

INDUSTRY EFFECTS IN DIRECTORS' DEALINGS AND ABNORMAL STOCK RETURNS: RESULTS FROM THE GERMAN STOCK MARKET

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Abstract

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While the occurrence of insider profits from directors' dealings has been discovered for international stock markets, the industry effects of executives' transactions have been scarcely part of previous research. Since on a firm-specific level, there are indications for a positive relation between companies' investments in research and development (R&D investments) and abnormal returns, this paper examines whether these results also hold on an industry level. We elaborate and apply an event study for all companies listed in the HDAX at the German stock market between January 2013 and August 2018, firstly on an overall level and secondly on an industry level within the HDAX. Additionally, we analyze the switch in the regulatory framework from national to EU legislation (WpHG to MAR) in 2016 and the potential consequences for directors' dealings and stock market reactions. Our analysis shows that insiders in general act as contrarian investors. However, our analysis of directors' dealings related to potential industry effects does not lead to significant abnormal returns. The shift in insider trading regulation from German to European legislation in the middle of the sample period leads to a decreasing in abnormal returns over time. Our results are robust to different market models as well as size effects. We conclude that outside investors cannot profit from monitoring and analyzing directors' dealings on an industry level and recommend a firm-specific level.

Keywords: Information Asymmetries, Insider Trading, Directors' Dealings, Industry Effects, R&D Investments

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1. INTRODUCTION

The existence of insider trading and its possible connections with certain ownership structures, with the design of corporate governance as well as with the occurrence of abnormal returns on international stock markets, is still a current field of research (Hodgson, Seamer & Uylangco, 2018; Antoniadis, Kontsas, & Gkasis, 2019; Chronopoulos, McMillan, Papadimitriou, & Tavakoli, 2019; Hartlieb, 2019).

Especially legal insider trading also referred to as directors' dealings, has been the focus of research. It can be argued that insiders, having access to private information on e.g., their companies' future performance or the "true" fair firm value, have a competitive advantage over regular (i.e. outside) investors and thus should not be allowed to exploit that advantage. On the other hand, if insiders act according to their knowledge, they will make private information public, which in turn serves to benefit outside investors.

Numerous studies show that insiders can earn abnormal returns by carrying out insider trades (Finnerty, 1976; Jaffe, 1974; Jeng, Metrick, & Zeckhauser, 2003; Lin & Howe, 1990; Rozeff & Zaman, 1988; Seyhun, 1986, 1988). However, there are also indications that outside investors earn profits by copying insiders' trading strategies (Bettis, Vickrey, & Vickrey, 1997) "by using the publicly available information concerning insider trades" (Rozeff & Zaman, 1988, p. 25). In order to reduce the existing information asymmetry between managers (i.e. insiders) and stockholders (i.e. outsiders), many countries - including Germany - have implemented a regulatory framework requiring insiders to publicly disclose any insider trading activity (Huddart, Hughes, & Levine, 2001).

Many aspects of directors' dealings - e.g., stronger signaling effects of purchases, as these are mainly driven by profit motives (Fidrmuc, Goergen, & Renneboog, 2006; Seyhun, 1986), versus lower effects of insider sales, which may be caused by diversification or liquidation plans (Iqbal & Shetty, 2002; Jenter, 2005; Lakonishok & Lee, 2001), effects of insider trades on market efficiency (Aktas, de Bodt, & Van Oppens, 2008; Seyhun, 1986), as well as other factors influencing profits from insider trading such as company size (Lakonishok & Lee, 2001) - have already been examined in previous research. Nevertheless, to date there has been scarcely examination of the effects directors' dealings may have on the market across industries as well as of the differences in abnormal returns insiders can earn across different industries.

Intuitively, as insiders tend to purchase stock when they foresee a positive development in their companies' performance and hence expect an increase in firm value, one might assume insiders to be more likely to earn (higher) excess returns in industries where the future development of business areas is less predictable for the public rather than in industries with a fairly solid outside predictability of the future performance of business fields. This suggests that insiders can earn higher abnormal returns in industries that have stronger information asymmetries between insiders and outsiders (Dardas & Güttler, 2011). The degree of information asymmetry in certain industries can be proxied by the intensity of research and development (R&D) investments across industries (Aboody & Lev, 2000).

Larger R&D investments can be associated with higher innovation, greater technology drive, and exponential growth of industries and therefore provide less transparency to the public in terms of future business development (Berninger, Schiereck, & Vormoor, 2017).

Furthermore, research on directors' dealings has thus far largely focused on the US and UK stock markets based on the long-existing Anglo-American legal regulations of directors' dealings in these countries. There is also evidence for Germany, which began to implement insider trading legislation in the early 2000s, that there is a "larger impact of insider trades on share prices than has been documented for the USA or the UK" (Betzer & Theissen, 2009, p. 403), making the analysis of this aspect for the German market even more interesting.

Thus, this paper sets out to examine the effects of directors' dealings by investigating different levels of information asymmetries across industries for the German stock market. Since there is evidence of a positive correlation between corporate investments in R&D and abnormal returns at the firm-specific level, we ask the research question whether positive abnormal excess returns can be achieved by observing insider trades on an industry level.

This paper conducts an event study analysis of all directors' dealings for companies listed in the HDAX between January 2013 and August 2018 both on an overall level as well as differentiated by industries, which are classified by the 2-digit SIC code. Our sample period includes the shift in policies from national to international legislation in mid-2016. A subsample of national WpHG legislation is analyzed separately from and compared to a subsample covering international MAR legislation only. Also, numerous subsamples such as the DAX and MDAX across industries as well as the TecDAX as a whole are investigated separately in order to check the robustness of our results and control e.g., size effects. We contribute the literature in several aspects. We analyze differentiated possible industry effects in the relationship between directors' dealings and abnormal stock returns; furthermore, we focus on the relationship between directors' dealings and corresponding stock market reactions after a switch from national to European legislation in the regulatory framework.

We find indications that insiders' purchases appear to contain relevant information for investors and are generally followed by significant positive abnormal returns, whereas sales transactions are usually not perceived as news of any relevancy. Also, stronger market reactions can be observed in smaller companies as opposed to those with higher market capitalization. The shift in insider trading regulation from German to European legislation in the middle of the sample period leads to a decreasing in abnormal returns over time. In terms of industry assessments on an index level, there is evidence of larger information asymmetries for technology-driven companies. In terms of industry effects of directors' dealings, however, this analysis cannot verify that stronger capital market reactions to insiders' transactions can be observed within industries with larger information asymmetries as proxied by average annual investments per company in R&D.

