whereas the implications were more ambiguous for smaller companies. This indicates that market efficiency is also distinguished by company size. As in the case of the strong form there are also papers relating to specific markets concluding the opposite, namely that abnormal returns cannot be achieved.

As indicated by the above papers there is a large body of research on both the strong and semi-strong form. Moreover, the finance research community appears to be in concurrence in regards to how insider trading relates these two forms. Given the limited research on the weak-form efficiency its implications remains very much unknown. As such this particular topic is highly relevant to study.

2.3 Random Walk Hypothesis

At the turn of the 20^{th} century statisticians observed that stock price changes seemed to follow an unpredictable pattern. This led to the Random Walk Hypothesis, first espoused in 1900 by mathematician Louis Bachelier. The RWH states that stock prices, similar to the steps taken by a drunkard, follow an unpredictable pattern. This stems from the notion that all information is incorporated in the pricing in an efficient market. As such, changes in stock prices must be as a result of only new information. Given that such information arrives unpredictably and its content is unknown, stock prices must also fluctuate randomly.

However, other researchers have since found imperfections in the RWH. The momentum theory constitutes one of such anomalies. Jegadeesh and Titman (1993) found that by longing recent winners and shorting recent losers it was possible to consistently earn excess returns. This was possible even on a risk-adjusted basis thus contradicting the RWH and the weak-form efficiency. Fama himself later accepted the momentum theory as the main anomaly in the weak-form efficiency. Grossman and Stiglitz (1980) also argue that the RWH cannot hold true as there reasonably must be incentives for investors to seek information.

Having said that, Fama still argues that the random walk model is a more powerful tool in testing the weak form of the EMH than the traditional fair-game model. He contends that it is an extension of the fair-game model which only indicates the market equilibrium conditions in

terms of expected returns. Meanwhile, the random walk model provides insight into the actual stochastic process which generates the returns. As such, it has been deemed an appropriate theory in testing the non-predictability of the market, i.e. the weak-form efficiency.

2.4 Signaling Effect

In economics signaling is defined as actions where one party, referred to as the agent, credibly conveys information to the other party, the principal. The concept of signaling was introduced 1973 by Michael Spence in an article relating to asymmetric information. It was proposed that the two parties could bridge the asymmetry by having one party sending a signal revealing information to the other. Consequently, the recipient would act on that information and adjust purchasing behaviour accordingly. In practice this could take the form of a better-informed company e.g. repurchasing shares which often is looked upon by investors as a signal that the share is undervalued. In contrast to a public announcement stating this undervaluation the act of repurchasing is believed to be a more credible signal as the company is willing to also invest in proving it.

Relating this to insider trading and the research of Grossman & Stiglitz (1980) it is implied that well-informed insiders feed uninformed investors with information. Insider trading in the stock would signal to the investors about the intrinsic value of the firm. The investors would then act on the information as it is considered superior to their own by trading in the given stock. This is made possible by lists of insider trades compiled and published by Finansinspektionen. It should be pointed out that the actual timing of the signaling is not when the trade occurs but rather when it is published a few days later.

Whilst this is the main interpretation of the effects of signaling there is also an alternative reasoning. Reasonably signals of insiders should in practice be informative in some cases and misleading in other in regards to the intrinsic value. The latter would in contrast add deceptive information of the actual share value triggering its price to move further from the fair value. Such signaling could occur e.g. when a company is in a cycle of poor performance and an executive despite this purchases company stock. The cynical interpretation is then that the inside trade is an attempt at overcompensating for the poor performance. Rather than an underlying undervaluation the motivation is simply to signal to the market that the stock is worth purchasing. The incentives behind providing this misleading signaling being to drive up the stock price.

As indicated, the concept of signaling is not as straightforward as it appears and adding more layers further adds to the complexity. E.g. it could also be argued that there is difference in magnitude or interpretation based on sender of the signal. The signaling of the CEO might be considered more credible than that of the relative to an insider. Moreover, one could also argue that an insider buy order transmits a different signal than a corresponding insider sale. As such, the seemingly marginal idea of signaling is rather complex and highly relevant for this study.

2.5 Insider Trading Contribution to Market Efficiency

There is a body of research relating to how insider trading impacts market efficiency. In reviewing said papers it becomes apparent that the lack of directly observable measure for market efficiency has a scattering effect on the research. Researchers have had to resort to a wide variety of proxies for such and consequently ended up with differing conclusions. This is not a problem in itself and most certainly the case for several niches in finance research. Though what perhaps should be considered problematic is that these studies often use somewhat indirect measures and rely on assumptions which perhaps require a separate study on their own.

An example of such a study is that of Albert and Axelsson Wadman (2008) measuring the relationship between insider trading and analyst coverage. This is then said to determine the impact on market efficiency. Though it is reasonable to assume that more analyst coverage should promote efficient markets the approach is indirect and subject to numerous other influencing factors. In any research it is of course difficult to isolate the studied factor and not rest on certain assumptions.

Having said that, the approach of this study using the multiple variance ratio test is believed to be a more direct test. Importantly, it also builds on the widely accepted RWH test for level of weak-form efficiency upon which the insider trading component is added. This should imply that the test to the same extent does not rely on assumptions which are not well-covered in finance research. Nonetheless, looking into existing research not only gives nuance on insider trading and market efficiency but also provides other results against which to compare the findings.

2.5.1 Fishman and Hagerty Model

Fishman and Hagerty (1992) contend that the presence of well-informed insiders is likely to drive out uninformed investors from the market. This is said to stem from investors' reluctance to trade with other better-informed insiders. The insiders are said to capitalize on this information asymmetry on behalf of the less-informed investors. Applying the Fishman and Hagerty model to this study ought to give a negative correlation between inside trading and market efficiency provided that the model holds true. This means more frequent insider trading should result in the stock price deviating more from the intrinsic value and vice versa. Similarly, companies with a higher proportion of inside trades should theoretically be less efficiently priced than companies without insider trading, all other factors constant.

The underlying reasoning behind the model also relates to the crowding out of information-seeking. In the presence of insiders, market actors would simply not have any incentives to seek information and analyse the company as insider information is deemed superior. As such stocks get less frequently traded and its intrinsic value less commonly evaluated by market actors. Consequently, as the pricing becomes less efficient giving rise to patterns the prices are anticipated

to follow less of a random walk.

Albert and Axelsson Wadman (2008) constructed a study along the same lines but relating to analyst coverage. They found a negative correlation between insider trading and analyst coverage also explained by the crowding out hypothesis. As previously mentioned, this rather indirect approach in determining market efficiency is subject to criticism. Regardless, relating the findings of this study to the crowding out theory ought to have interesting implications.

2.5.2 Spread Decomposition Model

Using spread and adverse selection components, the spread decomposition model measures information asymmetries and the contribution of insider trading. Van Ness et al. (2001) compared the estimate components of five different adverse selection models with other measures relating to informed trading and information asymmetry. However, said tests produced mixed results. Only in three of five cases where the models found to have a relation with the insider trading proxies thus its descriptive power should be questioned. Moreover, Neal and Wheatley (1998) similarly found that different spread decomposition produce conflicting research. Consequently, the applicability of the model has been subject to criticism in finance literature.

