An Empirical Analysis of Legal Insider Trading in the Netherlands

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Abstract

In this paper, we employ a registry of legal insider trading for Dutch listed firms to investigate the information content of trades by corporate insiders. Using a standard event-study methodology, we examine short-term stock price behavior around trades. We find that purchases are followed by economically large abnormal returns. This result is strongest for purchases by top executives and for small market capitalization firms, which is consistent with the hypothesis that legal insider trading is an important channel through which information flows to the market. We analyze also the impact of the implementation of the Market Abuse Directive (European Union Directive 2003/6/EC), which strengthens the existing regulation in the Netherlands. We show that the new regulation reduced the information content of sales by top executives.

JEL Code: G14, G28, K22.

Keywords: insider trading, financial market regulation.

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1 Introduction

Since the 1990s, countries worldwide have put into practice regulations against trading based on private information, from what it seems a consensus within the regulatory bodies that insider trading should be banned (Bhattacharya and Daouk, 2002). In the Netherlands, the current principles of law concerning securities trading, in line with the directives of the European Union on market manipulation and market abuse, stipulate that *anyone* in possession of private and price-sensitive information is not allowed to trade. Within this framework, legal insider trading, i.e. trading in one's own company's stock, is allowed provided that the trader is not in possession of such information. In addition, corporate insiders have to report their trades to a national registry of insider trading.

Even though their information might not qualify as "private" and "price-sensitive" when they trade, insiders may have more in-depth knowledge about the prospects of their company compared to other market participants. This information can manifest itself through abnormal stock price movement around their trades. In this paper, we investigate how important these price movements are, as well as the effect of regulation changes on these abnormal returns.

We measure empirically the short-term effects on the stock price when insiders trade, using the national registry of insider trading from the AFM (the Authority for the Financial Markets, the Dutch regulatory body in charge of the supervision of financial markets). We aim to answer the question whether insiders are trading upon special information, or mostly for liquidity reasons. The stock price effect of insider trading (whether it is a signal of new information or merely a market reaction) is measured by abnormal returns, estimated by the standard event study methodology.

Our dataset spans a long time period, from 1999 to 2008. The Netherlands is one of the countries in continental Europe with the longest history of insider trading

regulation and reporting of trades in a public registry. Our study differs from other insider trading studies since we focus on individual trades, as opposed to aggregated purchases or sales. Also, in a cross-sectional regression framework, we study the information content of trades by controlling for both trade characteristics and firm-level characteristics. This allows us to determine which trades are mostly information driven, and which are not. In doing so, we distinguish between trades that follow the exercise of employee stock options from trades in shares only.

Another important contribution of this paper is testing the effect of changes in insider trading regulations that occurred since the start of the insider trading registry in 1999. The first registration regime in effect until 2002 concerned all insiders. They had to notify their trades into a single public registry without distinction of position in the firm. Starting from September 2002, top executives had to register separately, so that we can identify the effect of their trades relative to the trades of other insiders. In 2005, the Market Abuse Directive (European Union Directive 2003/6/EC) was incorporated into Dutch law. As a consequence, the penalty for illegal insider trading was increased for top executives, and the notification delay was reduced for other insiders. These three regulation regimes are studied in a regression framework that allows controlling for confounding factors.

Our main results can be summarized as follows. Legal trades by corporate insiders indeed reveal information to the market. Moreover, trades by insiders that are higher in the hierarchy of the firm have larger effects than trades by other insiders, especially for share purchases. In average, these purchases by top executives are followed by a risk-adjusted abnormal return of 2% in the month following the purchase date (i.e. 24% on an annual basis), which is economically very large. It is in a same order of magnitude as other similar studies in European countries such as Germany and Italy, but higher than studies in U.K. and U.S. Trades in shares have more information content than trades following the exercise of employee stock options. In

addition, insiders have a good timing ability: they buy after a price decrease and sell after a price increase.

Overall our results show that in average, insiders are more informed than other market participants, even though this informational advantage is not reflected in each single trade. As such, trading by insiders can be analyzed to learn about the fundamental value of stocks. This is consistent with insider trading being an important channel of information flow from the company to the market.

In testing the impact of a change in regulation, we find that the Market Abuse Directive implemented in 2005 had no effect on the information content of share purchases. Holding other factors constant, top executives' purchases are still followed by positive abnormal returns. The only significant effect of this regulation change is a reduction in the information content of top executives' sales. These trades are now followed by less negative abnormal returns.

The remaining of the paper is organized as follows. Section 2 presents the related literature. Readers who want to go to our results directly can skip this section. In Section 3, we explain the essentials of insider trading regulation in the Netherlands. Section 4 presents a description of the data used and the methodology. Section 5 presents the results and Section 6 concludes.

2 Related literature

Although many asset pricing and market microstructure models are based on information asymmetry, very few theoretical papers have looked on the specific aspect of informed traders having to disclose their trades. To our knowledge, only two papers address directly the question from a theoretical perspective: Huddart, Hughes, and Levine (2001) and Buffa (2008). Both papers build a theoretical model inspired by

Kyle (1985) in which informed traders have to disclose their trades, thus the market maker can ex post distinguish between the order flow of informed traders and noise traders. When this trading game is repeated, the authors show that the well known Kyle (1985) equilibrium cannot exist. In order to find an equilibrium, the authors allow the informed traders to submit trading demand with a random component. In this case, the market maker cannot exactly infer the information content of the trade.

This last feature of the model is consistent with what is found in empirical studies about legal insider trading. Since insiders have to disclose their trades ex post, they will trade in a fashion such that it is very difficult to infer the extent of their information. By doing so, they will submit some trades that are uninformed, as if they were based on liquidity needs or diversification. They will post as well some informed trades, so that in average the information content of the trades is small.

On the contrary to the theoretical literature, the empirical literature on legal insider trading is sizable. An important, recent paper about insider trading in the U.S. market is Jeng, Metrick, and Zeckhauser (2003). The authors use SEC fillings on insider trading from 1975 to 1996. They study short term as well as long term abnormal returns to insider trading. Their methodology uses performance evaluation methods from the mutual fund literature. They form portfolios by buying stocks for which insiders provide a "buy" signal and hold them for a given number of days. For companies for which insiders provide a "sell" signal, they form a "sale" portfolio by buying stocks of these companies and holding to them for a given period of time.

For comparative purposes with our results, we report their results using short holding periods. They obtain a significant 2.5 to 2.8 % for the 6-day holding period for the buy portfolio, and a positive 0.8 to 0.9% for the sell portfolio. The positive abnormal return for a sell portfolio is not well understood, because we expect either negative returns if the insiders are informed, or zero returns if the trades have a liquidity or diversification motive. But this result is similar to the findings of Eckbo

and Smith (1998), Lakonishok and Lee (2001) and Aktas, De Bodt, and Van Oppens (2007). Breaking down into trade size (volume terciles), they find that for the purchase portfolio, larger trades result in larger abnormal returns.

Lakonishok and Lee (2001) use the same data as in the previous paper, but their methodology is closer to the event study methodology. They compute abnormal returns as excess returns over the market return. With an event window of five days, they obtain positive abnormal returns both for purchases (0.59%) and for sales (0.17%). Breaking down the results by firm size, they obtain an asymmetry between the effect of purchases and sales. For purchases, small firms have higher abnormal returns (it is even slightly negative for large firms). For sales, it is the contrary, the abnormal returns are more negative for large firms. Aktas, De Bodt, and Van Oppens (2007) reproduce the results of Lakonishok and Lee (2001) with similar U.S. data. They also find a positive abnormal return in the short run following sales by insiders. The authors argue that insiders are inclined to sell their shares when the market is dominated by a buy pressure (e.g. following good news announcements) in order to make sure that liquidity is sufficient.

A recent study of insider trading in the U.K. was done by Fidrmuc, Goergen, and Renneboog (2006), with data from the end of the 1990s. The results of their event study is that purchases and sales are followed by significant abnormal returns of the expected sign, both for 2-day and 5-day event windows. When differentiating between trades sizes, they find that large trades confer larger abnormal returns for purchases. For sales, the difference in *CAR* is small.

The Norwegian market has been studied by Eckbo and Smith (1998). The approach in this paper is similar to Jeng, Metrick, and Zeckhauser (2003) in the sense that the authors use insider trading as a information on which they build a trading strategy, with monthly data. In contrast to other European studies, including ours, their event study analysis shows no significant abnormal returns for purchase months.

Also, they find a significant price increase in a month of sales, followed by a month of negative abnormal returns. The differences in results is most probably due to their methodology, which is designed for long-term evaluation of portfolio performances.

Recently, legal insider trading has been studied for the German market. Betzer and Theissen (2008) use a dataset that spans from July 2002 to June 2004. Similar to the Dutch case, reporting delay of insiders varies a lot. Although the law stipulates that insiders have to report their trades without delay, more than half of their sample report after two days, and 7.6% of the trades are reported more than 30 days late. Note also that on the contrary to the Dutch regulations, in Germany insiders do not have to respect a blackout period, i.e. a period before major news, like earnings announcements, where insider trading is banned. The authors find very large abnormal returns after insider trading, and suggest that they are due to trades made before such earnings announcements. The *CAR*s have a magnitude of more than 2% in absolute value for both purchases and sales in a 11-day window including the trade day, and of 3.4% to 4.4% using large trades only.[1] On a larger event window of 21 days, they obtain 6% abnormal returns for purchases and almost -5% abnormal returns for sales.

For the Italian market, a paper by Bajo and Petracci (2006) shows that legal insider trades are followed by high abnormal returns, in the order of 3.18% 10 days following purchases and -3.67% for sales. They use about 4 years of data between 1998 and 2002. In a 5-week post-trade event window, the cumulative abnormal returns for purchases reach 7.29%, but is mainly driven by trades made by insiders owning more than 50% of all the shares outstanding of their company. Their results show as well that there is an asymmetry of response in terms of *CAR* for purchases and sales, with respect to the insider's holdings prior to the trade. Insiders owning between 30%

[1]Their definition of large trades is trade value that is more than 0.1% of the value of all shares outstanding.

and 50% of the shares have negative or no abnormal returns after their pruchases, but very high negative abnormal returns after their sales. By contrast, insiders that own more than 50% of the shares of the company have high and positive anormal returns after their purchases, but relatively low negative abnormal returns following their sales.