The paper is structured as follows. Section 2 provides an overview of the current state of the literature on insider trading internationally as well as both the legal framework for directors' dealings in Germany and the empirical evidence for Germany. This section also introduces the hypothesis to be investigated and the expected outcomes based on prior research. Section 3 describes the data and methodology applied in this paper. In Section 4 results and robustness checks are reported and discussed, while Section 5 provides the conclusion.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Numerous studies show that insiders can earn abnormal returns by executing insider trades (Finnerty, 1976; Jaffe, 1974; Jeng et al., 2003; Lin & Howe, 1990; Rozeff & Zaman, 1988; Seyhun, 1986, 1988). Lakonishok and Lee (2001) find that, while also short-term information appears to become public through stock transactions of executives, the information content is larger for long investment periods, which implies that the market fundamentally underreacts to these trades in the short term. The effects observed by international studies show that insider purchases yield higher abnormal returns than insider sales (Fidrmuc et al., 2006). Thus, purchases appear to contain more relevant private information to which the market reacts (Jeng et al., 2003). Further, Jeng et al. (2003), who find excess returns for purchases of more than 6% per year, do not find any related to insider sales. As purchases are positive signals for the stock market, selling might present a negative signal to the market. However, this "negative signal may be less informative" (Fidrmuc et al., 2006, p. 2938) because insider sales are also likely to be driven by diversification and liquidity needs (Fidrmuc et al., 2006; Lakonishok & Lee, 2001; Rozeff & Zaman, 1988) as large parts of executives' compensation is stock-based.

While, for both the US as well as the UK market, abnormal returns resulting from directors' dealings are observed unanimously, Eckbo and Smith (1998) present a counterexample as they find that insiders are not able to gain excess returns on the Oslo Stock Exchange (OSE) and thus contradict most prior international studies on directors' dealings. The authors conclude that insiders do not in general outperform the market. To explain this outcome, they put forward that "perhaps insiders, in a market like the OSE, only rarely possess inside information, or perhaps the value of maintaining corporate control benefits tends to offset the value of trading on such information" (Eckbo & Smith, 1998, p. 497).

In line with the signaling effect of insider transactions, insider purchases and sales appear to take place when directors believe the stock to be undervalued and overvalued, respectively (Fidrmuc et al., 2006; Jeng et al., 2003). This shows that insiders are particularly good at timing the market and thus their sell and buy transactions by leveraging their superior knowledge (Fidrmuc et al., 2006; Lin & Howe, 1990; Seyhun, 1988, 1998). Not only do they strategically pick the optimal time for their transactions, but they also follow a contrarian investment strategy as they seem to buy after significant downturns in stock performance

and sell after significant performance increases (Lakonishok & Lee, 2001; Rozeff & Zaman, 1988).

Based on this evidence of insiders profiting from their transactions, the question arises whether outside investors can also earn profits by copying insiders' trading strategies (Bettis et al., 1997) "by using the publicly available information concerning insider trades" (Rozeff & Zaman, 1988, p. 25). While some studies find that outsiders cannot profit from copying insiders' trading strategies (Lin & Howe, 1990; Rozeff & Zaman, 1988; Seyhun, 1986), Bettis et al. (1997) show that, by monitoring and analyzing public information on large transactions by directors, outsiders are also able to gain abnormal returns net of transaction costs.

One strand of literature on directors' dealings focuses on their legal regulations. In order to reduce the existing information asymmetry between managers and stockholders, many countries - including Germany - have eventually implemented a regulatory framework requiring insiders to publicly disclose any insider trading activity (Huddart et al., 2001). Thus, one would expect that the tighter regulations are set, the less insider trades occur as inside information does not provide an advantage to insiders, who thus will not be able to earn abnormal returns. However, Seyhun (1992) shows that even after the introduction of stricter regulations on the US market, instead of shrinking trading activity, insider transactions have increased in quantity and volume, which has led to greater excess returns. Furthermore, Fidrmuc et al. (2006) find "differences in regulation between the U.K. and the United States, in particular the speedier reporting of trades in the U.K." (Fidrmuc et al., 2006, p. 2931) to be the reason for larger abnormal returns observed in the British market. Also, directors' trades appear to contain more information in the UK than they do in the US (Fidrmuc et al., 2006).

Additional determinants of abnormal returns gained from directors' dealings discussed in the research are e.g., firm size, ownership structure, and information hierarchy. Firm size and excess returns are found to be negatively correlated (Seyhun, 1986). This means that insiders in smaller companies can profit more from larger excess returns (Gregory, Matatko, Tonks, & Purkis, 1994; Lakonishok & Lee, 2001), which may be due to the fact that "smaller firms may be less closely monitored by financial analysts and institutional investors, leading to a greater degree of information asymmetry" (Lin & Howe, 1990, pp. 1273-1274). Similarly, Jeng et al. (2003) point out that the informational advantage of executives increases in inverse proportion to the size of the firms because in smaller companies individual managers may "know a significant portion of the relevant information" (Jeng et al., 2003, p. 464). Also, in smaller companies, the impact of insider sales is much stronger (Fidrmuc et al., 2006).

Furthermore, the ownership structure appears to have an effect on abnormal returns. Directors' dealings in companies with a more concentrated ownership yield lower abnormal returns and thus appear to be less informative than transactions in "widely held firms that may suffer from higher informational asymmetry" (Fidrmuc et al., 2006, p. 2932) due to a lack of centralized monitoring power.

Another interesting aspect is the question of whether the position of the insiders within their

companies has an impact on stock market reaction as the information content of insiders' transactions may be related to the level of access to internal information. The information hierarchy hypothesis states that "different insiders possess differences in quality of information" (Seyhun, 1986, p. 210). Therefore, insiders who are more involved in the company's day-to-day business activities are expected to have access to more relevant information than others (Lin & Howe, 1990).

Germany - like many other countries of continental Europe - drew up the first legal guidelines with the Second Financial Market Development Act (Zweites Finanzmarktförderungsgesetz) on July 26, 1994, as well as with the Securities Trading Law (Wertpapierhandelsgesetz, WpHG) on August 1, 1994, making the use of insider information to obtain profits illegal (Dymke, 2011). The German counterpart to the insiders' duty to report as laid out in the US SEA was adopted on July 1, 2002. Since 1994 the WpHG, to ensure that executives do not have an unfair advantage over outside investors was continuously amended until its substitution by the European legislation of the EU Market Abuse Regulation (MAR) No. 596/2014 on July 3, 2016.