2.5.3 Permanent Price Impact Measure

In measuring the contribution of informed trading the Permanent Price Impact Measure conceptualized by Hasbrouck (1991) is also applicable. The idea is that the more informative a trade is considered the bigger its permanent impact on price should be. The dynamic between the pricing and order flow is computed using a vector autoregressive model. Hasbrouck's approach builds on the assumption that the unexpected component of the total order flow is a proxy for informed trading based on private information. The permanent, or rather long-term, price impact of such trading is then measured and used as gauge of information-based trading.

In terms of how the model has been received in the finance research community, it has been recognized as attractive though there are difficulties in its implementation. Such mainly relates to the need for a large quantity of observations. The requirement of high-frequency data implies that the model is only applicable to frequently traded stocks. Having said that the vector autoregressive model is still functional with fewer observations though the impact on less liquid stocks are likely to be exaggerated. This also relates to difficulties in determining the unexpected order flow component for such stocks.

2.5.4 PIN Model

The probability of information-based model, referred to as the PIN model, was originated by Easley et al. (1996). Its wide recognition is said to stem from it being structured as a sequential trade model. This not only allows for numerous applications in the field of empirical finance but also proves appealing from in terms of empirical tractability. The simplicity of the model can

also be derived from it solely requiring classified trades, i.e. buyer or seller-initiated trades.

However, critiques have contended that its information content is not sufficiently evident. Instead the model is simply said to indicate that discrepancies in classified trading is likely to relate to information-based trading. This limitation has also been empirically proven by Aktas et al. (2008) who found the PIN model to simply measure the trade imbalance statistic. As such it can be deemed appropriate in determining the ratio between the absolute spread in buy and sell orders and the total order flow but the link to informed trading can be questioned.

2.5.5 ROIB Model

Similarly to the PIN model the ROIB model introduced by Aktas et al. (2008) computes the relative order imbalance, i.e. the spread in buy and sell orders over the daily volume. This metric is put in relation to the price sensitivity of the stock price in the corresponding time period thus measuring the correlation. The study then determines the beta level, defined as the abnormal change in sensitivity, in concurrence with insider trading and when there is no such activity. As such the relation between stock returns and relative order imbalance is used in measuring the contribution to market efficiency.

The model was developed by Aktas et al. (2008) which in their study find that the price sensitivity to relative order imbalance increases on insider trading days. This implies that insider trading hastens price discovery which in its turn means that the prices move to reflect the intrinsic value. Hence applying the ROIB model on a U.S. data set suggests that insider trading increases market efficiency. In terms of merit of the model, using price sensitivity to relative order imbalance as a proxy for market efficiency has been subject to criticism in finance literature. It is contended that the measure is too narrow in answering the broader question relating to overall market efficiency contribution.

3 Data Description

The data set includes insider trades for companies listed on NASDAQ OMX Stockholm along with historical prices for corresponding stocks. Further, supplementary data relating to market capitalization and GDP has also been gathered from Thomson Reuters Datastream. The selected time period is 2004-2014 relating to electronic data availability from Finansinspektionen and was also deemed sufficient in ensuring the statistical strength. This section describes the collection process and characteristics of the gathered data along with possible limitations of the data set.

3.1 Stock Price Data

The database Thomson Reuters Datastream served as a source for data relating NASDAQ OMX Stockholm such as share price and company market capitalization as well as GDP. Similarly

to the insider trading data the data points were taken on active trading days in the period 2004-2014. The specific data points gathered in the study were:

i. Closing stock price

ii. Shares outstanding

iii. Market value

iv. GDP

In terms of the closing stock price, it is computed as the price of the last executed trade in a given day. If the study only looked into larger companies one could instead have used the last bid or ask price of the day as these are likely to give a similar outcome. This stems from the spreads of such companies often being small as a result of them being liquid.

However, for smaller companies, some of which are very infrequently traded, the bid-ask spread is likely to be much larger. Consequently, there can be substantial deviations from the close price when instead using say the ask price. On said basis, using the close price was deemed most suitable.

It should also be mentioned that the GDP-metric relates specifically to the state of the economy in Sweden. Considering that the studied companies are listed on a Swedish stock exchange this limitation to Sweden should be appropriate. This stems from the metric being a good proxy for the development of the studied Swedish companies in aggregate.

As a parenthesis it should be mentioned that Thomson Reuters Datastream only accounts for transactions made over the market. In other words, private transactions between two parties are not recorded in the database. Certain exclusions of data has also been made, e.g. companies which were not listed on the Stockholm exchange the entire study window. This means that companies that were listed or delisted within this window were not included. Instead extrapolating or in other ways approximating said series was deemed prone to errors with very marginal benefits.

3.2 Insider Trading Data

The insider trades reported to the Swedish Financial Authority, Finansinspektionen, in 2004-2014 were aggregated. This meant that all inside trades on NASDAQ OMX Stockholm were accounted for as Finansinspektionen is the supervisory authority of the exchange. This file was downloaded from Finansinspektionen and pruned based on a set criteria to form the sample.

Several transaction e.g. gifts and rights issues were excluded and the study limited to insider buy and sell transactions. The reasoning behind was that these two types of transactions were more likely to stem from active decisions and driven by private information. Conversely, e.g. the exercising of an option is usually schedule-bound and the result of a different mechanism. As such, the buy and sell transactions are more noteworthy and should be subject to less noise

than other types of transactions. This allows for more clear-cut interpretations of the results.

Further, insider trading records are known to contain anomalous records. Applying the same filter rules as Lakonishik and Lee (2001) eliminated transactions that were duplicated and amended as well as had no price information and recorded before the transaction date. Finally, replicating the criteria of Chordia et al. (2002) also removed transactions with no price information, negative price and no quantity. Said transactions were removed as these stem from errors in the reporting of Finansinspektionen.

3.3 Rationale for Swedish Context

Studying insider trading in Sweden particularly is interesting for a number of reasons. Wahlström (2003), and more recently Olofsson and Wahlberg (2011) evidence that the Swedish market is not semi-strong efficient. Concluding that abnormal returns can be earned by imitating insiders reasonably confirms that the empirical context is similar to that of the bulk of insider trading research. This study can also be considered a natural extension of their research which also actually measures the contribution to market efficiency.

Moreover, Sweden is considered a role model in terms of corporate governance and to have one the most well-functioning financial systems in the world. As such, data is readily available and generally speaking credible from e.g. Finansinspektionen and Thomson Reuters Datastream. This should also reasonably cancel out some of the noise one can expect to encounter when performing a study on a less developed stock market.

This is confirmed by Kam et al. (1997) concluding that the Swedish market is more or less weak-form efficient. In more volatile markets which are not weak-form efficient proving a causal link is likely more difficult as there are other biases and often highly fluctuating levels of autocorrelation. Instead having a base level with little autocorrelation should mean that any reactions concurring with insider trading are more likely to be causally related.

In terms of implications of the study, Sweden has recently adopted a legal framework for insider trading similar to that of Germany. This means that conclusions to some extent can be leveraged and have a wider application. Intentions to harmonize insider legislations in the EU using the German model have also been expressed. As such it is highly relevant to test its merit in terms of contribution to market efficiency.

3.4 Sample Selection Bias

Given exclusions of certain data there will inevitably selection biases. The perhaps most prominent of such is the survivorship bias. This stems from the sample only containing companies which have been listed on NASDAQ OMX Stockholm throughout the entire study window. Consequently, companies which are delisted, liquidated, bankrupt, etc. are not included in the studied data set. These companies are likely to have been performing worse than those which

survived and therefore made it to the sample. The actual implications the survivorship bias has on market efficiency relating to insider trading are however more ambiguous.