Another study is made for the Spanish market. The paper is by Del Brio, Miguel, and Perote (2002) and uses 5 years of data from 1992 to 1996. The specificity of the Spanish notification duty is that insiders have to tell the reason for trading their company's shares, which is not the case in the Dutch legislation. That makes it possible for the authors to remove transactions by insiders that are arguably not made upon information, like inheritance, bonus and gifts. In addition, the authors use non contaminated estimation windows. Their results are that there is a small but statistically significant abnormal return on the trading day itself, even though the trade was not yet announced to the public. For purchases, the 2-day *CAR* is not significant, but the 2-day *CAR* for sales is positive and significant (0.37%), which is another example of this unexplained positive reaction to insider sales.

There are two papers which study legal insider trading on the Dutch stock market. The first is by Biesta, Doeswijk, and Donker (2003). Although the aim of their paper is to assess the profitability of insider's portfolio based on a holding period of six months, they provide as well results on short term stock price movement after insider trading. Their data is from 1999 to 2003, and unlike us, they do not differentiate between top executives and other insiders. They use event study analysis and keep only non-overlapping event windows, further reducing their sample size. On a 21-day event window (i.e. from day zero to day 20), they obtain a significant 2.2% average cumulative abnormal return for purchases. On a smaller event window, their *CAR*s are positive but not significant. On the contrary, for sales, they obtain significant negative *CAR*s for shorter event windows (-2.8% from day zero to day 10) but not for

longer windows.

The second study with Dutch data, Aktas, De Bodt, Riachi, and de Smedt (2007), uses a similar dataset as ours, although less complete.[2] The authors use a market-adjusted model to compute *CAR*s around insider trades, not differentiating between top executives and other insiders. They find very small abnormal returns of less than 0.4% for purchases and almost -0.2% for sales, in a three day event window, including the transaction day. When they separate on trade value quartiles, they obtain a significant 2.3% for purchases on the very small trades in 2-day post-trade window, not including the trade day itself. When they include the trade day, the results become small and insignificant. With such a small event window, a large proportion of the trades are not yet made public. So it is not clear what causes the abnormal returns. It is well possible that a news announcement causes a drift in the stock price, during which the insiders trade. Indeed, Dutch companies have a blackout period[3] before important announcements, and insiders are allowed to trade only after the announcement. In that case, the abnormal returns are due to the post-announcement drift, and not to insider trades. By using a larger event window, we make sure that such situations do not bias our results.

Finally, there is a paper that sheds light on insider trading around news announcements. Sivakumar and Waymire (1994) study the difference between insider trading before and after a regulation in the U.S. that obliged companies to follow a black-out period before important news announcements. This is an important question since some companies have strict corporate governance rules that allow their insiders to trade only in some open windows after quarterly earnings announcements. This means that insiders can only trade after a public announcement. The question in

[2]The public registry of insider trading in the Netherlands available on the AFM website does not contain trades by former insiders and firms that are not public anymore (because of merger, bankruptcy, etc.) Thanks to our collaboration with the AFM, we use the full insider trading database.

[3]See next section for details about blackout periods and insider trading regulations.

the paper by Sivakumar and Waymire (1994) is whether insiders always trade in the direction of the news announcement (i.e. buying shares when news is good, selling shares when the news is bad) even when the price has already started to move. They find that it is not the case. Insiders might well sell after a good news announcement, or vice versa. On average, they make profits from their trades, even when they trade against the public news announcement. The authors argue that insiders know when the market is overly optimistic about some good news, or overly pessimistic about bad news. In these cases, trading as contrarians is profitable.

This paper by Sivakumar and Waymire (1994) shows that insiders have the ability to determine when the market is mis-pricing their company's stock. The paper suggests also that using a too short event window after trades by insiders might capture the price drift after some news announcement, since insider trades occur often after press releases, instead of the true impact of the trade. It also implies that with a sufficiently large event window, one might capture better the information content of the trade.

To summarize, the literature finds in general that insider purchases are mostly informed, whereas insider sales are mostly liquidity or diversification motivated, and thus not (or less) informed. Some studies use a methodology different from ours in that they use insider trading as a portfolio formation strategy, for which they evaluate the performance. Other studies use an event study methodology similar to the present paper. In general, studies from the U.S. and the U.K. have weaker results in the sense that the abnormal returns are smaller in absolute value, and less significant. Studies about European countries have larger abnormal returns, in the order of magnitude of a monthly 2%, for insider purchases (Netherlands and Spain), which is in line with our results. For Germany and Italy, the abnormal returns are much higher: about 7%. It is argued that in Germany insiders are not prevented to trade in advance of important information events, and in Italy, the results are driven by very large

shareholders that control 50% or more of the shares. No paper analyzes the exercise of employee stock option separately from trades in shares, like we do, and neither use de-aggregated data in order to study the effect of a single trade. They all aggregate the insider trades in a given company.

The next section develops on the Dutch regulation concerning insider trading.

3 Regulation

Since March 2002, the Authority for the Financial Markets (AFM) supervises Dutch financial markets. The AFM is responsible for the market supervision and the application of the different laws regulating conduct of financial institutions and financial markets. One of its duties is to supervise insider trading and to maintain a public registry of all transactions made by corporate insiders of listed companies. Insider trading is regulated in the Netherlands since 1987 (see Kabir and Vermaelen, 1996).

Dutch laws on insider trading mainly implement E.U. directives, in particular the Insider Dealing Directive 89/592/EEC and its successor, the Market Abuse Directive 2003/6/EC. The principles of law concerning insider trading are similar to those found in the U.S. or in the U.K.: it is forbidden for all market participants to trade according to private and price-sensitive information. Private information means information that is not publicly available to the market. Price-sensitive information means an information that is likely to affect the price of the company's stock. Examples of such information are financial results or merger negotiation.

In addition to the prohibition of trade based on private information, there is the obligation for insiders to report their trades on their company's stock. Here, insiders are defined as directors, managers, members of the supervisory board, employees and member of staff that are in contact with potentially private, price-sensitive in-

formation, as well as their spouse/partner and children living with them. The law stipulates that every listed company should have a written set of rules of conduct that specifies among other things when an insider is not allowed to trade (the so-called blackout periods). The notification duty concerns trades in shares or in any other standardized instruments for which the value depends on the value of the share. This includes employee stock options.

The companies that are tied by these rules include all publicly listed companies registered in the Netherlands (even if they are not listed in Euronext Amsterdam). Included are as well all companies (be it European of foreign) that have financial instruments listed on Euronext Amsterdam.

3.1 Act of the Supervision of Securities Trade 1995

From April 1999 until September 2006, there were two main acts that regulated insider trading. The first is called the Act of the Supervision of the Securities Trade 1995 (or Wte 1995). In 1999, some provisions concerning the notification of insiders' trades and the disclosure of these trades in the public registry were added.[4] At that time, the rules specified that the reporting by insiders should be no later than ten days after the end of the month in which the trade occurred.[5]

3.2 Act of the Disclosure of Major Holdings 1996

The second set of rules concerning insider trading are those arising from the Act of the Disclosure of Major Holdings and Capital Interests in Securities-Issuing Institutions 1996 (or Wmz 1996). This act obliged all major shareholders to disclose the level of their holding. In October 2002, a new provision in this act came into effect and

[4] Cf. Rules on the Notification and Regulation of Securities Transactions 1999.
[5] *Id.*, Section 4.

concerned the disclosure of the holding and voting rights by directors and members of the supervisory board (what we call *Top executives* for simplicity. We call the insiders not in this category *Other insiders*.) Top executives had still to notify the AFM of their trades but the information was disclosed to the public by the AFM through a different registry. They had to report their trades as soon as possible, without delay. This Act expired in October 2006 and was replaced by another one with similar provisions.

3.3 The Market Abuse Decree 2005

In October 2005, the European Market Abuse Directive[6] was incorporated into Dutch law as the Market Abuse Decree that modifies the Wte 1995. This directive is concerned by market abuse in general and has the aim of increasing market integrity and confidence. The provisions relating to insider trading have the effect of increasing substantially the penalties to illegal insider trading. In addition, the legal reporting delay for other insiders is brought to five working days after the date of the transaction. However, notifications can be delayed until the moment that the value of the transactions reach or exceed the amount of €5,000 in the calendar year in question. The implication is that if this €5,000 threshold is not reached in a particular calendar year, no notification need be sent. Also, insiders do not have to report acquisitions of shares or other instruments as part of a regular employee compensation scheme. The exception extends to the sale of shares acquired by exercising employee stock options as part of a scheme, if the exercise was made at the day of expiry or five working days prior to expiry and if there was a written note made by the insider at least four months in advance that revealed its intention to sell the shares so obtained.

Table 1 summarizes the main provisions of the law and tracks the changes made

[6]Directive 2003/6/EC of the European Parliament and of the Council of 28 January 2003 on insider dealing and market manipulation (market abuse).

in time.

[Table 1 about here.]

The next section explains more precisely the data and methodology used. The results follow.

4 Data and methodology

We have access to two different insider trading databases. The first one includes trades from top executives, such as directors and members of the supervisory board, as prescribed by Article 2a of Wmz 1996. We call this database "Top executives". Entries in this dataset go from September 2002 until December 2007, inclusive. The second dataset includes trades from what we call "Other insiders", i.e. corporate insiders that are *not* part of the management board or the supervisory board. This registry is based on Sections 46b and 47a of Wte 1995, and includes trades from April 1999 until June 2008, inclusive. Note that before September 2002, top executives' trades are included in the "Other insiders" database without distinction.

From both databases, we use trades of shares and employee stock options, and firms that are listed in the Netherlands that have price history available from Datastream. We discard investment funds, leaving us with a total of 149 listed firms.