As stated by the MAR, in Germany, as in the rest of the EU, using inside information to trade securities is prohibited (formerly § 14(1) WpHG, now Art. 14 MAR). Any transaction that is not explicitly banned must be reported on time and made public across the EU. This duty to disclose (formerly § 15a(1,4) WpHG, now Art. 19(1) MAR) covers directors' dealings. Thus, according to Art. 19 MAR, insiders, especially members of the executive and the supervisory boards of listed companies must immediately - not later than three business days after the transaction - publish any trades with securities of the respective company. Furthermore, the notification must contain all relevant information about the transaction (Art. 19(6) MAR). In general, legislation on insider trading is supposed to reduce the information asymmetry that traditionally exists between company insiders and outside parties such as shareholders. It aims at providing transparency to the market (Bhabra & Hossain, 2014).

One of the first studies of directors' dealings based on insider trading regulation in the form of § 15 of the WpHG is by Rau (2004). In a short-term event study, he analyzes the returns for reported insider transactions. In contrast to former research on the US as well as the UK market, he finds that insider trades actually yield higher abnormal returns for sales than for purchases. In line with international research, abnormal returns are larger in smaller companies (Rau, 2004).

Since not only Germany but also other European countries introduced legislation on insider trading in the early 2000s, Heidorn, Meyer, and Pietrowiak (2004) examine the Italian, Dutch, and German stock markets, and in general, arrive at similar findings to the international research. Insider sales take place after an abnormal negative return whereas purchases are initiated in response to abnormal positive returns. However, in contrast to Rau (2004), they find that sales do not contain relevant information for the market and are thus probably mainly motivated by diversification or liquidation interests as no significant abnormal returns can be observed after-sales.

Another study focusing on the market's reaction to insider transactions is conducted by Stotz (2006). He discovers an average abnormal return of about 3% for insider purchases within 25 days after the transaction. When "restricting the sample to large stocks with a company size (...) of more than 100 million euros market capitalization" (Stotz, 2006, p. 459), profits rise to more than 4%. Also, in regard to outsiders copying insiders' trading strategies, it can be observed that there are "many opportunities to profit from insiders' superior knowledge" (Stotz, 2006, p. 459).

Klinge, Seifert, and Stehle (2005) provide confirmation of findings of former international studies with German data and find that the German stock market is semi-strongly efficient. They observe significant positive and negative excess returns after the announcement of insider purchases and sales, respectively. Furthermore, they find evidence that the "diversification and liquidity hypothesis for the management with stock-based compensations seem [sic] to be generally accepted by the German capital market" (Klinge et al., 2005, p. 21).

As mentioned above, additional aspects that play an important role in the research on directors' dealings are effects observed prior to news announcements as well as ownership structure and information hierarchy. Not only do Betzer and Theissen (2009) find significant abnormal returns after insider trades in Germany to be even larger than in the US or the UK, but they moreover observe that transactions initiated before earnings announcements have a stronger effect on stock prices, supporting "the hypothesis that informational asymmetries between corporate insiders and the capital market are larger prior to earnings announcements" (Betzer & Theissen, 2009, p. 404). Furthermore, the ownership structure also plays a decisive role in the German market. It turns out that insider transactions have a greater impact on stock prices in widely held firms. In terms of the information hierarchy hypothesis (Seyhun, 1986), they do not find evidence that the position held by an insider within the company matters as "trades initiated by the CEO do not convey more information than trades by other insiders" (Betzer & Theissen, 2009, p. 404). This outcome clearly contradicts the information hierarchy hypothesis.

Information hierarchy is a determinant of excess returns that is also covered in a study by Dymke and Walter (2008), who again endorse the findings that abnormal returns which insiders earn from trading based on their knowledge are larger in Germany than in the US or UK stock markets. Inconsistent with the hypothesis that insiders who are more involved in the day-to-day business of a firm should have access to superior knowledge and should thus be able to profit from acting on this information, it becomes apparent that "members of the executive board (...) do not seem to exploit insider information (...) as they do not realize superior returns" (Dymke & Walter, 2008, p. 203). Hence, they do not trade as frequently as members of the supervisory board and other insiders.

Another interesting aspect with regard to the reporting duty of insiders when trading is to analyze the effect disclosure delays have on abnormal returns. Betzer and Theissen (2010) examine this topic and conclude that transactions are reported earlier when they are sales whereas purchases are disclosed with some delay. Moreover,

the ownership structure has an impact on the length of delay since a very dispersed ownership structure allows for longer reporting delays than in companies owned by large controlling shareholders. A concentrated ownership structure forces managers to reveal their transactions on time since the controlling power of concentrated owners is significantly stronger (Betzer & Theissen, 2010). The authors also provide evidence that delays tend to be longer in smaller companies and for smaller transaction volumes. With reference to abnormal returns, they find that these are independent of the delay of the reporting date, which leads to the conclusion that prices do not contain all relevant information between the reporting and the transaction date.

Dickgiesser and Kaserer (2009) confirm the results of Rau (2004), Klinge et al. (2005), as well as those of Betzer and Theissen (2009) by underlining the distinct finding that the market reacts more strongly to insiders' sales than to purchases. The authors additionally state that the "market's under-reaction to reported insider trades can mainly be explained by the cost of risky arbitrage and is therefore not exploitable" (Dickgiesser & Kaserer, 2009, p. 302). Therefore the authors argue that the observed excess returns "do not constitute evidence against the efficient market hypothesis" (Dickgiesser & Kaserer, 2009, p. 330).

Dickgiesser (2010) focuses on two other important aspects, namely insiders' strategic trading around news announcements and market efficiency in terms of price discovery. His results show that "while insiders do trade prior to ad-hoc announcements, trading activity increases in particular after news events" (Dickgiesser, 2010, p. 1), which proposes that insiders prefer trading when the reputational, as well as the litigation risks, are lower. Moreover, since excess returns from directors' dealings are often examined in the context of market efficiency, he makes an important addition to research on directors' dealings in Germany in that he analyzes the slow price discovery following directors' trades. He finds that the main reason for this is the cost of risky arbitrage as "price efficiency is impeded by arbitrage risk" (Dickgiesser, 2010, p. 1).