Though it means that the sample is not perfectly representative of the population it in fact probably has little effect on the outcome of the study. In finance literature there are not any well-known empirical studies evidencing that companies with weaker performance have more frequent insider trading or are less efficiently priced. This implies that if one was to assume that the only differentiating factor between these two groups of companies is the performance then the sample would still be representative. Of course it would be reduced by corresponding number of observations but still representative. In reality, said assumption is perhaps not fully accurate but this exclusion nonetheless should have little effect on the results of the study.

Meanwhile, there is sample selection bias that is more likely to have a somewhat distorting effect on the sample. Such partly stems from Thomson Reuters Datastream only collecting transactions over the market. For that reason e.g. over-the-counter transactions between insiders and the other party are not recorded. Meanwhile, said transactions are accounted for in the Finansinspektionen data list. If they were recorded the closing price of the stock might have been different which could have translated into other levels of price autocorrelation. Excluding certain types of insider transactions such as gift and exercising options are deemed to have very similar uncertain implication.

In summary, the outcome would likely have been somewhat different without said exclusions though it is difficult to speculate in which direction. Consequently, the "expected outcome values" are deemed to be constant with or without this specific selection criteria. This implies that these biases are not likely to heavily skew the sample.

4 Methodology

In testing the impact of insider trading on market efficiency, a multiple variance ratio-test is applied to stock price data. This examines the correlation between present and past prices. The time-varying level of share price efficiency then comprises the dependent variable. Correspondingly the insider trading, company size and state of the economy components are set as independent variables. The subsequent Generalized Least Squares regression determines the relationship between the variables, i.e. to what extent the independent variables explain the dependent variable.

4.1 Rationale for Measure of Market Efficiency

Considering that market efficiency is not readily observable the level of autocorrelation in stock prices was introduced to proxy for such. This proxy relates to the weak-form efficiency for which a widely recognized test is based on the RWH. In testing the extent of random walk researchers have employed the serial correlation test. Performing this test measures the autocorrelation in

stock prices changes, i.e. if there are patterns between past and present prices.

Numerous empirical studies solely focusing on autocorrelation in share prices have been performed using the variance ratio approach. There appears to be consensus in the finance research community that the multiple variance ratio method is superior to the simple variance ratio test. The difference between the two lies in how many holding periods, k, are studied. Whereas the simple variance ratio test only uses a single period the multiple tests several. Though the single study has its applications, given the characteristics of this particular panel data it proves unsuitable. There could e.g. be a scenario where the approach indicates a random walk for the entire study window. What the test fails to address is the pattern in individual periods which may well follow a specific pattern.

In light of this, the multiple variance ratio with several holding periods is chosen. The fact that the multiple variance ratio test is widely accepted in weak-form efficiency research also has implications. Building on recognized research methodology to some extent legitimizes this study. This not least since the subsequent link to insider trading is relatively untested in the literature. In other words, having the same approach for the first part of the study as many acknowledged papers should in part confirm the propriety of this methodology.

4.2 Measuring Market Efficiency

The multiple variance ratio test measures the level of random walk by placing the variance of a sub-period in relation to the variance of the overall period. In other words, it determines how efficiently stocks are priced in the study window. For the random walk hypothesis to hold true there should be no correlation in prices between different periods. In the multiple variance ratio model, this implies that the variance in returns of k-periods must be equal to k multiplied by the variance in one period. In other words, the variance for the entire period divided by the corresponding variance for the subperiod returns should be equal or close to one. In the following equation modelling the one-period variance in relation to the k-period variance, the VR-term refers to the variance ratio, k represents number of holding periods, μ is the mean, r the return and σ_j the standard deviation.

$$VR(r,k) = \frac{\frac{1}{Tk}\sum_{t=k}^{T}(r_t + r_{t-1} + ... + r_{t-k+1} - k\mu)^2}{\frac{1}{T}\sum_{t=1}^{T}(r_t - \mu)^2}$$

Subsequently a test statistic is generated by subtracting the above with one and then dividing it with the standard error of the return. In obtaining the test statistic, TS, the following formula is applied:

$$TS(r,k) = \frac{VR(r,k) - 1}{\sqrt{\sigma_j}\sqrt{\sum_{j=i}^{k-1}[\frac{2(k-j)}{k}]^2}}$$

This test statistic is compared with the critical value assigned to a certain significance level. The critical value for rejecting the null hypothesis given a significance level of 5% is 1.96. Test statistics exceeding this value rejects the null hypothesis, i.e. the existence of a random walk. Such results would instead imply that there are patterns in stock prices thus evidencing that the random walk does not hold true. Values below the critical value have the opposite implications.

4.3 Regression Model

In determining the appropriate regression model, it is important to consider the characteristics of the data set. Using a conventional OLS regression as Söderberg and Nyström (2013) in a similar study is likely to produce flawed results. This stems from the assumption in the OLS framework stating that there should be no autocorrelation between observations, an assumption which is violated for the data set. Given that their panel data set also had time-series characteristics the errors are likely to have the same time-series structure violating the assumption of independent errors. As a result, the estimates of coefficients and corresponding standard errors have likely been distorted. This in its turn means that corresponding findings cannot be validated.

Instead the GLS regression framework allowing for unequal variances of the observations, heteroskedasticity, is instead applied for the purposes of this study. In addition, the unobserved individual heterogeneity is treated as being distributed independently of the regressors. This means that the model uses so called random-effects. Unlike conventional regression models, the random-effect regression model does not work under the assumption that each observation is independent. Instead it allows for some data to be dependent to an extent thus allowing for data sets with certain autocorrelation.

The level of informational efficiency constitutes the dependent variable in the GLS regression. To explain the dependent variable in the regression, several independent variables are introduced namely insider trading activity, company size and state of the economy. These are in corresponding order measured by the proportion of shares outstanding traded by insiders, market capitalization and GDP.

Though there is daily data for the insider trading variable, the panel data framework and corresponding regression model would not be suited for the resulting data set. This data set would not only have multiple variables for more than hundred companies but also in the other direction have daily data points for a period spanning more than ten years. Clearly, this data set would be far too extensive making it incompatible with the more conventional regression models. For the data to fit within the panel data framework, the time dimension is cut and the insider trading frequency computed annually. This means that each company has eleven observations for each variable which given the large number of companies has been deemed sufficient.

As a parenthesis it should be pointed out that the insider trading variable is measured as the aggregated insider transactions in a specific period for each of the companies. The aggregated trading variable comprise both insider buy and sell transactions. In testing the distinction

between the two types of insider activity, the respective transactions are treated separately.

The rationale behind including the company size component stems from the notion that there might be a difference in price efficiency depending on the size of the company. Based on existing finance research, larger companies tends to be somewhat more efficiently priced because of higher trading activity.

In terms of the state of the economy, Lazar et al. (2012) conclude that informational efficiency has a slight positive correlation with market conditions. Further, it is evidenced that said efficiency is especially prone to suffer in times of financial crises. The notion that financial crises are often associated with higher volatility and more limited resources also supports this reasoning.

Based on the independent variables, a set of hypotheses are devised to be tested using the regression model. The significance level, the probability of rejecting a null hypothesis which is true, is set at 5% giving a threshold-value of 1.96.