The data can be analyzed according to two different levels of aggregation. The concept of "company-day" is a day when a company has insider trading. If at a given date, two or more insiders from the same company report trades, we group them into one trade. The direction of this trade (i.e. whether it is a buy or a sell) is determined by aggregating the trades. If more shares are sold than bought, the event is classified as a sell, and vice versa. In addition, we use "insider-day" events, i.e. days when a

given insider trades. In the above example, there would be two observations. This is the least aggregated level insider trading.

For the univariate analysis, we use company-days events. But later, in the multivariate analysis, we use insider-days events to capture the effect of insider-specific characteristics on the information content of trades.

Table 2 shows the number of observations according to the two levels of aggregation. We have overall 1,654 different insiders that reported trades. The number of insider-days events is 5,761. Aggregating to company-days events gives us a total of 3,612 observations. Notice that the number of insider-days is larger than the number of company-days. This shows that insiders from a given company trade often on the same day (but not necessarily on the same side).[7]

[Table 2 about here.]

The main hypotheses of this paper are tested using the event study methodology. We follow the method outlined in Campbell, Lo, and MacKinlay (1997). In this part of the methodology, we use company-day events because the ex-post performance of a given stock is the same whether there is one or many insiders who trade during that day. The time line of the event study is described in Figure 1. The event, i.e. a trade by an insider, occurs at period T_e. In order to calculate the abnormal returns, we need to estimate the parameters of the predictive model. These parameters are estimated in the estimation window, which occurs before the event, from time period T_0 until but excluding period T_1 (n observations). Once the parameters are estimated, the abnormal returns are calculated during the so-called event window, from period T_1 to period T_2. There are m periods in the event window, including periods that are

[7]Most, if not all of the empirical literature about insider trading use aggregated measures of insider trading. Some authors use company-days events, some discard company-days where insiders traded in different directions, because it is interpreted as a conflicting signal. Some papers use company-months events. The benefit of using de-aggregated data is to analyze the effect of insider or trade-specific characteristics, which is not possible when many trades and insiders are aggregated.

prior to the actual event. In this paper, we use $n = 250$ trading days as estimation period, and $m = 51$ trading days as event period (the event day itself, plus 20 and 30 trading days before and after then event, respectively).

[Figure 1 about here.]

As predictive model for the normal rate of return we use the market model (with the AEX index return as a proxy for the market return). The parameters are estimated by OLS with one year of data prior to the event window. To test the significance of the cumulative abnormal returns, we use the J_2 test statistic of Campbell, Lo, and MacKinlay (1997). For more detail on the event study methodology and the test statistic, see Appendix A.

We measure the cumulative abnormal returns for an event window of 20 trading days (i.e. approximately one calendar month) prior to the trade up to 30 trading days after the event, thus for an event window of 51 days. The event date is the day of the transaction – not the day at which the trade was made public. The significance levels are from a two-sided test. We use company-day observations (i.e. when many insiders from the same company trade during the same day, their trades are aggregated).

The second part of the empirical analysis is a cross-sectional regression of the cumulative abnormal returns following insiders' trades. We use insider-day observations and regress the individual *CAR*s on a set of explanatory variables:

$$CAR = X\Gamma + \epsilon \ ,$$

where X is the matrix of regressors and Γ is the vector of the associated coefficients. ϵ is the vector of error terms.

We use robust standard errors that are corrected both for clustering (same company, same date) and for heteroskedasticity between firms. See Appendix C for the

details of the methodology regarding the robust standard-deviations.

5 Results

In this section, we present the event study results. Subsection 5.1 shows how the average cumulative abnormal return varies with firm characteristics and insider type. The *CAR* shown is for trades aggregated by company-date (buy or sell signal by a firm for a given day). Subsection 5.2 studies in a regression framework the effect of trade-specific and insider-specific variables, such as trade size, prior holdings and notification delay. For that analysis, we do not aggregate insider trades for a given company on a given date, but rather we use insider-date observations. The results will also give a different view on firm-specific variables because we control for characteristics such as industry and reporting delay. The analysis will also help to study the effect of regulatory regimes on the information content of insider trading.

All the variables used in the empirical analysis are defined in Table 3.

[Table 3 about here.]

We start the description of our empirical results by discussing the market reactions around trades by *all insiders*. Figure 2 shows the average cumulative abnormal return (or $\overline{CAR}$) around purchases and sales by all insiders. The horizontal axis represents the number of days before and after the trade. Day zero is the event day, i.e. the transaction day. The curves are normalized to have an average *CAR* of zero at day -1, so that the curve at time $t = 0$ shows the the event day effect. The graph shows price movements before and after the trade as well. The markers show the two-sided significance of the average *CAR* (that is, a test that the effect is significantly different from zero).

[Figure 2 about here.]

If we believe that insiders provide new information to the market when trading, and that they have timing ability, the average *CAR* curve for purchases should have a "V" shape with the spike at day zero. This would mean that insiders wait for the right moment to buy shares (i.e. they wait for the price to be low), and this purchase provides a positive signal to the market, which would make the price rise. This is precisely what we observe for the trades in shares. In a window of one month prior to purchases, we see that prices are decreasing by 1% on average (statistically significant). During the month and a half after purchases, the cumulative abnormal returns are increasing very steadily by more than 2%. This is a sign of persistence of the daily abnormal returns, which is confirmed by the fact that the abnormal returns are typically more and more significant the further we move from the trading date. They start to be significantly different from zero at the 10% level from day 8 after the trade.

Concerning sales (dotted line of Figure 2), we see the opposite pattern, an inverted "V" shape: the price increase before the trade is quite strong and steady (about -1.3%), and after the trade, we observe a decrease in prices of more than 2%, significant at the 5% level. This means that even if sales are partly based on diversification and liquidity purposes, thus are less likely to confer new information, in average they still are informative. Also, the sales take place at the right moment (after a price increase of about 1.3% on average). This shows the timing ability of insiders with respect to sales of shares.

Figure 3 shows the $\overline{CAR}$ around the exercise of employee stock options, for all insiders. We separated these option exercises in two categories: instances where insiders exercise their options and sell all their shares (exercise and sell), and instances where insiders keep at least some of the shares obtained with the option (exercise and

keep). This latter category occurs rarely – only 108 times in the whole sample. The rationale for separating these categories is that keeping (part of the) shares could mean that insiders have positive information, whereas selling all shares could mean negative information about the firm.

[Figure 3 about here.]

The results show that for both categories (exercise and keep, exercise and sell), the abnormal returns are not significant after the trade. This means that no information is provided by these trades in average. But insiders still have a good timing ability: they choose to exercise their options after a price increase. This timing is at its best when insiders exercise and sell their shares: the price increase in the month prior to the trade is close to 3%.

5.1 Insider types

Breaking down these results into *different categories of insiders* can help to understand which trades are more important. Figure 4 shows the same graph, but for top executives and other insiders separately, and for trades of shares and exercise of options. The top left graph shows that trades in shares by top executives are informative only for purchases, for which abnormal returns cumulate to about 3.4%, 30 trading days after the trade. Following sales, we observe negative abnormal returns of about 2.8%, although less significant than for purchases. Moreover, their timing ability seems to be weak: the abnormal returns prior to the trade are close to zero. This means either that top executives do not have timing ability, or that they do not have the freedom to trade whenever they want. The results here cannot distinguish between these two explanations.

[Figure 4 about here.]

The top right graph of Figure 4 shows the average *CAR* for other insiders when they trade in shares. We see that the information content of the trades is weak: the curves do not show much statistical significance in the post-trade window. But the averages are of the "right" sign. In contrast, the *CAR*s prior to the trades are very pronounced. Purchases are preceded by a significant -2% abnormal return and sales, by a 1.9% abnormal return, statistically significant as well. This implies that other insiders have the ability and freedom to choose the right moment for executing their trades, but they cannot predict the price movement of the stocks.

Now for trades related to the exercise of employee stock options, we see by the sample sizes that most of the time, insiders liquidate their shares when exercising options. This is consistent with diversification, as they typically have already a large stake in their company through their employment. The small sample sizes of exercise and keep may explain also the low significance level of the *CAR*s, both for top executives and other insiders. But we can distinguish a certain pattern when exercising the option and liquidating the shares. Both top executives and other insiders seem to have good timing ability as the left part of the curves is significantly negative.

5.2 Firm characteristics

Following the literature (see Section 2), we condition the abnormal returns on firm-specific variables: market capitalization and book to market ratio. In the remaining, we concentrate on a post-event window of 21 trading days for top executives, and 31 trading days for other insiders because of the longer reporting delay allowed for the latter (see Section 3). The reason for this relatively long event window is that we allow enough time for all information contained in insiders' trades to be incorporated in the stock price.

Theory predicts that large firms are typically more followed by analysts, so that

there should be less information asymmetry between management and investors. In addition, the market for these companies is more liquid, so that large trades have less price impact. By contrast, insider trades in small firms that are more opaque would imply more information revelation. Table 4 shows the abnormal returns following insider trading broken down into firm size terciles. We determine firm size every year, on the 1st of January, by multiplying the stock price by the total number of shares outstanding. Then, we separate firms into three quantiles: small caps, mid caps and large caps. As expected, purchases by top executives in small companies have very high and significant abnormal returns. By contrast, purchases by top executives in the large cap group provides almost no abnormal return. We also observe that sales by both types of insiders in mid-size firms provide large negative abnormal returns, but not in large firms.

[Table 4 about here.]

The book to market ratio of a firm is known in the asset pricing literature to proxy for the value anomaly. There is evidence from previous studies with U.S. data that insiders act as contrarians (see e.g. Jenter, 2005): at an aggregate level, there are more insider purchases in value firms and more insider sales in growth firms, thus explaining in part the profit made by insiders. It is thought that insiders have a better idea of the growth opportunities of their companies and their trades can help to correct the expectations of the market, thus providing abnormal returns to their trades. Table 5 shows the *CAR*s after trades by insiders, broken down into book to market terciles. Value firms are those that have a market price relatively small with respect to the book value. If the company is indeed under-valued by the market, insiders' purchases should be followed by large abnormal returns. By contrast, growth firms are those for which the stock price is high relative to the accounting value. If insiders sell shares, the signal should be clear that the firm is over-valued by the

market. In Table 5 we see that top executives that buy shares in value firms make indeed a large and significant abnormal return. In the same column, we also note that the average *CAR* and the test statistic diminishes with the book to market ratio (i.e. going to Mid BM firms and Growth firms). The pattern is less clear for sales by top executives. Their sales do not predict future down turns for growth firms. Other insiders, on the other hand, do not profit from buying shares in value firms, but they do take advantage of selling shares of growth firms before a down turn.