For the ten years after the introduction of the obligation to publicly disclose insider transactions in 2002, Hussmann and Fieberg (2014) find abnormal returns of only 1.47% for insider purchases and -0.98% for sales, which in comparison to prior findings is much smaller. Berninger et al. (2017) show that even more than a decade after the introduction of insider trading regulations in Germany, insiders can still earn abnormal returns. Aligned with most research on the German stock market, they observe larger profits for sales than for purchases. Since, their results show that excess returns have decreased over time; they interpret this development as an increase in information efficiency on the German market (Berninger et al., 2017). Furthermore, they do not find any support for the information hierarchy hypothesis as the position of insiders within a company does not seem to affect excess returns. Most interesting for this study is that Berninger et al. (2017) conduct a small analysis of abnormal returns in different industry sectors and find that the more innovative and technology-driven a sector, the larger the information asymmetry is

and thus the excess returns to be earned, which is in line with the hypothesis of this paper.

Concluding from the existing literature for international as well as the German stock markets, it becomes apparent that there is a gap with reference to the analysis of industry effects of directors' dealings. Thus, this paper examines those effects on the German stock market. As research reveals, insiders are able to better anticipate the future development of business areas leveraging inside information (Fidrmuc et al., 2006; Finnerty, 1976; Lakonishok & Lee, 2001; Lin & Howe, 1990). Therefore, "it is reasonable to infer that (...) trades insiders make are largely based on their expectations about the general prospects of their firms (i.e. expectations related to private information about, and intimate knowledge of, their firms' strategies and operating environments in general)" (Bettis et al., 1997, p. 61). Accordingly, this paper builds on the fact that insiders tend to purchase stock when they foresee a positive development in their companies' performance and hence expect an increase in firm value. However, due to different levels of information asymmetry across industries, one might expect insiders to be more likely to earn (higher) abnormal returns in industries where the future development of business areas is less predictable for the public rather than in industries with a fairly solid outside predictability of the future performance of business fields.

According to the fairly limited research on differences in insider gains across industries, insiders are expected to earn higher abnormal returns in industries that have stronger information asymmetries between insiders and outsiders. Especially investments in R&D are found to be a major determinant of information asymmetry because research shows that "insider gains in R&D-intensive companies are significantly larger than insider gains in firms not engaged in R&D" (Aboody & Lev, 2000, p. 2765). Since the market's reaction to the publication of directors' dealings is much stronger in research-intensive businesses, it is reasonable to assume that these findings hold not only on a firm-specific but also on an industry-wide level. As "the R&D-related private information is not fully revealed prior to the public disclosure of insiders' trade(s)" (Aboody & Lev, 2000, p. 2765), information asymmetries are expected to be larger in industries with significant investments in R&D.

These expectations are confirmed by the results of Dardas and Güttler (2011). For Europe, they find the highest excess returns in the "healthcare, energy, and IT sectors, whereas the consumer, financials, and materials sectors show the smallest announcement effects" (Dardas & Güttler, 2011, pp. 25-26). A similar result is obtained by Berninger et al. (2017), who find larger abnormal returns in industries that are more innovative and technology-driven and thus are characterized by larger information asymmetry.

Thus, the hypothesis to be investigated in this paper is the following:

The disclosure of insider sales (purchases) yields higher negative (positive) abnormal returns in industries with higher R&D investments and thus larger information asymmetries than the disclosure of transactions in industries with lower R&D investments and therefore smaller information asymmetries.

3. DATA AND METHODOLOGY

Our paper investigates the effects of directors' dealings on the German stock market for companies listed in the HDAX. The HDAX summarizes the values of all 110 companies listed in the DAX, MDAX, and TecDAX, which are all also examined as subsamples, thus presenting the largest values from the Prime Standard across industries. Comparing abnormal returns earned in DAX companies and those earned in MDAX companies ensures control for firm size as research shows that, generally, abnormal returns earned by insiders are higher in smaller firms, which draw less public focus upon themselves. The TecDAX is the only industry-focused index included in this analysis as it lists the 30 biggest companies of the technology sector following the DAX.

Since directors are obliged to notify not only the issuer but also the responsible public authority when trading with stock from their respective companies, the BaFin maintains a database of all registered insider transactions on the German capital market. Thus, data for disclosed directors' dealings are obtained from this database for the time period between January 2013 and August 2018. Our observation period includes the transition from national to European legislation in July 2016, which for the first time offers the opportunity to examine whether this shift in a regulatory framework leads to differences in abnormal returns earned by insiders. Thus, the HDAX WpHG as well as the HDAX MAR data sets act as subsamples for this analysis. In total, the sample period includes 13,368 transactions - 6902 still under the legislation of § 15 WpHG and 6466 after the introduction of the European MAR - before data preparation.

Over the entire sample period, there are 126 companies listed in the HDAX: 32 companies in the DAX, 61 companies in the MDAX, and 37 companies in the TecDAX of which four companies are listed in two different indices over the entire sample period yet never at the same point in time.

In our first step to clean all data, we exclude all transactions that are not clearly referenced to as a purchase or sale. Also, only stock transactions are kept in scope, while options, derivatives, etc. are excluded from the sample since the emphasis is on stocks. Further, since this analysis focuses on

the German stock market, all transactions conducted in foreign currencies are eliminated from the sample. After joining the MAR and the WpHG datasets, duplicate transactions as well as transactions with missing values that could not be manually retrieved are excluded. Then, directors' transactions which display a reporting delay - calculated as the number of days passed between transaction and reporting date - of more than 20 days are excluded from the analysis since these might contain false data entries in the first place given that the legal reporting delay is a maximum of three working days. Due to the frequent changes that occur in the composition of the HDAX and all its subindices, the most relevant step of data preparation is to only include events for those exact time periods during which the respective firm was actually listed in the particular index. For example, if SUESS MicroTec AG was deleted from the TecDAX on March 18, 2013, and again added to it on March 23, 2014, then only events occurring within the sample period before March 18, 2013, and after March 23, 2014, are included in the analysis. All events occurring in the year during which it was not part of the TecDAX are excluded from the sample. This ensures that samples are constructed correctly and only include the precise index constellation at any point in time. A different approach would be to perform the analysis on a quarterly basis. This would, however, not necessarily precisely account for changes down to the day of the actual change and would at the same time deliver fairly small quarterly samples, potentially making it impossible to obtain statistically sound results. As a final step, transactions of companies for which not sufficient Xetra stock returns could be obtained are excluded from the sample.