For tests relating to aggregated insider trading, the following null and alternative hypotheses are applicable:
$\boldsymbol{H_0}$: Aggregated insider trading does not impact the level of informational efficiency
$\boldsymbol{H_A}$: Aggregated insider trading does impact the level of informational efficiency

Similarly the hypotheses are as follows for tests determining the contribution to market efficiency of insider buy respectively sell transactions:
$\boldsymbol{H_0}$: Insider buy/sell transactions do not impact the level of informational efficiency
$\boldsymbol{H_A}$: Insider buy/sell transactions do impact the level of informational efficiency

When examining the effect of market capitalization on market efficiency, these hypotheses are tested:
$\boldsymbol{H_0}$: Company size does not impact the level of informational efficiency
$\boldsymbol{H_A}$: Company size does impact the level of informational efficiency

In testing how market efficiency relates to the performance of the economy, the latter of which is proxied by GDP, the following hypotheses are applied:
$\boldsymbol{H_0}$: State of the economy does not impact the level of informational efficiency
$\boldsymbol{H_A}$: State of the economy does impact the level of informational efficiency

The model then determines the relationship between the dependent and independent variables. In other words, it tests to what extent the dependent variable is explained by the independent variable. As such, the model is represented by the following equation:

$$y_{i,t} = \alpha + \beta_1 x_{1,i,t} + \beta_2 x_{2,t} + \beta_3 x_{3,i,t} + \epsilon_{i,t}$$

In the model, $y_{i,t}$ refers to the market efficiency for company i at time t. The $x_{1,i,t}$-term represents the insider trading activity level for company i during year t, $x_{2,t}$ to the year t GDP-level and $x_{3,i,t}$ to the average size of company i during year t. The impact on market efficiency by each of the included independent variables, quantified as the β-values are obtained from running the GLS regression.

5 Results

It should be noted that whilst the tests relating to the descriptive statistics, regressions and robustness are performed in Stata, the outputs have subsequently been formatted in LaTeX. This simply comes down to preference as this particular formatting has been deemed more presentable and easier to interpret.

5.1 Descriptive Statistics

Initially, in familiarizing with the data set, it is appropriate to review the descriptive statistics pertaining to the respective variables in Table 5.1.

Aggregated Summary Statistics for the Respective Variables

	Mean	Std Dev	Median	Min	Max
Insider trading	0.047	0.073	0.018	$3*10^{-5}$	0.404
Variance Ratio	1.12	0.87	0.95	0.001	5.16
Company Size	17,134	46,671	2,053	25	424,764
GDP	100.07	1.73	99.86	95.94	102.84

Table 5.1: Summary statistics for the respective variables of the 149 companies each of which has annual observations over the study window 2004-2014. The Insider Trading variable is measured as the proportion of shares outstanding traded by insiders. Variance Ratio refers to the test statistic determining existence of autocorrelation in share pricing for which the threshold-value is 1.96 at a 5% significance level. Test statistics exceeding said value indicates share price autocorrelation. The Company Size-metric is in BNSEK and the GDP-measure referring to Sweden is normalised with a base level of 100 which is continuously reweighted.

As a parenthesis it should be mentioned that the main variables will not be treated in this first part but instead in greater detail in the subsequent section. The main variables are namely the insider trading activity and variance ratio statistic leaving the company size and GDP-measures to be treated in this first section.

In terms of the company size, the most noticeable statistic is the difference in mean at 17.134 BNSEK and median at 2.053 BNSEK. This is in part explained by the massive span in

min-max as the smallest company had a market capitalization of 25 MSEK and the largest in excess of 400 BNSEK. Whilst this spread appears to have a distorting effect on said metrics, this finding is in line with the expectations about the constituents of the OMX Stockholm exchange. The absolute bulk of these listed companies are at the lower end of the span but there are nonetheless a few giants bolstering the mean. This highlights the importance of using the median-measure alongside the mean.

Contrastingly, the GDP-measure has demonstrated a stability consistent with the development of the Swedish economy. It should be mentioned that the GDP data points are continuously normalised meaning that the absolute differences in GDP are higher. Having continuous reweighting was however deemed more suitable given that the relative, rather than the absolute, changes in the GDP were of interest.

Aggregated Yearly Averages for the Respective Variables

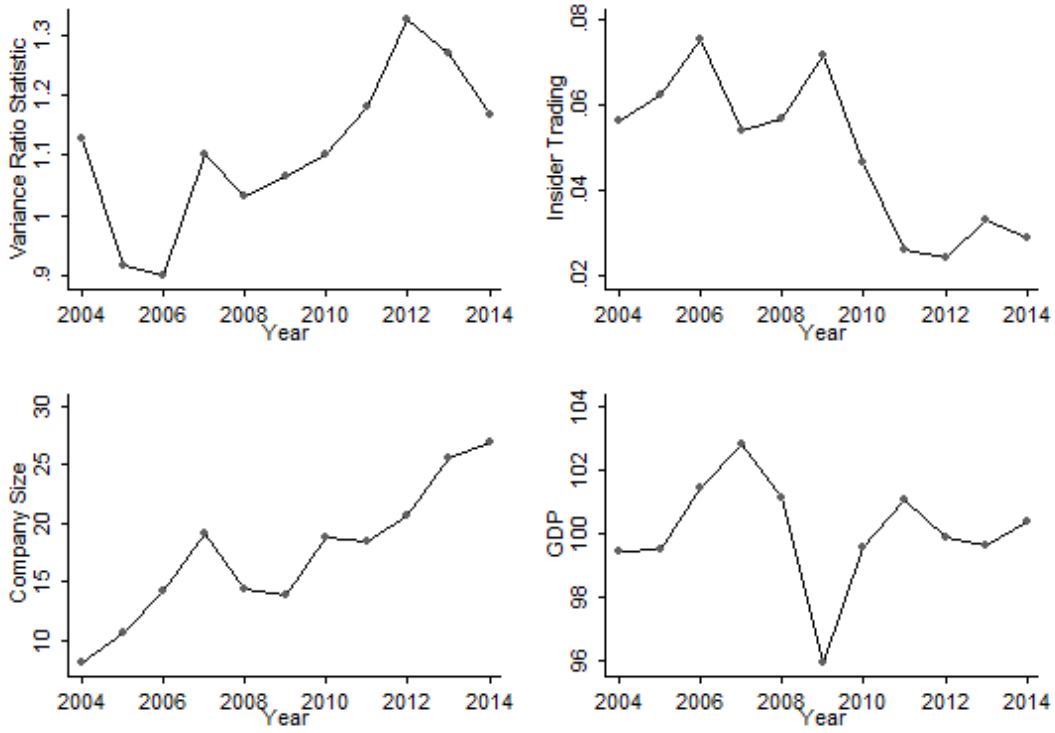

Figure 5.1: Yearly averages for the respective variables of all 149 companies. The Variance Ratio is measured as test statistic and the insider trading as a proportion of shares outstanding. Company size is in BNSEK and the GDP-metric is normalized with a base level of 100.

Figure 5.1 depicts average company values for the variables included in the regression. Given that the graphs plot yearly averages for all companies in aggregate, any observations will be general in nature. As anticipated, the sample companies have had a steady increase in market cap. Considering that the selection criteria was to only include companies that were listed

throughout the study window this is not surprising. Generally speaking companies either grow or cease to exist. The GDP-curve has as expected a significant dent attributed to the financial crisis.