[Table 5 about here.]

Tables 4 and 5 showed an overview of some patterns of stock price movements after insider trading, at the company level. Since there might be many other confounding factors that explain these patterns, in the next sub-section we will study the impact of insider trading in a regression framework.

5.3 Cross-sectional regression

As explained above, the cross-sectional regression framework allows us to use trade information at the insider level, and to use individual and company characteristics. In order to do so, we now use insider-day events, instead of company-day events. This allows us to study the effect of trade-specific information, as well as company-specific characteristics while controlling for other relevant factors.

Many of the control variables that we use are dummy variables that represent membership in a group. These groups are size terciles, book to market terciles, industry membership, regulatory regime and notification delay groups. The industry groups are classified according the the ICB industry classification.[8]

[8]ICB stands for Industry Classification Benchmark. It is created by Dow Jones and FTSE. There are ten industries in this classification framework. Information about the ICB industry of Dutch firms is taken from Datastream.

To solve the dummy variable trap (i.e. exact multicolinearity), we use constrained OLS estimation. This makes the results easier to interpret because we do not have to take one group as a reference group. The constraints are such that the coefficients of every set of dummy variables must have a weighted average equal to zero. The weights applied are the proportion of the observations in each group. With this a specification, the coefficient of the dummy variables gives the deviation from the overall mean effect. Details about the constrained OLS used for the cross-sectional regression are found in Appendix B.

For top executives, we have access to the information concerning the holdings of the insider before the trade. We use this information to control for the importance of the stake the insider has in the firm. This might influence the signal given to the market. Specifically, we use the proportion of all shares outstanding owned by the insider. In addition, we control for the size of the trade. We use two alternative variables to proxy for this: the relative volume and the relative turnover. The former variable is defined as the number of shares traded divided by the total number of shares outstanding. The latter variable is the euro value of the trade divided by the average daily euro turnover for the stock. (The average daily euro turnover is computed every year for each stock.)

We use a dummy variable "Cluster" to control for the trades that are closely followed by other trades by the same company. The variable Cluster is equal to one when any insider of a given company trades on the same side within one week of interval before or after the current trade, and zero otherwise. For example, if two insiders of the same company buy shares in a given week, the Cluster dummy is equal to one for both observations that come into the cross-sectional regression. This dummy variable is used to test the stealth trading hypothesis (see Barclay and Warner, 1993), which states that insiders that trade on private information have the incentive to split their trade into several small trades so that their information

would be less likely to be detected by the market (and also to catch less the scrutiny of the legislator).[9] The coefficient of this variable will therefore capture whether insiders cluster their trades when they trade upon information, or when they trade for liquidity reasons. For exercise of options, this variable is defined as trades in shares that are done within one week before or after the exercise of the option, on the same side. More precisely, if an insider exercises his stock option and sells the shares obtained, the Cluster dummy would be equal to one if within a week, an insider of the same firm sold shares. Similarly, when an insider buys shares within a week of a conversion of option into shares, the Cluster dummy is equal to one.

In addition to firm-level and individual characteristics, we use a market-wide characteristic that is not captured by the market model in the event study methodology. It is known in the market liquidity literature that the level of liquidity affect firms' returns (see e.g. Chordia, Roll, and Subrahmanyam, 2000; Amihud, 2002). In the time period in which our sample takes place, there are periods of high liquidity and of low liquidity, and this factor affects firms' returns as well as abnormal returns to insider trading. The proxy for market liquidity is a variable called *ILLIQ* (see Amihud, 2002). Our measure of illiquidity is based on the median monthly illiquidity in the market. It is computed as follows:

$$\begin{aligned} ILLIQ_m &= \text{median}\left(ILLIQ_{im}\right) \\ ILLIQ_{im} &= \frac{1}{D_m}\sum_{d=1}^{D_m}\frac{|r_{id}|}{V_{id}}\,, \end{aligned} \tag{1}$$

for each firm i, where d is the day of the month m (from 1 to D). r_{id} is the log return of day d. V_{id} is the number of shares traded during day d for firm i. From

[9]Note that our event window is one month for top executives and a month and a half for other insiders, so the *CAR*s obtained are not likely to include price movements due solely to price impacts of trades. Alternative definitions of clusters (e.g. trade by other insiders of the same company, trades that are done within two weeks instead of one week) were used (not shown here) and results where the same.

these firm-specific monthly measures, we obtain a market-wide illiquidity measure by taking the median firm in the month.

Regression results are presented in Table 8. Coefficients for control dummy variables are shown in Table 9. In addition, we show some descriptive statistics of the group dummies and regression variables in Tables 6 and 7.

[Table 6 about here.]

[Table 7 about here.]

The results are separated into insider type (top executives, other insiders) and trade type (purchases, sales, exercise of options). For each, two specifications are shown. The first, called Model (1) uses as a measure of trade size the share volume relative to the total number of shares outstanding. Model (2) uses euro volume relative to the average daily euro turnover.

The first thing to notice in Table 8 is that the intercept of all regressions is insignificant.[10] This is in contrast with the graphs showing unconditional averages of *CAR*s, above (Figure 2 and 4), where the average abnormal returns were large and significant. This means that some factors or characteristics are responsible for bringing the $\overline{CAR}$ far from zero in Figures 2 and 4.

[Table 8 about here.]

For top executives, their holdings of their company stock is an important factor indicating information. The larger their holding in the company, the more their purchases are related to future positive abnormal returns. This means either that executives with large holdings are more informed, or they refrain to buy new shares

[10]Note that the explanatory variables are all deviations from their mean. Thus, the intercept represents the average *CAR* for non clustered trades.

unless their company has very good future prospects. For sales, the effect of holdings is not significant. This contrasts with the results obtained in Fidrmuc, Goergen, and Renneboog (2006) who document that CEOs with large holdings send an entrenchment signal when they purchase more shares.[11]

The *ILLIQ* variable helps to explain the magnitude of abnormal returns. For ease of interpretation, the variable has been divided by its standard deviation. The coefficient is the increase in abnormal returns when illiquidity of the market increases by one standard deviation. For top executives, this variable is significant for all types of trades. For purchases, the sign of the coefficient is positive, meaning that purchases in times of low market liquidity are followed by higher abnormal returns. This is consistent with the hypothesis of information content of insider purchases. Indeed, if liquidity is low, and thus implicit trading costs are high, an investor would require a higher rate of return to compensate. Or in other words, an insider would refrain to trade unless the information content is high.

Interestingly, the sign of the illiquidity coefficient is also positive and significant for sales (only top executives). This means this variable has the opposite effect for sales compared to purchases: sales in period of illiquid markets trigger higher (i.e. less negative, or even positive) abnormal returns. The effect is economically important: when the market's illiquidity increases by one standard deviation, the abnormal returns are 1.82% higher in average. This result can be explained by the timing ability in conjunction with the liquidity motivation for sales. In times of low liquidity, if insiders have to sell, they will choose the right moment, e.g. after good news on the firm or whenever other market players need to buy. This is in line with the conjecture of Aktas, De Bodt, and Van Oppens (2007).

[11]The authors use information about the shareholder structure of the firms. In their regression, they find that purchases by CEOs that own a large stake in their firm produce a large abnormal return only when there is another blockholder that acts as a monitor. If there is no active blockholder, the entrenchment is seen as a negative signal by the market and produces negative abnormal returns.

The variables that proxy for trade size give interesting results. For both top executives and other insiders share purchases, the coefficients are negative. This means that very large purchases are *not* associated higher abnormal returns. This is consistent with the stealth trading hypothesis of Barclay and Warner (1993), which stipulates that traders tend to use small or medium trades to trade upon information. But it is in strong contrast with the literature, in particular Betzer and Theissen (2008) and Fidrmuc, Goergen, and Renneboog (2006), where they report (although not in regression framework) that the *CAR*s are higher for higher trade sizes. This shows that it is important to control for other characteristics.

The Cluster dummy variable for purchases has a coefficient that is not significant either for purchases or for sales. This means that insiders do not systematically use clustered trades when they trade upon information, as the stealth trading hypothesis suggests.

Results concerning group dummies are shown in Table 9. The coefficients of these dummies is taken from the first specification in each category of insider and trade. Note that the coefficients designate the difference of a group with respect of the overall mean. Similar to what is obtained in Table 4, we see that purchases by top executives in small firms are followed by strong positive abnormal returns. In contrast, sales by top executives in small firms do not impact subsequent share price. This is in line with the hypothesis that purchases are more informed than sales.

[Table 9 about here.]

In contrast to top executives, other insiders have no impact on abnormal returns when they buy shares, but they do have an impact when they sell in small and medium firms. It may be conjectured that other insiders allow themselves to sell shares in front of bad news because they fear less the regulator's scrutiny than top executives.

The effect of book-to-market ratio is also similar in the regression framework compared to the results in Table 5. Top executives that buy stocks in value firms obtain positive and significant abnormal returns. This is consistent with insiders indicating that the market is undervaluing the company. Similar results are obtained for other insiders. Buying value stocks is followed by large positive abnormal returns. In addition, when other insiders sell growth stocks, there is a sharp decrease in subsequent returns. This is consistent with information that the market is overvaluing the stock.

For top executives, we have a more precise information about the position of the insider in the firm. The last group dummies distinguish between "Board of directors" and "Supervisory board". We see that the abnormal returns following trades do not differ between these two categories of top executives.