Thus, the total HDAX sample consists of 2678 transactions, of which 1874 are purchase and only 804 are sale transactions. A similar ratio of purchase and sale transactions can be observed for most subsamples (Table 2), as insiders usually report significantly more purchase than sale transactions. This can also be observed for most time periods across the majority of studies of directors' dealings on the German stock market (Berninger et al., 2017). Only the TecDAX sample shows the opposite ratio with more sales than purchases.

Table 1. Overview of numbers of transactions per index

		Total	§15 WpHG	Art. 19 MAR
HDAX		2678	1887	791
	<i>Purchases</i>	1874	1243	631
	<i>Sales</i>	804	644	160
DAX		1105	774	331
	<i>Purchases</i>	871	602	269
	<i>Sales</i>	234	172	62
MDAX		1111	742	369
	<i>Purchases</i>	818	502	316
	<i>Sales</i>	293	240	53
TecDAX		462	371	91
	<i>Purchases</i>	185	139	46
	<i>Sales</i>	277	232	45

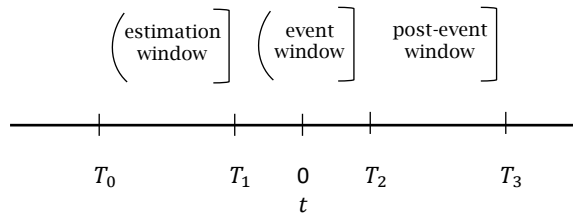
Note: This table presents an overview of the number of transactions in total as well as the split in purchases and sales for every index as well as by applicable legislation. HDAX transactions consist of the accumulation of the DAX, MDAX, and TecDAX transactions due to the composition of the HDAX index.

Xetra stock data for all 126 HDAX sample companies are obtained from Thomson Reuters Datastream. Our analysis uses the total return index (RI), which more accurately accounts for stock performance. Non-trading days are excluded from the analysis. Also, following prior research on directors' dealings on the German stock market, CDAX market returns as a market proxy are also downloaded from Datastream. Returns for day t for both stocks as well as the market are calculated as the log return:

$$ret_t = \log\left(\frac{RI_t}{RI_{t-1}}\right) \quad (1)$$

In prior research, the event study methodology (MacKinlay, 1997) has been employed in the vast majority of studies as it measures the impact a certain event has on a company's stock performance. Thus, this paper uses an event study design (Figure 1) to investigate the effects of directors' dealings across industries.

Figure 1. Event study design



After defining the event t itself as the reporting date for the first part of the analysis and then as the transaction date for robustness checks, abnormal returns have to be identified as these show the impact directors' dealings have on the market. Since "the abnormal return is the actual ex-post return of the security over the event window minus the normal return of the firm over the event window" (MacKinlay, 1997, p. 15), abnormal returns can be calculated as:

$$AR_{i,t} = R_{i,t} - E(R_{i,t}) \quad (2)$$

for the point in time t , where $R_{i,t}$ represents the observed returns and $E(R_{i,t})$ the expected returns as estimated via asset pricing models over an estimation period from [-260, -10] covering approximately one year of trading days (i.e., 250 days) before each event. Then for N events, the average abnormal returns AAR_t are obtained by:

$$AAR_t = \frac{1}{N} \sum_{i=1}^N AR_{i,t} \quad (3)$$

Cumulative average abnormal returns (CAARs) are obtained by accumulating the AAR_t over the time span of the event window by:

$$CAAR_{t_1,t_2} = \sum_{t=t_1}^{t_2} AAR_t \quad (4)$$

and are reported for the [-5, 0], [0, 1], [0, 5], [0, 10], and [0, 20] event windows, which are typical of the analysis of ad hoc releases of any kind (Dymke & Walter, 2008; Dickgiesser & Kaserer, 2009; Berninger et al., 2017).

In order to determine abnormal returns, the expected return of the respective security needs to be calculated. MacKinlay (1997) shows that for event studies in general the determination of abnormal returns is usually not dependent on the model chosen. We use the market model as the most commonly used method in the field of directors' dealings research and "represents a potential improvement over the constant mean return model" (MacKinlay, 1997, p. 18). Nevertheless, to check the robustness of our results, we also use the constant mean return model to proxy expected returns.

Applying the market model to calculate abnormal returns our paper uses daily returns from 260 to 10 trading days before the actual event date, thus ensuring an estimation window of 250 days (MacKinlay, 1997). To be more precise, α_i and β_i are estimated using OLS for the equation:

$$\begin{aligned} R_{i,t} &= \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \\ E(\varepsilon_{i,t}) &= 0 \\ var(\varepsilon_{i,t}) &= \sigma_{\varepsilon_i}^2 \end{aligned} \quad (5)$$

where $R_{m,t}$ is the daily return of the market portfolio and $R_{i,t}$ the daily return for company i . Inserting the estimated coefficients $\hat{\alpha}$ and $\hat{\beta}$ into the equation above yields the normal returns for every company.

In a mean-adjusted model expected returns can be calculated as:

$$\begin{aligned} R_{i,t} &= \mu_i + \varepsilon_{i,t} \\ E(\varepsilon_{i,t}) &= 0 \\ var(\varepsilon_{i,t}) &= \sigma_{\varepsilon_i}^2 \end{aligned} \quad (6)$$

where μ_i is the mean return for security i . Although this model is presumably the simplest model to estimate returns, it has been shown that the results are usually very similar to those of more enhanced models (Brown & Warner, 1980, 1985).

Industry classification is done using the primary SIC code. As many companies conduct business in various fields, it denotes their main area of business. For the means of this analysis, the 2-digit SIC code classification is applied to obtain a general yet accurate framework for the determination of industry affiliation since both the 3- as well as the 4-digit industry classification would provide a too narrow separation of sectors, which would not fit the data set as there would not be enough companies within each industry to obtain statistical results.

The primary SIC codes are obtained from Worldscope and provide the basis for industry classification of all companies that were listed in all indices over the sample period from January 2013 to August 2018. Table 2 provides an overview of the industry allocation for all 126 HDAX sample companies, including the DAX, MDAX, and TecDAX companies.