Meanwhile, the variance ratio test statistic and insider trading variable are particularly prone to outliers. This is exemplified by a few companies having proportions upwards of 30% of shares outstanding traded by insiders thus distorting the entire curve. Similarly, outliers in the variance ratio test statistic means the representability of the corresponding graph in Figure 5.1 can be questioned. Consequently, more nuanced measures are introduced below to map out the how the observations are actually distributed for the two main variables.

Company Proportions of Shares Outstanding Traded by Insiders

Percentile	Insider Trading (%)
1	0.006
5	0.03
10	0.06
25	0.59
50	1.80
75	4.91
90	11.02
95	21.67
99	32.78

Table 5.2: Percentiles of the proportions of shares outstanding traded by insiders for the 149 companies. The figures are computed from the company averages for each year in the study window.

Descriptive	Insider Trading (%)
Mean	4.68
Std. Dev.	7.28
Variance	0.53
Skewness	2.72
Kurtosis	10.74

Table 5.3: Descriptives of the proportions of shares outstanding traded by insiders for the 149 companies. The figures are computed from the company averages for each year in the study window.

As displayed in Tables 5.2 and 5.3, the 149 companies in the study have on average had around 4.7% of respective shares outstanding traded by insiders each year. Having said that, it should be noted that this figure does not account for size-differences between companies. It is also evidenced that a few companies have had a significantly larger proportion of shares outstanding traded by insiders. Looking at the actual data set also appears to suggest a negative correlation between size and proportion of shares outstanding traded by insiders.

Significant intercompany differences are also reinforced by the skewness value exceeding 2.7 indicating a much asymmetric distribution with a positive skew. Put differently, the distribution is skewed with a long tail on the positive right-hand side. Clearly, the observations do not follow a normal distribution. Instead, the absolute majority of the companies have less than 4.7% of shares outstanding traded by outsiders. At the same time, there are several outliers much on

the positive side with significantly higher proportion of insider-traded shares which bolster the mean value. This is also implied by the median value at a mere 1.8%.

Distribution of the Proportions of Shares Outstanding Traded by Insiders across Companies

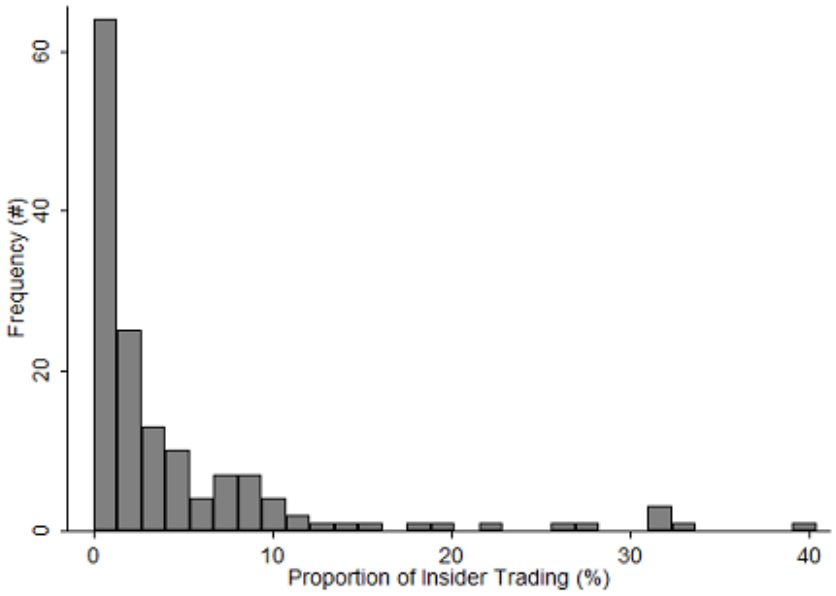

Figure 5.2: Histogram plotting the average annual proportion of shares outstanding traded by insiders for each company. The histogram displays the number of firms which have had the respective proportions of shares outstanding traded by insiders.

Plotting the data in a histogram as per Figure 5.2 reaffirms the positive skew in the distribution and that the observations are clearly not normally distributed. As stated, the absolute majority of the companies have averaged well below 5% of shares outstanding traded by insiders on an annual basis. Meanwhile, a few companies have on average had in excess of 30% each year throughout the entire study window. These differences might appear startling given that the companies are listed on the OMX Stockholm exchange, face the same legislation framework and so on.

However, when considering the differences in ownership structures for the constituents on OMX Stockholm the results are very much as anticipated. The companies showcasing high levels of insider trading, e.g. Elanders, have clear family business-characteristics. In other words, the ownership at any given point is much concentrated to a few insiders which tend to trade large chunks of their holdings. It should also be noted that these are the average trading turnovers over the period meaning that are individual years where more or less the entire ownerships have been transferred. Similarly, there are years where little insider trading has been performed even in this subset of companies. It should also be pointed out that these companies tend to be the

smaller companies in the sample. As a result, it is more feasible that individual insiders have traded a large portion of the shares outstanding.

In contrast, the bulk of these listed companies have a large group of investors rendering in more ownership dispersion. Moreover, the retail investors are generally not registered insiders meaning that there is a much smaller proportion of insiders to shareholders. The companies with a lower proportion of insider-traded shares also tend to be larger. As such, when considering the underlying ownership dynamics the positive skew is much in line with expectations.

Company Test Statistics for Level of Autocorrelation

Percentile	Variance Ratio Statistic
1	0.02
5	0.09
10	0.18
25	0.46
50	0.95
75	1.55
90	2.22
95	2.81
99	3.90

Table 5.4: Percentiles of the variance ratio test statistics for the 149 companies. The figures are computed from company averages for each year in the study window.

Descriptive	Variance Ratio Statistic
Mean	1.12
Std. Dev.	0.87
Variance	0.76
Skewness	1.24
Kurtosis	4.83
% Obs >1.96	14.83

Table 5.5: Descriptives of the variance ratio test statistics for the 149 companies. The % of observations with a higher test statistic than the threshold-value indicates the proportion of observations with autocorrelation in the pricing.

Judging from Table 5.4 and 5.5, the companies tend to be efficiently priced and not exhibit autocorrelation in the share pricing. Nonetheless, 14.83% of the observations show autocorrelation and as such do not conform to the weak-form efficiency.

This finding can be considered in line with the paper of Kam et al. (1997) concluding that the Swedish market is more or less weak-form efficient. Moreover, comparing the mean and median test statistic at around 1 to the threshold-value at 1.96 also confirms an overall high level of price efficiency. Similarly to the proportion of shares outstanding traded by insiders, the skewness metric indicates a significantly positive skew meaning that the observations are not normally distributed.