The right hand side Table 8 shows regression results for exercise of options. Since the majority of these trades are actually liquidation (exercise and sale of the shares), we do not show different regression results for option conversion. Rather, we control for those insiders who convert instead of liquidating by a dummy variable. Coefficients of these dummies (not shown in tables) are that insiders who sell shares at the same time as liquidating their options account for 7% of the sample, and the abnormal return for this group is on average 3.9% lower (significant at the 5% level) than those who just liquidate their options. In contrast, those who keep part or the total number of shares obtained by the option account for 13.5% of the sample, and they do not obtain statistically different abnormal returns than the average option exercise.

For other insiders, the proportion of option exercises that are full liquidation of the shares obtained is even higher: 91%. And no statistically significant difference is measured between those who sell more than the option, those who liquidate the shares, and those who keep some shares.

Table 8 shows as well that for top executives option exercises, the variable *ILLIQ* is

negative and significant. This means that when the market liquidity is low, liquidating options is associated with larger negative abnormal returns. This is consistent with information.

5.4 Regulatory implications

The regression framework allows us to study the effect of two regulatory aspects. First, the effect of late reporting can be observed by the coefficients of the fourth dummy group. As Table 9 shows, a relatively large proportion of top executives report their trades later than the allowed period stipulated by the regulation (see column 3 and column 6). The effect of late notification for purchases is small and insignificant. But the effect is quite important for sales: 39% of stock sales by top executives are reported late (after winsorizing out the trades that were reported more than 3 months late, which we assume is a mistake in the data), and these stocks have in average 1.78% negative abnormal returns (significant at the 5% level). That is, even after controlling for other factors, sales that are reported late to the regulator carry more information than sales that are reported on time.

The analysis also allows us to study the regulation changes concerning insider trading, through the years. The fifth dummy group are time dummies that correspond to different regulatory regimes. The different regimes are described in Section 3, above. Still from Table 9, we see that for top executives purchases, no significant difference can be observed concerning the information content the the trades. For top executive sales, the abnormal returns were in average 1.11% lower in the period prior to the Market Abuse Decree. This means that there is nowadays less information content in the sales of Top executives. The dummy variable for the period immediately after the implementation of the Market Abuse Decree shows no statistical significance. But the period after November 2006 until the end of the sample shows a positive

coefficient and is significant. This result shows that it took one year (from October 2005 to November 2006) before the effect of the new regulation could be seen on the average *CAR* following sales of top executives.

Very similar results are obtained for other insiders. There is no difference in abnormal returns following purchases between the periods. For sales, the first period dummy, i.e. prior to September 2002, has a negative coefficient of -0.94%. Note that this period is where Top executives and Other insiders where not differentiated in the dataset. The results show again that in the recent period, sales have less information content than in earlier periods.

6 Conclusion

Corporate insiders are often allowed to trade in their own company's stock. Legal insider trading however is in many countries subject to regulation. This paper examines the information content of legal insider trading in the Netherlands. We also investigate how regulatory changes impact this information content. We proxy the information content by the cumulative abnormal returns around dates at which insiders trade. We obtain a set of interesting results.

First, we find important differences in information content both between purchases and sales as well as between category of insiders (top executives and other insiders). For example, the unconditional average abnormal return after purchases by insiders is large and significant: up to 2% in a window of one month and a half. The information content is lower in magnitude and less significant for sales. When separating between category of insiders, the magnitude of the cumulative abnormal return is larger for top executives whereas it is not statistically significantly different from zero for other insiders. This is consistent with top executives being much better

informed than other insiders. However, other insiders seem to have a good timing ability: they buy when the stock is at a relative low and sell when it is at a relative high.

Second, important differences in information content of insiders' trades exist between small and large firms and between firms within different book-to-market terciles. Separating the sample in size terciles, the abnormal returns after purchases by top executives are much larger for small firms than for large firms. This is consistent with the hypothesis that small firms are more opaque and less followed by the press and by analysts, so that legal insider trading confers more information to the market (or in other words, there is more information asymmetry in these stocks.) Breaking down the sample into book-to-market terciles, we find that purchases by top executives are more informative for value firms, i.e. firms that have low stock price compared to their accounting value. This suggests that when top executives buy shares in these value stocks, it is perceived as a sign that the company's prospects are good.

Third, we employ a regression framework in order to sort out the possible confounding factors, and to control for more variables that explain the variation in abnormal returns. We show that large holdings prior to purchases by top executives are associated with greater abnormal returns: insiders that have large holdings are more informed. A larger relative trading volume however is not associated with information asymmetry: the larger the purchase, the lower the abnormal returns. We also find that market conditions are important determinants of the magnitude of the abnormal returns. For purchases by top executives, a market with low liquidity is associated with higher abnormal returns. This is consistent with information asymmetry. For insider sales, market liquidity has the opposite effect: a lower market liquidity is associated with less information asymmetry. It is as if insiders make less informed sales when the market is less liquid. This is consistent with diversification motives.

Fourth, new to this literature is the comparison of the exercise of employee stock options to purchases and sales of shares. We observe that a very small proportion of insiders convert their options to stocks. Most of the time, they liquidate the shares obtained, and the abnormal returns are on average negative after the execution of the options.

Finally, we study the impact of regulatory changes on legal insider trading in the Netherlands, especially the impact of the implementation of the Market Abuse Directive of the European Union. We show that this new legislation had a significant effect on sales by top executives. The sales following the implementation of the Market Abuse Directive were less information driven. Another policy implication of this study is the fact that many insiders report their trades after the legal notification period allowed by law. We show that sales that are notified late are followed with negative abnormal returns. These sales have thus more information content and should be monitored more closely.

Overall, the results show that some trades by insiders are information driven, and the public registry of insider trading can be used by outsiders to evaluate the fundamental value of the stocks. This is consistent with legal insider trading being a channel through which information circulates from the firm to the investors.

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Appendix

A Event study methodology

The event study methodology used in this paper is exposed here. For each company-day observation, we run the following regression:

$$r_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it} \ ,$$

where r_{it} is the return of firm i at time t, r_{mt} is the return of the AEX index at time t, α_i and β_i are the parameters for firm i, and ε_{it} is an error term. The normal rate of return is the expectation of the company's return conditional of the contemporary market return and the parameter estimates:

$$E\left[r_{it} \middle| r_{mt}, \hat{\alpha}_i, \ \hat{\beta}_i\right] = \hat{\alpha}_i + \hat{\beta}_i r_{mt} \ .$$

The abnormal return, or *AR*, for a given firm at a given date is the difference between the realized return and the normal return:

$$AR_{it} = r_{it} - \left(\hat{\alpha}_i + \hat{\beta}_i r_{mt}\right) \ .$$

The cumulative abnormal return, or *CAR*, for a given firm is the sum of the daily abnormal returns between two time periods, τ_1 and τ_2. It is defined as follows:

$$CAR_i(\tau_1, \tau_2) = \sum_{k=\tau_1}^{\tau_2} AR_{ik} \ .$$

We then aggregate the abnormal returns of all company-days in the sample by averaging the preceding variable over $i = 1, \ldots, N$:

$$\overline{CAR}(\tau_1, \tau_2) = \frac{1}{N} \sum_{i=1}^{N} CAR_i(\tau_1, \tau_2) \ .$$

The main hypothesis to test is whether the average cumulative abnormal return, or $\overline{CAR}$, is different to zero. The test statistic is the following (the J_2 statistic in the notation of Campbell, Lo, and MacKinlay, 1997):

$$J = \frac{\sum_{i=1}^{N} SCAR_i(\tau_1, \tau_2)}{\sqrt{N\left(\frac{n-2}{n-4}\right)}} \ ,$$

where

$$SCAR_i(\tau_1, \tau_2) = \frac{CAR_i(\tau_1, \tau_2)}{\sqrt{\mathrm{var}(CAR_i(\tau_1, \tau_2))}} \ .$$

Under the assumptions of independence of the abnormal returns between events, this test statistic is approximately distributed as standard normal.

B Cross-sectional regression methodology

Here is the regression equation (in matrix notation):

$$CAR = \gamma_0 \iota + \sum_{d=1}^{D} X_d \delta_d + Y\gamma + \epsilon \ .$$

There are a total of N observations, with $k+1$ regressors (including the constant). The notation is the following:

γ_0	is the intercept (a scalar),
ι	is a N-vector of ones,
D	(a scalar) is the number of category sets (size categories, book-to-market categories, notification delay categories, industry categories, etc.),
X_d	is a $N \times \text{length}(\delta_d)$ matrix of dummies that associate each observation to the right category,
δ_d	is the vector of the coefficients of each category,
Y	is a $N \times \text{length}(\gamma)$ matrix of other regressors,
γ	is a vector of coefficients, and
ϵ	is the vector of OLS residuals.

In order to identify the coefficients, we use the following restrictions:

$$\omega_d' \delta_d = 0 \ , \ d = 1, \ldots, D \ ,$$

where ω_d is a set of weights. In words, the weighted sum of the coefficients of the dummies, for each set, must be equal to 0. By imposing this restriction, we can identify the intercept, and the effect of each dummy in a category set. For example, in the size category set, if the coefficient for small capitalization firms is positive, it means that this category has relatively more impact than the average firm, in addition to the value of the intercept.

The weights are set in order to balance the fact that some categories have more observations than others. For example, in the industry dummy set, the industry "Health care" have less observations than other industries. Using this weighting scheme gives more intuitive results, as the sum of the coefficients in a given category set is always zero, even if the number of observations is not equal in each category. This is obtained simply by setting the weight to be the number of observations in a given category divided by the total number of observations.

C Computation of the standard-deviations in the cross-sectional regression

We need a robust method for the standard-deviation for the cross-sectional regression because we use observations that are de-aggregated, i.e. insider-day events. The variance-covariance matrix used to robust to heteroskedasticity between observations, as well as robust to clustering. By clustering, we mean two or more insiders from the same company that trade during the same day. In this case, the *CAR* of the stock is not independent between these observations; on the contrary the *CAR* will be identical for these observations. Ignoring this fact would bias upward the test statistic, thus over-rejecting a null hypothesis.