Table 2. Industry classification according to 2-digit SIC code for considered companies

SIC	Industry	Companies	
01-09	Agriculture, forestry, and fishing	-	
10-14	Mining	K+S AG	
15-17	Construction	Bilfinger SE	
20-39	Manufacturing	Adidas AG ADVA AG Airbus SE Aixtron SE Aurubis AG BASF SE Bayer AG Beiersdorf AG BMW AG Hugo Boss AG Continental AG Covestro AG Daimler AG Dialog Semiconductor Diebold Nixdorf AG Draegerwerk AG Duerr AG ElringKlinger AG Evonik Industries AG Evotec AG FUCHS Petrolub SE GEA Group AG Gerresheimer AG Gerry Weber AG HeidelbergCement AG HELLA GmbH & Co. KGaA Henkel AG & Co. KGaA Infineon Tech. AG Jenoptik AG Jungheinrich AG KION Group AG Kontron AG	Krones AG KUKA AG Lanxess AG LEONI AG Linde AG LPKF Laser & Electronics AG MAN SE Manz AG Merck KGaA MTU Aero Engines AG Nordex SE NORMA Group SE Osram Licht AG Pfeiffer Vacuum Tech. AG QIAGEN N.V. RATIONAL AG Rhein AG Salzgitter AG Schaeffler AG SGL Carbon SE Siemens AG Siltronic AG SLM Solutions Group AG SMA Solar Technology AG SolarWorld AG STADA Arzneimittel AG STRATEC Biomedical AG Suedzucker AG SUESS MicroTec AG Symrise AG Volkswagen AG Wacker Chemie AG
40-49	Transportation and public utilities	1&1 Drillisch AG Deutsche Lufthansa AG Deutsche Post AG Deutsche Telekom AG E.ON SE Fraport AG Freenet AG Innogy SE	Kabel Deutschl. HLD AG ProSiebenSat1 Media SE QSC AG RWE AG Telefonica Deutschl. HLD AG TUI AG Uniper SE United Internet AG
50-51	Wholesale trade	Brenntag AG Celesio AG	Kloeckner & Co. SE ThyssenKrupp AG
52-59	Retail trade	Fielmann AG Metro AG	Rocket Internet SE Zalando SE
60-67	Finance, insurance, and real estate	Aareal Bank AG Allianz SE Alstria Office REIT-AG Commerzbank Deutsche Bank AG Deutsche Boerse AG Deutsche Euroshop AG GAGFAH S.A.	GSW Immobilien AG Hannover Rueck SE LEG Immobilien AG Muenchener Rueck SE TAG Immobilien AG Talanx AG Vonovia SE Wirecard AG
70-89	Services	Axel Springer SE Bechtle AG CANCOM SE Carl Zeiss Meditec AG CompuGroup Medical SE CTS Eventim AG Euromicron AG Fresenius SE Fresenius Medical Care AG & Co. KGaA GFT Technologies SE	Medigene AG MorphoSys AG Nemetschek SE PSI Software AG Rhoen Klinikum AG RIB Software SE SAP SE Software AG Stroer SE & Co. KGaA XING AG
91-99	Public administration	-	

Note: This table presents the industry classification of all companies included in the final HDAX sample after data preparation. Industry classification is done by 2-digit SIC codes.

In order to measure the degree of information asymmetry in industries, this paper follows the approach employed by Dardas and Güttler (2011). Thus, investments in R&D are used as a proxy for information asymmetry since research shows that the larger the R&D investments, the more insiders can profit from directors' dealings (Aboody & Lev, 2000). As mentioned above, it is reasonable to

assume that these findings hold not only on the firm-specific but also on the industry-wide level. Information asymmetries are supposedly larger in industries with a strong focus on investments in R&D as only the official disclosure of directors' dealings reveals private information related to this area (Aboody & Lev, 2000). Thus, in order to determine the degree of information asymmetry

across industries, the total R&D investments are calculated for each industry over the period of time between 2013 and 2017. The industry with the highest average annual spending in R&D per company is assumed to display the highest insider gains whereas the industry with the lowest average annual R&D investment per company over this period is expected to yield the lowest insider profits.

Annual R&D investments for all sample companies are also obtained through Datastream if available. Furthermore, missing data are manually obtained from annual reports where possible. However, there are companies that either do not provide any information on R&D costs or do not pursue any activities in this field (especially in the finance, insurance, and real estate sectors).

Thus, based on the hypothesis that the public disclosure of insider sales (purchases) yields higher negative (positive) returns in industries with higher R&D investments and thus larger information asymmetries than the disclosure of transactions in industries with lower R&D investments and therefore smaller information asymmetries, one can expect the following: Based on industry-wide R&D investments, information asymmetries are assumed to be largest in Manufacturing, followed by finance, insurance, and real estate, and services. This implies that for the purchase portfolio, positive abnormal returns are expected to be larger in these sectors than in the other business areas. In the same industries, negative excess returns are expected to be larger for the sale portfolio.

4. RESULTS AND DISCUSSION

As prior international research suggests, insiders time their transactions well and follow contrarian investment strategies (Lakonishok & Lee, 2001). Also, for the German stock market, it has been shown that they tend to purchase stock after large decreases in performance, which means after observing significant negative excess returns (Heidorn et al., 2004; Stotz, 2006). For purchases of the overall HDAX sample, this is true. Although the CAARs before the reporting date itself are not statistically significant, those leading up to the transaction are negative. Irrespective of the asset pricing model applied, purchase transactions take place after highly statistically significant cumulative average excess returns of -0.92% for the market model and even 2.21% for the constant mean return model (see Table 3). The reporting of purchases is on average followed by positive CAARs, which in general are also highly statistically significant at the 1% significance level regardless of the asset pricing model. However, the market model yields higher CAARs, which, as expected, increase with an increasing holding period from 0.77% on the day after the disclosure to 1.77% and 4.53% over the 5- and 20-day event windows. When instead of the reporting date the transaction date itself is set as the event date, it is notable that not only the pre-event CAARs are significantly negative, but also the positive capital market reaction cannot be observed until the 5-day holding period, at the end of which insiders can earn a CAAR of 1.54%. Abnormal returns observed during the [0, 1] event window, which reflect the ultimate effect on the event day itself, are not significant, which

underlines that the information revealed by the transaction itself is not reflected in prices upon the transaction, but rather becomes public later through the official publication of the reported trade and is then incorporated in the prices. This suggests that the German stock market can be semi-strongly efficient at a maximum under the efficient market hypothesis (EMH) since the price discovery process appears to be efficient after the reporting date yet not upon the transaction itself.¹ Therefore, the strong form of market efficiency can be rejected, which is also supported by previous research on insider profits (Finnerty, 1976; Rozeff & Zaman, 1988), as the transaction itself does not convey the information by itself without the official notification of the respective authority, which ultimately reveals information on predictions of future business performance to the market.