Distribution of Variance Ratio Test Statistics across Companies

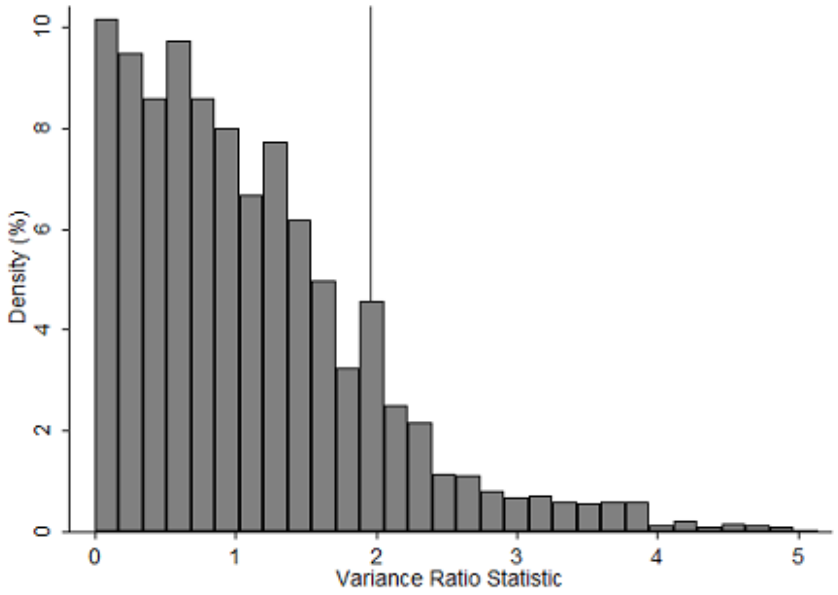

Figure 5.3: Distribution of the variance ratio test statistics for all company observations. The variance ratio measures the existence of autocorrelation in share prices where the threshold-value given a 5% significance level is plotted at 1.96. The density measured in percent refers to the proportion of observations having a certain test statistic value.

Based on the histogram in Figure 5.3 and in line with the aforementioned descriptives, the observations of the variance ratio test statistic do not follow a normal distribution. As in the case of proportion of insider-traded shares, the outliers can be attributed to the smaller companies where the ownership is concentrated to a smaller group of insiders. It becomes evident that when said insiders make their often sizeable trades the pricing of the share tends to show greater signs of autocorrelation.

Intuitively, this is also reasonable given the distorting effect of such block sales which tend to give rise to a lingering drift in the pricing. It appears that investors are not able to instantly disseminate this information and trade accordingly. Instead the dynamics are often similar to that of post-earnings-announcement drift, the prices adjusts partly but still have a built-in bias. Said would explain more prevalent autocorrelation for companies with frequent block trades. After these transactions, the market does not seem able to react efficiently without delay causing the weak-form efficiency not to hold true.

5.2 Regression Analysis

The initial regression for all companies using the GLS model and random-effects produced the coefficients as per the equation:

$$y_{i,t} = 1.3565 + 0.0685x_{1,i,t} - 0.0022x_{2,t} - 0.0013x_{3,i,t}$$

The regression indicates that insider trading has a negative impact on efficiency in share pricing. This is the case as higher proportions of insider-traded shares implies a higher variance ratio test statistic given the positive coefficient. Applying an analogue interpretation, increases in the GDP-measure translates to a decreased variance ratio statistic. In other words, the share pricing becomes less autocorrelated meaning that the contribution to market efficiency is positive. Correspondingly, the negative coefficient of the size variables also implies that increases in the size variable leads to more weak-form efficient pricing of shares. This reasoning stems from the threshold-value for the variance ratio statistic at 1.96 where values exceeding said value indicates autocorrelation in share pricing.

Whilst a direction is indicated by the coefficients, the magnitude of the GDP and size coefficients renders them more or less negligible. Though the insider trading coefficient exceeds the other coefficients by a factor of 30-60 times, the value at around 0.07 nonetheless indicates a weak effect. More importantly, however, the poor significance levels of the coefficients translates to any output from the regression being inconclusive. As such, even the directional impacts of the variables cannot be validated. Given insignificant coefficients for this regression, it is then not surprising that the coefficient of determination indicating model fit also is at far from acceptable levels.

This is probably related to the alternative explanations, there are likely too many factors influencing the level of autocorrelation in share pricing of e.g. the company H&M. Combining said complexity with the often relative absence of insider trading for such companies leaves this model with little explanatory value for this subset of companies.

Connecting this reasoning with the findings in the descriptive statistics, it is perhaps more relevant to study the subset of companies with so called family business-characteristics. These companies are generally speaking at the lower end of the sample in terms of size and often have its ownership concentrated to a smaller group of insiders. This group tended to have higher proportions of insider trading and shares were often traded in block transactions. Pertaining to these specific characteristics it becomes interesting to study these companies in isolation. This is the case as the insider trading dynamic this study seeks to examine is likely most prevalent for them. The output from regressing 41 companies is showcased in Table 5.6.

Regression Analysis Output for Subsample of Companies

	Coefficient	Std. Err.	t	P> |t|	95% Conf.	Interval
Insider Trading	0.70	0.25	2.78	0.01	0.20	1.19
GDP	-0.01	0.02	-0.34	0.73	-0.05	.04
Size	$-5*10^{-4}$	$1*10^{-3}$	-0.45	0.65	$-3*10^{-3}$	$2*10^{-3}$
Constant	1.82	2.26	0.80	0.42	-2.62	6.25

Table 5.6: Regression analysis for the subset of 41 companies selected based on a set criteria namely high ownership concentration and large proportions of insider-traded shares.

Similarly to the regression output for all companies, the coefficient for insider trading indicates that such activity is negatively correlated with market efficiency. In other words, more frequent insider trading implies more autocorrelation in the share pricing. In line with the aforementioned regression, the directional impacts of the GDP and size-coefficients are the opposite. Increases in said variables results in share prices becoming more efficiently priced.

In contrast to the aforementioned regression, regressing this subset of companies gives a significant coefficient for insider trading. This pertains to the p-value of 0.01 well beneath the threshold-value at 0.05 for the 5% significance level. This in its turn suggests that the null hypothesis most likely does not hold true, which can be claimed with certainty at the 5% significance level. Consequently, at least the directional impact of insider trading is validated for this subset of companies. This is also reinforced by the 95% confidence interval only spanning positive numbers. Hence, the null hypothesis namely that insider trading has no effect on share price efficiency can be rejected at a 5% significance level. Moreover, the magnitude of the coefficient implies a significantly larger effect on level of price efficiency than previously indicated.

The two supplementary coefficients on the other hand are not nearly significant. As such, it is not possible to draw any conclusions based on these coefficients. This is not least exemplified by the GDP coefficient which appears to be negative. However, the 95% confidence interval extends almost as long on the positive side as on the negative side. This means that observations are more or less equally likely to be either positive or negative. These insignificant coefficients in extension also impacts the model fit resulting in a poor coefficient of determination-value. So whilst this model proves successful in explaining the insider trading variable, the overall fit is inadequate. With this in mind, it is appropriate to regress each variable isolatedly in order to determine whether to e.g. exclude a certain variable. Running multiple regressions, one for each of the variables, gives the output in Table 5.7.

Regression Analyses Output for the Respective Variables in Isolation

	Coefficient	Std. Err.	t	P> |t|	95% Conf.	Interval
Insider Trading	0.29	0.16	1.85	0.05	0.00	0.60
Constant	1.04	0.04	28.30	0.00	0.96	1.11
GDP	-0.01	0.01	-0.72	0.47	-0.04	.02
Constant	2.11	1.47	1.44	0.15	-0.77	5.00
Size	$-1*10^{-3}$	$4*10^{-4}$	-2.56	0.01	$-2*10^{-3}$	$2*10^{-4}$
Constant	1.07	0.04	27.45	0.00	1.00	1.15

Table 5.7: Regression analyses for each of the three variables in isolation for the subset of companies with concentrated ownership and high proportions of insider-traded shares.