In this paper, we use the following variance-covariance matrix of the estimators:

$$\text{var}\left(\hat{\Gamma}\right) = \left(X'X\right)^{-1} X'\hat{\Sigma}X \left(X'X\right)^{-1} \ ,$$

where $\hat{\Sigma}$ is the robust estimate of the variance-covariance matrix of the error terms. This matrix is block-diagonal:

$$\hat{\Sigma} = \begin{bmatrix} \hat{\Sigma}_1 & 0 & \cdots & 0 \\ 0 & \hat{\Sigma}_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \hat{\Sigma}_k \end{bmatrix} ,$$

where the index represents the company-day events. If many insiders from the same company trade during the same day, the element $\hat{\Sigma}_i$ is not a scalar, but a square matrix of size equal to the number of observations for this company-day. In this case, this square matrix is equal to:

$$\hat{\Sigma}_i = \left(\frac{\hat{\epsilon}_{i1} + \hat{\epsilon}_{i2} + \ldots + \hat{\epsilon}_{iJ}}{J}\right)^2 \mathbf{1}_J \ ,$$

where J is the number of insiders of the i^{th} company trading during this day, and where $\mathbf{1}_J$ is a square matrix of ones of size J, and $\hat{\epsilon}_{i\cdot}$ is the OLS residual.

An example will illustrate best how the matrix $\hat{\Sigma}$ is constructed. Assume there are four observations for the cross-sectional regression, i.e. four *CAR*s. Assume two of them are trades by insiders from the same company that traded during the same day. We have CAR_{ij} for company $i = 1$ to 3. Company $i = 2$ has two insiders and so we have $j = 1$ to 2 for that company. We estimate the coefficients by OLS, and we obtain the residuals $\hat{\epsilon}_{\cdot}$. The estimate of the variance-covariance matrix of the residuals is the

following:

$$\hat{\Sigma} = \begin{bmatrix} \hat{\Sigma}_1 & 0 & 0 \\ 0 & \hat{\Sigma}_2 & 0 \\ 0 & 0 & \hat{\Sigma}_3 \end{bmatrix} = \begin{bmatrix} \hat{\epsilon}_1^2 & 0 & 0 & 0 \\ 0 & \hat{\sigma}_2^2 & \hat{\sigma}_2^2 & 0 \\ 0 & \hat{\sigma}_2^2 & \hat{\sigma}_2^2 & 0 \\ 0 & 0 & 0 & \hat{\epsilon}_3^2 \end{bmatrix},$$

where

$$\hat{\sigma}_2^2 = \left(\frac{\hat{\epsilon}_{21} + \hat{\epsilon}_{22}}{2} \right)^2 .$$

Figure 1: Timing of an event study

This figure shows the time line of an event study. The event date is T_e. The estimation of the benchmark model uses n observations from date T_0 until (but excluding) date T_1. Abnormal returns are computed for the m periods of the event window, which starts at date T_1 and ends at date T_2.

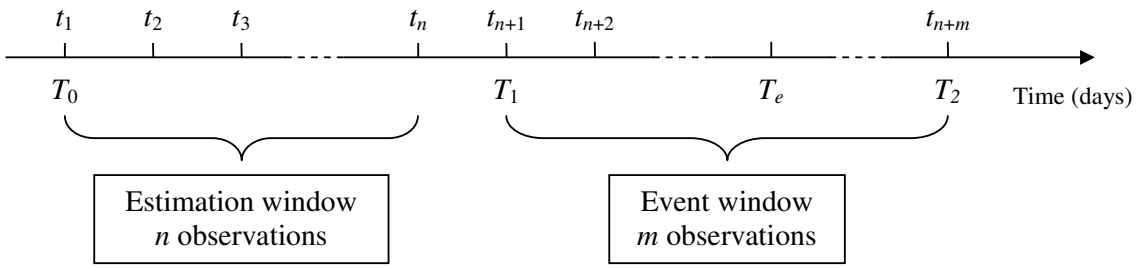

Figure 2: Trades of shares

The graph shows the average cumulative abnormal returns around purchases and sales of shares by insiders. The two curves are normalized to be zero at day −1.

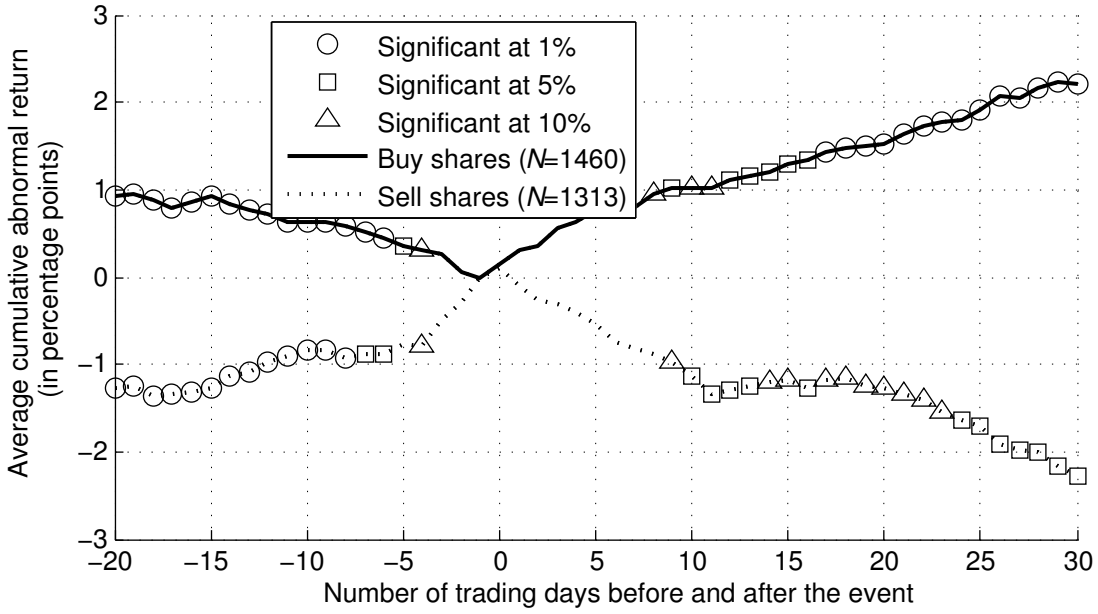

Figure 3: Exercise of employee stock options

The graph shows the average cumulative abnormal returns around exercises of employee stock options by insiders, where insiders can sell all the shares, or they can keep at least part of the shares. The two curves are normalized to be zero at day −1.

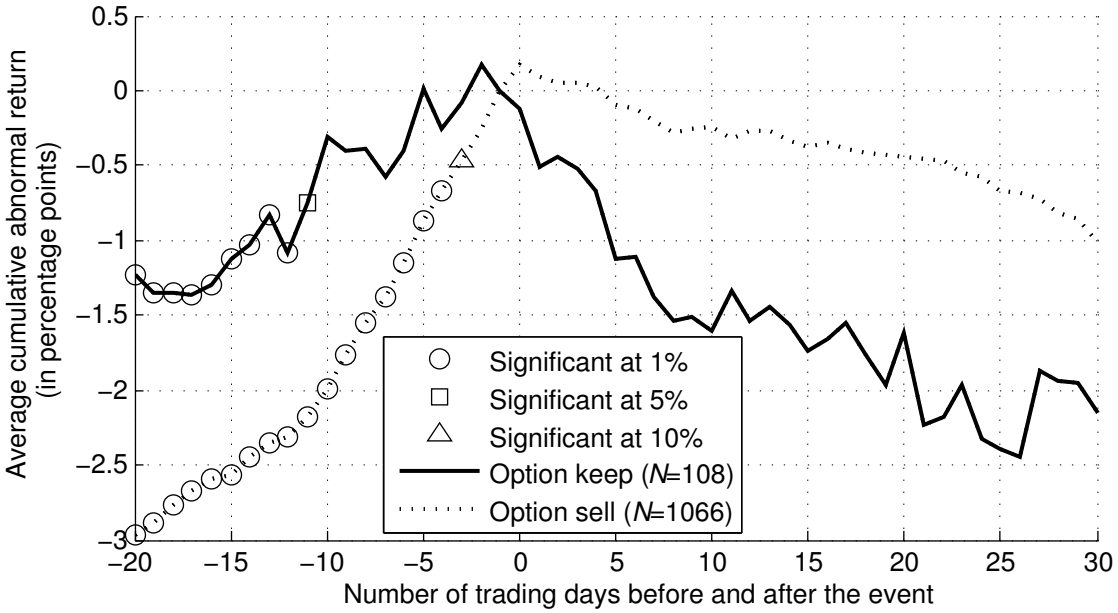

Figure 4: Category of insiders, shares and options

This figure shows the average cumulative abnormal returns to insider trading for top executives and for other insiders, and for trades in shares and exercise of employee stock options. In the case of options, insiders can either keep the shares (convert the option), or sell the shares (liquidate the obtained shares). The x axis shows the day relative to the trade day, which is day zero. The y axis shows the average *CAR* in percentage points. All graphs are normalized such that the average *CAR* is zero at day -1. The markers show the significance level: circles, squares and triangles indicate 1%, 5% and 10% significance level, respectively.