As contrarian investors, insiders often sell a stock after positive abnormal returns have been perceived (Heidorn et al., 2004; Lakonishok & Lee, 2001; Stotz, 2006), which is underlined by the results for sales in the HDAX (see Table 3). When it comes to the information content of sale transactions, results from the market model underline what some studies on directors' dealings in Germany have already suggested. Since for the HDAX sales no statistically significant negative CAARs can be observed following the reporting date, they do not evoke any reactions from the investors' side, which is aligned with prior studies not detecting any significant effects for sale transactions on the German stock market (Heidorn et al., 2004). Thus, sales are likely driven by diversification or liquidation needs (Fidrmuc et al., 2006; Lakonishok & Lee, 2001; Rozeff & Zaman, 1988) and therefore may not contain as much relevant information on the future business development of the respective companies as is the case with purchase transactions. Nevertheless, these findings run counter to some of the findings for the German as well as international capital markets, which observe a lower information content for sales than purchases (Fidrmuc et al., 2006; Jeng et al., 2003; Klinge et al., 2005) and which even suggest that sale transactions contain more information than purchases on the German stock market (Betzer & Theissen, 2009; Dickgiesser & Kaserer, 2009; Klinge et al., 2005; Rau, 2004), as can be observed for the constant mean return model results. Interestingly, while insiders are only unable to earn any significant CAARs over the 20 days following the disclosure when applying the market model, the constant mean return model yields highly statistically significant negative CAARs after the reporting. This is evidence that the CAARs observed are dependent on the asset pricing model chosen and underlines the diffuse state of evidence for the impact of insider sales on the German stock market. Still, sales are considered to contain next to no information because the market model does not provide proof otherwise. Since the market model is more established in research on directors' dealings and more enhanced than the constant mean return model, more explanatory power should be attributed to these results.

¹ Note that these results do not take into account transaction costs and only consider insider profits.

Table 3. Event study results for HDAX sample, market model, and constant mean return model

<i>Market model</i>	<i>[-5, 0]</i>	<i>[0, 1]</i>	<i>[0, 5]</i>	<i>[0, 10]</i>	<i>[0, 20]</i>
<i>A. Purchases</i>					
RD	-0.00339	0.00772***	0.01771***	0.02928***	0.04528***
TD	-0.00919***	0.00192	0.01536***	0.02711***	0.04303***
<i>B. Sales</i>					
RD	0.01607***	-0.00006	0.00045	0.00866	0.01632
TD	0.01873***	0.00295**	0.00202	0.00634	0.01637
<i>Constant mean return model</i>					
<i>A. Purchases</i>					
RD	-0.01674***	0.00329***	0.00437***	0.00484***	-0.00106
TD	-0.02213***	-0.00237**	0.00245**	0.00343**	-0.00190
<i>B. Sales</i>					
RD	0.00379**	-0.00416***	-0.01186***	-0.01371***	-0.02626***
TD	0.00768***	-0.00075	-0.00913***	-0.01392***	-0.02214***

Note: This table presents the event study results for the HDAX sample across chosen event windows. CAARs are determined with the market model as well as the constant mean return model as the asset pricing models. Panel A displays CAARs for purchases, Panel B - for sales. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

Our analysis is based on the fact that the sample period from January 2013 to August 2018 covers the shift from national German legislation on directors' dealings in the form of the WpHG to the European MAR in July 2016, which - to the best of our knowledge - no study has done previously. Consequently, Table 4 displays the event study results for the HDAX WpHG and HDAX MAR subsamples. For the HDAX WpHG subsample, the market model presents the general findings for the reporting date of insider purchases. Pre-event CAARs are not significantly negative, lacking proof that purchases are well-timed, while post-event excess returns appear all to be positive, significant at the 1% significance level, and increasing in value over the event windows investigated to 7.46% after 20 days. Immediately after the transaction, there is no positive market reaction, which again supports the semi-strong form of market efficiency on the German capital market, and the capital market reaction of 2.19% CAARs can first be observed in the [0, 5] event window. In terms of robustness,

the constant mean return model yields significant CAARs of -2.22% before the transaction and no significant market reactions over the 5- and 10-day holding period. Another result not robust to the asset pricing models are the CAARs over the 20-day holding period as they are statistically highly significant and positive under the market model, yet even negative under the constant mean return model. However, this does not provide enough grounds to challenge the effects of insider purchases under WpHG. For sales, the general market reactions of the overall HDAX sample can also be observed for this subsample with sales occurring after positive CAARs, yet not conveying relevant information to investors. Again, applying the alternative asset pricing model suggests that insiders can earn significant negative CAARs over all event windows of up to -2.81% over 20 days after reporting a sale, which underlines that - depending on the asset pricing model - the impact of insider sales is different.

Table 4. Event study results for HDAX regulatory framework subsamples, market model and constant mean return model

<i>Market model</i>	<i>[-5, 0]</i>	<i>[0, 1]</i>	<i>[0, 5]</i>	<i>[0, 10]</i>	<i>[0, 20]</i>
<i>A. Purchases</i>					
HDAX WpHG					
RD	0.00466	0.01042***	0.02675***	0.04627***	0.07456***
TD	-0.00120	0.00214	0.02192***	0.04051***	0.06894***
HDAX MAR					
RD	-0.01935***	0.00238	-0.00024	-0.00443	-0.01279
TD	-0.02504***	0.00148	0.00234	0.00051	-0.00834
<i>B. Sales</i>					
HDAX WpHG					
RD	0.01316***	-0.00088	-0.00138	0.00700	0.01197
TD	0.01635***	0.00137	-0.00074	0.00340	0.01105
HDAX MAR					
RD	0.02982***	0.00381	0.00907*	0.01649*	0.03688**
TD	0.03003***	0.01047***	0.01508***	0.02022**	0.04153***
<i>Constant mean return model</i>					
<i>A. Purchases</i>					
HDAX WpHG					
RD	-0.01752***	0.00304***	0.00459***	0.00567***	-0.00294
TD	-0.02220***	-0.00483***	0.00096	0.00208	-0.00449*
HDAX MAR					
RD	-0.01518***	0.00377***	0.00394**	0.00320	0.00268
TD	-0.02200***	0.00249*	0.00541***	0.00612**	0.00323
<i>B. Sales</i>					
HDAX WpHG					
RD	0.00163	-0.00473***	-0.01294***	-0.01397***	-0.02807***
TD	0.00636**	-0.00199	-0.01085***	-0.01492***	-0.02378***
HDAX MAR					
RD	0.01398***	-0.00148	-0.00675**	-0.01249***	-0.01773***
TD	0.01394***	0.00510***	-0.00100	-0.00921**	-0.01437**