This output has some interesting implications in that it identifies the GDP coefficient as problematic. Whereas the other coefficients are significant the GDP coefficient is much insignificant given its p-value of 0.47. When regressing the size variable on its own, the magnitude is still more or less negligible. More importantly however, the coefficient is significant and the 95% confidence interval only spans one side of 0. As is the case for the insider trading coefficient. Consequently, each of these two single variable-models are valid meaning that backed deductions can be made. Combining these two variables in the same regression, which is the original regression with the GDP variable removed, produces the statistics as in Table 5.8.

Regression Analysis Output for the Insider Trading and Size Variables

	Coefficient	Std. Err.	t	P> |t|	95% Conf.	Interval
Insider Trading	0.70	0.25	2.80	0.005	0.21	1.19
Size	$-5*10^{-4}$	$1*10^{-3}$	-0.46	0.26	$-2*10^{-3}$	$1*10^{-3}$
Constant	1.04	0.06	17.27	0.00	0.93	1.17

Table 5.8: Regression analysis for the insider trading and size variables for the subset of companies with concentrated ownership and high proportions of insider-traded shares.

Judging from Table 5.8, the coefficients are at similar levels in this combined model meaning that insider trading has a negative impact on price efficiency whilst the size effect is negligible. Moreover, the insider trading coefficient is still very much significant whilst the size coefficient is insignificant for this particular regression. Nonetheless, the p-value of the size coefficient is not massively insignificant which is also reflected in the coefficient of determination for the model at 0.23. Though this level generally implies poor model fit, it should be considered acceptable for this particular model given its simplicity and the rather complex panel data characteristics. This implies that the model has explanatory value in mapping out the effect of insider trading

and company size on share price efficiency. This then allows for the distinction between buy and sell orders to be studied, with regressions output displayed as in Table 5.9.

Regression Analyses Output for the Insider Buy Respectively Sell Transactions

		Coefficient	Std. Err.	t	P> |t|	95% Conf.	Interval
Buy	Insider Trading	1.77	0.51	3.49	0.001	0.77	2.76
	Size	$-5*10^{-4}$	$3*10^{-4}$	-1.64	0.10	$-1*10^{-3}$	$1*10^{-4}$
	Constant	1.04	0.06	18.71	0.00	0.93	1.15
Sell	Insider Trading	0.90	0.29	3.08	0.00	0.33	1.47
	Size	$-2*10^{-4}$	$3*10^{-4}$	-0.55	0.58	$-7*10^{-4}$	$4*10^{-4}$
	Constant	1.07	0.06	17.85	0.00	0.96	1.19

Table 5.9: Regression analyses for the insider trading and size variables in which the insider buy and sell transactions are studied in isolation.

The output in Table 5.9 indicates that both insider buying and selling has a negative impact on share price efficiency. This is validated at a 5% significance level. Expectedly, the size component has little to no effect though it cannot be claimed with certainty given its p-values. That the magnitude of the coefficients for the buy and sell variables isolatedly is much larger than the aggregated variable might appear odd. However, given the same directional impact of the two, studying each transaction type on its own simply means that there are fewer transactions to explain the same variance ratio test statistic. As such, the coefficients are larger for the buy and sell variables than for aggregate trading. So the effect of an e.g. buy transaction might appear very large in this model framework. It should, however, be taken into consideration that sell transactions are likely coinciding which the buy-model does not account for.

The respective magnitudes of the coefficients are nonetheless noticeable. They imply that whilst both types impact share price efficiency negatively the buy transactions have a stronger negative effect. Granted that the number of sell transactions is higher than buy transactions, the buy coefficient is almost twice as large which cannot purely be attributed to this relatively much smaller difference. This implies that buy transactions have a bigger impact on share price efficiency. This likely stems from the different signaling effects of the two. Whereas insider selling is likely to stem from diversification and liquidity reasoning, the buy orders tend to be the result of a more active decision often with a specific timing component. This stronger signal is likely to be acknowledged and acted upon by investors which triggers a reaction in the market. As this reaction is more or less predictable in that it follows the published insider trade, a bias is built into the share pricing. As such, the autocorrelation in share pricing increases translating to less efficiently priced shares.

5.3 Robustness Tests

Going back to the original sample data set containing 149 companies, one of the problems giving rise to insignificant coefficients appears to be the proportion of shares traded by insiders in certain companies. According to the descriptive statistics well above 25% of the companies have less than 1% of their shares outstanding traded by insiders annually. This relative absence of insider trading naturally makes it difficult to study the effect of insider trading on share price efficiency. The reasoning being that the resulting more subtle nuances are likely to disappear in noise. So whilst the model ideally should have explanatory value for the entire sample, these infrequently traded companies are creating noise.

As such, rather than having a selection criteria based on ownership concentration this robustness test is based on proportion of insider-traded shares. Starting with the entire data set and excluding the most sparsely traded companies gives a subset of 100 companies. This process can be likened with winsorizing in which outliers are excluded. The subsample still represents more than two thirds of the original data set. This test can also be considered a robustness test for the subsequent regressions in the previous section. Regressing the variables for these 100 companies produces the output in Table 5.10.

Regression Analysis Output for Subsample of Companies

	Coefficient	Std. Err.	t	P> |t|	95% Conf.	Interval
Insider Trading	0.30	0.17	1.83	0.04	0.02	0.63
Size	$-1*10^{-3}$	$7*10^{-4}$	-1.30	0.19	$-2*10^{-3}$	$4*10^{-4}$
Constant	1.09	0.04	24.94	0.00	1.01	1.18

Table 5.10: Regression analysis using the Random Effect Model in which the most sparsely traded companies are excluded giving a subset of 100 companies.

These findings are much in line with the output from the regressions on only 41 companies. Whereas the coefficients are somewhat weaker in magnitude, the significance levels are at similarly good levels despite the p-value for size not being significant. Nonetheless, it proves a wider application for the model and its ability to map the relationship between insider trading and share price efficiency. This is the also reinforced by a strong coefficient of determination indicating good model fit. So theoretically speaking, after excluding barely insider-traded companies this model should be applicable to any data set and yield significant results.

Another means of robustness testing is to change one of the main assumptions. As such, the regression is repeated using fixed-effects rather than random-effects as in previous tests. The output for the fixed-effect test on the subset of 100 companies is shown in Table 5.11.

Regression Analysis Output for Subsample of Companies using Fixed-Effects

	Coefficient	Std. Err.	t	P> |t|	95% Conf.	Interval
Insider Trading	0.27	0.17	1.54	0.12	0.01	0.61
Size	$-2*10^{-3}$	$2*10^{-3}$	-1.28	0.20	$-5*10^{-3}$	$1*10^{-3}$
Constant	1.12	0.05	23.69	0.00	1.02	1.21

Table 5.11: Regression analysis using fixed-effects in which the most sparsely traded companies are excluded giving a subset of 100 companies.

Judging from Table 5.11, the output indicates a weaker model fit as both coefficients are insignificant. This is likely to stem from the underlying premise of the FE-model. The model assumes that the companies instead have special characteristics which impact or bias the predictor or outcome variables. The FE-model removes company characteristics so that the net effect of the predictors on the outcome variables can be assessed. If the error terms however are correlated then the FE-model is not suitable as it inferences may be incorrect. Further, the difference in output indicates that the underlying assumptions for using the RE-model were correct.