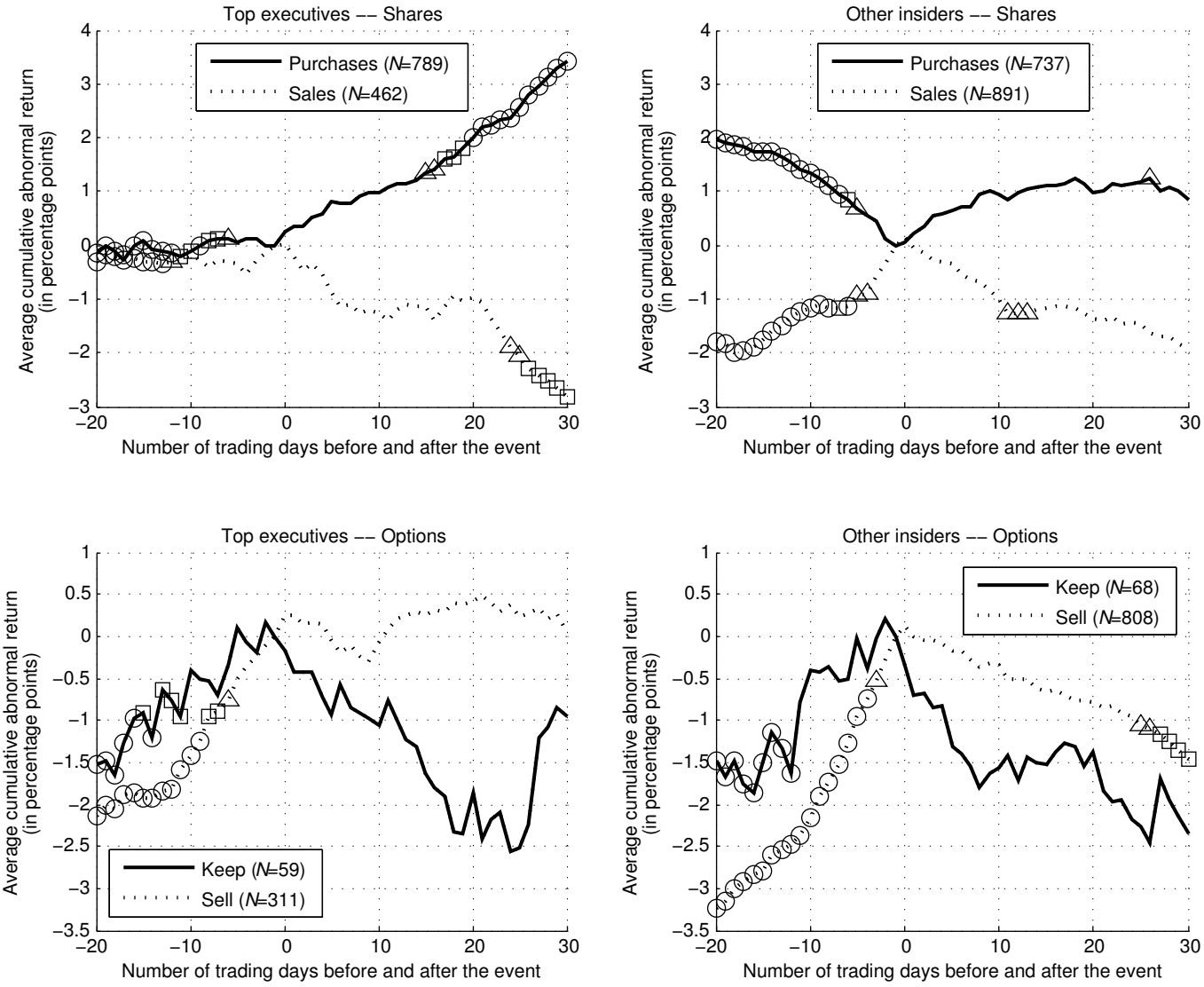

Table 1: Summary of the insider trading regulations

This table gives an overview of the relevant articles of law regulating insider trading in the Netherlands.

Top executives		
Date	**Act-article**	**Content**
Sept. 2002	Wmz 1996 – Art. 2a	Notification of trades. Delay: immediately after the trade
Nov. 2006	Wmz 2006 – Art. 16	New legislation, but the rules are the same.
Other insiders		
Date	**Act-article**	**Content**
Apr. 1999	*Wte 1995 – Art. 46b	Notification of trades. Delay: 10 days after the end of the month
Oct. 2005	Wte 1995 – Art. 47a	Notification of trades. Delay: 5 working days or until the total value of trades reaches €5,000. In any case, notification has to be done before the end of the calendar year.
Oct. 2005	Market Abuse Decree 2005 – Art. 2	Exceptions to the notification: a) if shares are given to the insider as part of employee scheme in doing a constant course of action; b) exercising options granted by employee scheme on the expiration date or within 5 working days prior to the expiration date; c) if the shares obtained are sold, there is an exception on the prohibition if there was a written note made on the subject at least 4 months before the expiry date.

*Note that between April 1999 and September 2002, all insiders had to notify their trades according to this provision, including directors and members of supervisory boards.

Table 2: Descriptive statistics

This table shows some descriptive statistics of the combined dataset of insider trading. The trades for which notification delay exceeds 90 calendar days are discarded.

Category	**Number of Companies**	**Number of Insiders**	**Number Company-Days**	**Number Insiders-Days**
Top executives				
Shares	117	416	1152	1869
Options	65	192	330	464
Other insiders				
Shares	127	899	1493	2174
Options	70	617	830	1254
All	149	1654	3612	5761

Table 3: Variable definition

We define here the variables used in the cross-sectional regression. Variables followed by an asterisk (*) are available only for top executives.

Variable	Definition
	Dependent variables
$CAR(0, 20)$	Average cumulative abnormal return starting at day zero (the trading day) and ending day 20 (approx. 1 month).
$CAR(0, 30)$	Average cumulative abnormal return starting at day zero (the trading day) and ending day 30 (approx. 1 and a half month).
	Explanatory variables – Dummy variables
Small cap	Equals 1 if the firm belongs to the smallest tercile group, based on market capitalization computed at the beginning of each calendar year.
Mid cap	Equals 1 if the firm belongs to the middle tercile group, based on market capitalization computed at the beginning of each calendar year.
Large cap	Equals 1 if the firm belongs to the largest tercile group, based on market capitalization computed at the beginning of each calendar year.
Growth firm	Equals 1 if the company is in the tercile with the lowest book to market ratio. The companies in the sample are ranked every beginning of calendar year.
Mid BM	Equals 1 if the company is in the second book to market tercile. The companies in the sample are ranked every beginning of calendar year.
Value firm	Equals 1 if the company is in the tercile with the highest book to market ratio. The companies in the sample are ranked every beginning of calendar year.
Notification in time	Equals 1 if the notification of the trade is done within the limits established by the regulations.
Late notification	Equals 1 if the notification of the trade is made after the time limit established by regulation.
Board of directors*	Equals 1 if the insider is member of the board of directors.
Supervisory board*	Equals 1 if the insider is member of the supervirosy board.
Cluster	Equals 1 if any insider from the same company traded stocks within a window of 1 week before or after the trade.
	Explanatory variables – Continuous variables
Holdings *	The holdings in shares of the insider prior to the trade. Holdings are defined as the stake of the insider as the proportion of the total number of shares outstanding. This variable is provided only for trades in shares.
Volume	The trade size in shares relative to the total number of shares outstanding.
Turnover	The trade's turnover in € divided by the average daily turnover of the stock (computed at the beginning of each calendar year).
ILLIQ	Moving average of the median of Amihud's illiquidity measure for the firms in the sample during the calendar month preceding the trade. The illiquidity measure is the absolute return divided by the euro value of the shares traded. See Equation 1. In the regression, this measure is standardized for ease of interpretation of the coefficient.

Table 4: Breakdown by size

This table shows the average cumulative abnormal returns to insider trading for top executives and for other insiders. Only trades of shares are used here, not trades related to exercises of employee stock options. The event period is a 21 trading day period (beginning with the transaction day) for top executives, and a 31 trading day period for other insiders. The average *CAR* is broken down into market capitalization terciles. In each row, the first number shows the average *CAR*, the second in brackets shows the test statistic, and the third is the number of observations. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Firm size	**Top executives**		**Other insiders**	
	Purchases	Sales	Purchases	Sales
Small caps	8.02%	0.75%	0.99%	-5.12%
	(4.22) ***	(0.15)	(0.50)	(-0.37)
	178	161	175	176
Mid caps	0.37%	-3.03%	1.63%	-3.72%
	(-0.23)	(-2.43) **	(-0.09)	(-3.29) ***
	231	139	235	405
Large caps	0.30%	-1.43%	0.29%	1.53%
	(1.24)	(0.09)	(1.58)	(1.83) *
	399	136	366	326
All	1.97%	-1.16%	0.83%	-2.04%
	(2.73) ***	(-1.23)	(1.28)	(-1.27)
	808	436	776	907

Table 5: Breakdown by book to market ratio

This table shows the average cumulative abnormal returns to insider trading for top executives and for other insiders. Only trades of shares are used here, not trades related to exercises of employee stock options. The event period for top executives is a 21 trading day period beginning with the transaction day. For other insiders, the event period spans 31 days including and after the trade. The *CAR* is broken down into book to market terciles. At the beginning of January of each year, the book to market ratio of firms in the sample is computed and firms are then separated into three groups. High book to market is a proxy for value firms, low book to market is for growth firms. In each row, the first number shows the average *CAR*, the second number in brackets shows the test statistic, and the third is the number of observations. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Book-to-market ratio	**Top executives**		**Other insiders**	
	Purchases	Sales	Purchases	Sales
Value firms	5.33%	4.33%	2.39%	1.61%
	(5.12) ***	(1.35)	(1.20)	(0.49)
	149	60	182	107
Medium	1.69%	-3.44%	1.79%	-0.13%
	(0.64)	(-2.68) ***	(0.62)	(0.55)
	319	159	287	310
Growth firms	0.77%	-0.85%	-1.36%	-4.27%
	(0.20)	(-0.16)	(0.51)	(-2.38) **
	340	217	307	490
All	1.97%	-1.16%	0.83%	-2.04%
	(2.73) ***	(-1.23)	(1.28)	(-1.27)
	808	436	776	907

Table 6: Descriptive statistics of the variables used in the cross-sectional regressions – Shares

Variables used are defined in Table 3.

Descriptive statistics							
Top executives							
Variable	**Mean**	**St.dev**	**Min**	**Q2**	**Median**	**Q3**	**Max**
Holdings	0.8307	6.3408	-0.0091	0.0000	0.0004	0.0068	53.69
ILLIQ	1.1518	1.2543	0.1754	0.3109	0.5638	1.6286	4.8516
Volume	0.0092	0.0662	7.500E-9	2.205E-6	4.461E-5	4.667E-4	1.0000
Turnover	6.161E+5	2.428E+7	0.0013	0.4613	11.21	338.21	1.037E+9
	Prop.						
Cluster	.89						
Other insiders							
Variable	**Mean**	**St.dev**	**Min**	**Q2**	**Median**	**Q3**	**Max**
ILLIQ	1.2264	1.0176	0.1754	0.4631	0.8684	1.6647	4.8516
Volume	0.0041	0.0387	4.352E-9	5.907E-6	6.419E-5	4.058E-4	1.0000
Turnover	1.667E+4	4.960E+5	7.023E-4	1.7019	24.04	224.08	2.287E+7
	Prop.						
Cluster	.87						

Correlation matrix				
Top executives				
Holdings	1			
ILLIQ	-0.015	1		
Volume	0.053	-0.001	1	
Turnover	-0.002	0.014	0.370	1
Other insiders				
ILLIQ	1			
Volume	-0.005	1		
Turnover	0.030	0.190	1	

Table 7: Descriptive statistics of the variables used in the cross-sectional regressions – Options

Variables used are defined in Table 3.

Descriptive statistics							
Top executives							
Variable	**Mean**	**St.dev**	**Min**	**Q2**	**Median**	**Q3**	**Max**
ILLIQ	0.7207	0.8359	0.1754	0.2514	0.4665	0.7311	4.6227
Volume	1.034E-3	3.244E-3	8.255E-8	8.850E-5	3.326E-4	7.549E-4	0.0421
Turnover	832.27	3797.20	0.1040	19.06	116.61	387.98	53658.00
	Prop.						
Cluster	.89						
Other insiders							
Variable	**Mean**	**St.dev**	**Min**	**Q2**	**Median**	**Q3**	**Max**
ILLIQ	0.8625	0.7087	0.1754	0.2852	0.5790	1.2886	4.4516
Volume	2.281E-4	6.418E-4	2.200E-8	1.543E-5	5.736E-5	2.076E-4	0.0104
Turnover	120.30	730.16	2.277E-3	2.5972	8.9422	45.30	20769.00
	Prop.						
Cluster	.88						

Correlation matrix			
Top executives			
ILLIQ	1		
Volume	0.058	1	
Turnover	0.008	0.600	1
Other insiders			
ILLIQ	1		
Volume	0.022	1	
Turnover	0.023	0.603	1

Table 8: Cross-sectional regression results

This table shows cross-sectional regression results. In Panel A, results for top executives are shown, where the 21-day cumulative abnormal return is used as dependent variable. In Panel B, results for other insiders are shown with $CAR(0, 30)$ as dependent variable. In each panel and for each category of trade (purchases, sales, exercise of options), we control for groups using dummy variables (coefficients of groups shown in subsequent tables.) Right-hand-side variables used are defined in Table 3. For each category of trade, two specifications are used, denoted as Model (1) and Model (2). The observations are Winsorized at the 98 percentile to avoid biases due to outliers. Trades for which the notification delay was greater than 90 calendars days were omitted. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Panel A – Top executives – Dependent variable: $CAR(0, 20)$

Model	**Purchases**				**Sales**				**Options**			
	(1)		**(2)**		**(1)**		**(2)**		**(1)**		**(2)**	
	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)
Intercept	-0.0018	(-0.17)	-0.0024	(-0.22)	-0.0166	(-1.03)	-0.0166	(-1.05)	0.0129	(1.00)	0.0125	(0.98)
Cluster	0.0111	(0.94)	0.0118	(0.99)	0.0044	(0.25)	0.0046	(0.27)	-0.0156	(-1.16)	-0.0153	(-1.13)
Holdings	0.0672	(3.04) ***	0.0677	(2.79) ***	0.0448	(0.98)	0.0477	(1.09)	–	–	–	–
ILLIQ	0.0076	(1.90) *	0.0082	(2.02) **	0.0182	(2.18) **	0.0186	(2.21) **	-0.0183	(-3.86) ***	-0.0181	(-3.79) ***
Volume	-0.1757	(-3.33) ***	–	–	0.0165	(0.14)	–	–	-0.2100	(-0.26)	–	–
Turnover	–	–	-0.0000	(-1.48)	–	–	-0.0000	(-0.08)	–	–	0.0000	(0.68)
N	1355		1336		492		436		464		461	
Adj. R^2	0.0956		0.0895		0.0445		0.0955		0.1210		0.1217	

Panel B – Other insiders – Dependent variable: $CAR(0, 30)$

Model	**Purchases**				**Sales**				**Options**			
	(1)		**(2)**		**(1)**		**(2)**		**(1)**		**(2)**	
	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)	Coef	(t-stat)
Intercept	-0.0025	(-0.19)	-0.0011	(-0.08)	-0.0146	(-1.61)	-0.0158	(-1.72) *	-0.0124	(-1.52)	-0.0125	(-1.53)
Cluster	0.0191	(1.12)	0.0199	(1.15)	0.0056	(0.54)	0.0072	(0.68)	-0.0095	(-1.07)	-0.0102	(-1.15)
ILLIQ	-0.0108	(-0.96)	-0.0082	(-0.71)	0.0052	(1.19)	0.0051	(1.17)	-0.0047	(-0.73)	-0.0045	(-0.71)
Volume	-0.4550	(-3.70) ***	–	–	-0.2036	(-1.78) *	–	–	3.0078	(0.40)	–	–
Turnover	–	–	-0.0000	(-2.15) **	–	–	0.0000	(0.48)	–	–	0.0000	(0.55)
N	1170		1155		1001		1001		1251		1240	
Adj. R^2	0.0865		0.0643		0.0795		0.0762		0.1572		0.1545	

Table 9: Cross-sectional regression results: Group effects for trades of shares

This table shows the group effects of trades of shares. For each type of insider and each category of trade, only one specification of the regressions is shown here, namely Model (1) of Table 8. The results for the groups are qualitatively similar for the second specification. Variables used are defined in Table 3. *, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Groups	**Top executives**						**Other insiders**					
	Purchases			**Sales**			**Purchases**			**Sales**		
	Coef	(t-stat)	Prop.	Coef	(t-stat)	Prop.	Coef	(t-stat)	Prop.	Coef	(t-stat)	Prop.
1. Market cap												
Small cap	0.0319	(2.86) ***	.14	0.0113	(1.14)	.35	-0.0141	(-0.87)	.16	-0.0244	(-2.13) **	.18
Mid cap	-0.0076	(-1.10)	.28	-0.0084	(-1.14)	.31	-0.0108	(-0.70)	.29	-0.0150	(-3.08) ***	.42
Large cap	-0.0041	(-1.14)	.57	-0.0041	(-0.45)	.34	0.0098	(1.28)	.55	0.0267	(4.84) ***	.40
2. Book to market												
Value stock	0.0291	(3.09) ***	.17	0.0274	(1.59)	.13	0.0477	(2.76) ***	.25	0.0376	(2.95) ***	.14
Medium	-0.0002	(-0.04)	.40	-0.0181	(-2.38) **	.38	-0.0194	(-1.88) *	.38	0.0098	(1.63)	.39
Growth stock	-0.0112	(-2.31) **	.43	0.0070	(1.11)	.49	-0.0130	(-1.17)	.37	-0.0201	(-3.95) ***	.46
3. Industry												
Oil & Gas	0.0550	(4.58) ***	.01	0.0442	(2.50) **	.03	0.0293	(1.20)	.02	-0.0221	(-0.99)	.01
Basic Materials	-0.0404	(-3.27) ***	.01	0.0029	(0.15)	.02	-0.0499	(-1.97) **	.02	-0.0190	(-0.68)	.02
Industrials	0.0075	(1.22)	.34	0.0086	(0.84)	.16	0.0095	(0.80)	.39	-0.0247	(-2.85) ***	.26
Consumer Goods	-0.0155	(-1.98) **	.16	0.0257	(2.18) **	.17	-0.0267	(-1.90) *	.14	0.0087	(0.90)	.10
Health Care	-0.0119	(-0.41)	.02	-0.0322	(-1.58)	.06	0.2536	(2.89) ***	.02	-0.0209	(-0.60)	.00
Consumer Services	0.0109	(1.07)	.12	0.0232	(2.07) **	.11	-0.0028	(-0.17)	.13	0.0411	(4.57) ***	.14
Telecommunications	0.0194	(1.05)	.00	0.0985	(1.97) **	.01	0.0380	(0.69)	.04	0.1193	(10.54) ***	.00
Financials	-0.0069	(-1.05)	.28	-0.0199	(-1.41)	.20	-0.0359	(-1.54)	.15	-0.0081	(-1.09)	.24
Technology	0.0137	(0.60)	.04	-0.0193	(-1.53)	.24	-0.0033	(-0.11)	.09	0.0114	(1.11)	.22
4. Delay groups												
Notification in time	-0.0004	(-0.11)	.57	0.0114	(2.34) **	.61	0.0011	(1.01)	.96	0.0013	(2.08) **	.96
Late notification	0.0005	(0.11)	.43	-0.0178	(-2.34) **	.39	-0.0286	(-1.01)	.04	-0.0327	(-2.08) **	.04
5. Regulatory regimes												
Before Sept. 1, 2002	–	–	–	–	–	–	0.0090	(1.01)	.48	-0.0094	(-2.11) **	.50
Sept. 2, 2002 – Oct. 1, 2005	0.0026	(0.71)	.61	-0.0111	(-2.26) **	.61	0.0064	(0.35)	.22	0.0017	(0.25)	.33
Oct. 1, 2005 – Nov. 1, 2006	-0.0050	(-0.70)	.19	0.0069	(0.68)	.19	-0.0046	(-0.23)	.06	0.0235	(1.38)	.05
After Nov. 1, 2006	-0.0031	(-0.36)	.19	0.0276	(2.37) **	.20	-0.0229	(-1.64)	.24	0.0237	(2.30) **	.13
6. Position												
Board of directors	-0.0002	(-0.18)	.85	0.0015	(0.38)	.69	–	–	–	–	–	–
Supervisory board	0.0013	(0.18)	.15	-0.0034	(-0.38)	.31	–	–	–	–	–	–

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