6 Conclusion and Discussion

The initial regression yielding an insignificant coefficient for the insider trading variable might at first appear to confirm the weak form of the EMH. The weak-form efficiency states that there should be no autocorrelation in share prices. Instead the share pricing should follow a random-walk regardless of e.g. insider trading frequency. However, rather than implying that the coefficient magnitude is insignificant it signifies that its value cannot be reaffirmed. For the weak-form efficiency to be proven, the regression should have produced a significant coefficient very close to zero. As such, the initial regression neither confirms nor rejects that insider trading affects share price efficiency. The same applies for the supplementary GDP and size variables in this regression.

When considering the characteristics of the data set, this outcome is actually in line with expectations. The panel data set comprises 149 highly diverse companies each of which has different frequencies and patterns of insider trading. Moreover, the companies with a relative absence of insider trading are likely to mostly create noise when the entire data set is regressed. In accordance with the alternative explanations, there simply appears to be too many factors influencing the level of autocorrelation in share pricing for e.g. H&M. Given the variety and complexity of the data set, the model is likely too simplistic in describing the relationship of the variables for all companies. Having said that, the findings in subsequent regressions are very much conclusive and consistent throughout. The descriptive statistics identified a subset of 41 companies which had high ownership concentration and tended to be at the lower end of the

sample in terms of size. This group generally had higher proportions of insider trading and the transactions were often block trades. Regressing these companies yielded a highly significant coefficient for insider trading. Said coefficient indicated that autocorrelation increases in concurrence with insider trading resulting in less efficient pricing. Meanwhile, the size component was proven to have a negligible effect whereas the coefficient for GDP was insignificant. Importantly, these findings were also reaffirmed for a subsample of 100 companies in which only the most sparsely insider-traded companies were excluded.

Connecting this output to the hypothesis has interesting implications. In line with the findings, it was hypothesized that insider trading has a negative impact on share price efficiency despite a previous study claiming the opposite. Whereas insiders may very well feed outsiders with information as stated by Grossman & Stiglitz (1980), the findings of this study indicates that it not necessarily results in more efficient pricing. This inefficiency is perhaps best exemplified by insider block transactions as companies with the highest frequency of such were particularly prone to autocorrelation in share prices. Whilst these transactions convey certain information about the intrinsic value, they are also likely to have a distorting effect on price efficiency.

This is likely attributed to a lingering drift in the pricing, similar dynamics to that of post-earnings-announcement drift. In other words, when a large portion of the shares are flooded onto the market investors do not instantly disseminate this information in its entirety. The prices tend to adjust partly but then have a built-in bias going forward. This built-in bias would explain why these particular stocks often have test statistics exceeding the threshold-value thus indicating autocorrelation. These block sales might simply be too disruptive for the market to react efficiently without delay causing autocorrelation in the share pricing.

The reasoning around the impairing effect of insider trading on price efficiency in the hypothesis is slightly different though equally valid. Seyhun (1986) concluded that outsiders are able to earn abnormal returns simply by mimicking insider trades. This implies that insider trades will be followed by a predictable stream of outsider transactions giving rise to autocorrelation. This explanation, however, rests on the assumption that the insider signaling not only is correctly interpreted but also acted upon. This issue is still heavily debated, Lakonshik and Lee (2001) on the one hand suggest that there is little market response to insider activity. Contrastingly, Leland and Pyle (1977) contend that insider trades have a strong signaling effect.

Another theory applicable to the findings is that of Fishman and Hagerty (1992), namely that insiders crowd out alternative information-seeking and analyst coverage. This leaves the overall market less informed allowing for the stock price to deviate further from its intrinsic value. This is contended to create a bias in the price resulting in autocorrelation.

Whereas the findings are in line with most literature, Aktas et al. (2008) argue that the presence of insiders promotes efficient markets. This paper has been subject to criticism for its use of proxy namely the price sensitivity to relative order imbalance which has been deemed too specific and indirect. However, rather than discarding the paper on said basis it highlights

an important issue for these types of studies. Market efficiency, the broad term this and related papers are examining, is not readily observable. As such, the findings are very much dependent on the proxy to measure for it, in this case the level of autocorrelation based on the weak-form efficiency.

In terms of the supplementary size variable, the directional impact of the factor was in line with the hypothesis. The negative coefficient implies that increasing the company size reduces the test statistic meaning that prices are less prone to be autocorrelated. This is not surprising given more extensive analyst coverage, higher trade frequency, etc. Meanwhile, the GDP variable expectedly proved too broad in explaining the level of autocorrelation evidenced by an insignificant coefficient. Whilst these supplementary variables are trivial on their own they are highly relevant as magnitudinal benchmarks. Granted that the size coefficient is extremely small in all regressions, the different insider trading coefficients still indicate a material effect on share price efficiency.

The coefficients appear even stronger in magnitude when splitting insider buy and sell transactions. This is however not entirely accurate as the same test statistics values are attributed to only the buy respectively sell transactions thus bolstering the coefficients. Nonetheless, the relative magnitudes of the coefficients have interesting implications. As anticipated, the buy transactions are associated with higher levels of autocorrelation. The explanation likely follows along the lines of corresponding hypothesis, namely that the two types of transactions have different signaling effects.

Insider purchases are likely the result of a more active decision whereas insider selling tends to be for diversification and liquidity reasons. As a result insider buying is likely to be more frequently concurring with spreads between market and intrinsic value whereas selling theoretically should occur more randomly. This explains why the results indicate that insider buying has a larger impairing effect on price efficiency as it more likely leads to autocorrelation than insider sales.

Taking a holistic approach, the rejection of the null hypothesis that insider trading has no effect on market efficiency has interesting implications for the EMH. Whilst the study did not set out to examine if markets were weak-form efficient it nonetheless proves insider trading giving rise to patterns in share pricing. Connecting this with related literature indicates in theory that abnormal returns can be made simply by technical analysis. Contrastingly, studies have proven that the Swedish market is efficient using the EMH-framework. This highlights the limitations of the EMH and points to its binary approach being too blunt in describing real markets. Whilst it has merits as a theoretical representation it appears that real markets are seldom either strictly efficient or not, or at least it very much varies depending on metrics and over time.

In terms of limitations of the studies, as identified the study builds on a specific proxy for testing market efficiency. Whilst it is widely recognized as a measure of weak-form efficiency using a different proxy has proven to yield different results. Further, though there is daily data

available the study employed longer periods of time between observations. This relates to the panel data framework not being susceptible to data sets extending massively in both dimensions. At least conventional regression models are not able to model for such. However, complex statistical tools may very well be able to regress daily observations of multiple variables for hundreds of companies over a 10-year event window. This should in expectation yield even more significant results and is as such suggested for future research. Given the contradictory findings in the literature relating to different proxies, a study across proxies could add conclusiveness in determining the impact of insider trading.

Nonetheless, the study contributes to the understanding of the impact of insider trading on market efficiency. It introduces a new approach which builds on the widely recognized multiple ratio test and then adds a regression component allowing for the relationship to be studied. The study has also value in mapping out the dynamics of insider trading allowing for more effective legislation. Moreover, the study contributes to the understanding of investors on the effects of insider trading. With said understanding, investors should in theory be able to exploit existing inefficiencies driving the market to higher levels of efficiency.

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