Note: This table presents the event study results for the HDAX WpHG and the HDAX MAR samples across chosen event windows. CAARs are determined with the market model as well as the constant mean return model as the asset pricing models. Panel A displays CAARs for purchases, Panel B - for sales. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

Different trends for purchases can be observed for the HDAX MAR subsample. They are still timed well and occur, in comparison to the HDAX WpHG subsample, after significant CAARs of -1.94% (-2.5%) over the 5 pre-reporting (pre-transaction) days when applying the market model. Similar results are obtained under the constant mean model. However, the CAARs following the purchase are not significant in any event window for the reporting or the transaction date under the market model. This evidence aligns with the study by Hussmann and Fieberg (2014), who find that, over time, the profits of insiders have decreased, but it objects to their statement that returns can still be observed. Only the fact that the constant mean return model provides very small yet significant post-purchase CAARs of below 0.4% for 5 days after the reporting, as well as slightly larger CAARs of up to 0.61% after 10 days after the transaction itself for the HDAX MAR subsample, is the reason for not entirely rejecting the idea that insiders are still able to earn abnormal returns under MAR. However, positive CAARs can only be observed until 5 (10) days after the reporting (transaction) as afterwards there are no more market reactions. Thus, the information content of purchases overall under MAR has decreased in comparison to the HDAX WpHG subsample. Furthermore, differences between the legislation periods can be observed in terms of investors' reactions to executives' sales. Evidence of perceptions of sales as negative news can be found for events occurring before and after July 2016 under the constant mean return model but are in general much smaller under MAR legislation. For the market model, in contrast to the HDAX WpHG subsample, CAARs for the HDAX MAR subsample are on average not only positive in value but also mostly statistically different from zero following the reporting. This development does not appear to have much of an economically reasonable explanation as positive abnormal returns would imply that the market perceives directors' sales as positive signals in terms of future performance and thus may result from developments observed for sales in the TecDAX subsample - which will be elucidated later in this section - since the TecDAX comprises a significant portion of the overall HDAX. This is also underscored by the analysis of post-transaction returns since CAARs over the 20 following days are also sometimes even highly significantly positive, which severely refutes former research. Underlining the different opinions on the effects of sales, the constant mean return model, as mentioned above, displays significant positive pre-event CAARs and post-sale CAARs mostly significantly negative for the 5-, 10-, and 20-day event window independent of the event date setting. Still, it seems that the information content of sales has decreased over the entire 2013-2018

sample period. Especially since the introduction of the MAR regulation, sales are likely to be largely motivated by diversification objectives rather than conveying relevant inside information to the market. To sum up, there are notable differences in the occurrence of abnormal returns for all transactions before and after the shift in policy as it can be shown that profits have decreased and even partially disappeared under the MAR regulation, which is in line with the development that abnormal returns decreased in general between 2002 and 2012 (Hussmann & Fieberg, 2014). It also seems plausible that the overall information symmetry has increased since insiders' ability to exploit their knowledge as much as under WpHG has been limited under MAR. This may be a consequence of somewhat stricter regulations in terms of reporting timelines and thresholds for the obligation to notify.

A similar analysis has been conducted for all events in the DAX, MDAX, as well as TecDAX subsamples (Table 5). While for the DAX purchase sample, with both the reporting and the transaction date as the event date, it can also be shown that insiders from DAX companies time their purchases to periods following a significant downturn in performance; these transactions do not trigger a significant reaction of the German market. These results are robust to the asset pricing model choice. In terms of market efficiency, the transaction date analysis for purchases indicates that - although on the day the insider buys the stock, lower negative CAARs occur compared to the 5 preceding days - no effect in the opposite direction can be observed. This underlines that the German capital market is not strongly efficient under the EMH. Moreover, this analysis also emphasizes that in DAX companies insiders' sale transactions, occurring after significant positive performance developments of 0.83% prior to reporting, do not contain relevant information due to a lack of stock market reactions, being statistically indifferent from zero, and thus sales do not suggest negative performance developments in the foreseeable future. This again can be explained by the assumption that these transactions are motivated by diversification and liquidation since top management in DAX companies usually receives a large portion of their salaries as stock. However, over a 20-day holding period after the transaction, CAARs of -2.65% can be observed, slightly challenging the aforementioned lack of information content of sales. Also, the results obtained by the constant mean return model suggest some relevant information content for these transactions. Still, the results under the market model are attributed to more explanatory power, supporting the tendency that insiders in DAX companies do not convey negative information to the capital market by selling stock.

Table 5. Event study results for DAX, MDAX, and TecDAX subsamples, market model and constant mean return model

<i>Market model</i>	<i>[-5, 0]</i>	<i>[0, 1]</i>	<i>[0, 5]</i>	<i>[0, 10]</i>	<i>[0, 20]</i>
<i>A. Purchases</i>					
DAX					
RD	-0.01225***	0.00108	0.00081	0.00065	-0.00093
TD	-0.01641***	-0.00359**	0.00011	-0.00167	-0.00364
MDAX					
RD	0.00250	0.01052***	0.02534***	0.04130***	0.06533***
TD	-0.00262	0.00403**	0.02105***	0.03926***	0.06369***
TecDAX					
RD	0.00947	0.02565***	0.06057***	0.10655***	0.16683***
TD	-0.00783	0.01783***	0.06016***	0.10447***	0.16371***
<i>B. Sales</i>					
DAX					
RD	0.00834**	-0.00160	-0.00227	-0.01273	-0.02257
TD	0.00576	0.00226	-0.00194	-0.00755	-0.02654*
MDAX					
RD	0.01070*	-0.00500*	-0.00436	0.00232	0.01623
TD	0.01549**	-0.00215	-0.00734	-0.00306	0.01349
TecDAX					
RD	0.03058***	0.00698**	0.00867	0.03970***	0.06052***
TD	0.03694***	0.00921***	0.01653**	0.03214***	0.06813***
<i>Constant mean return model</i>					
<i>A. Purchases</i>					
DAX					
RD	-0.01334***	0.00075	-0.00030	-0.00136	-0.00466
TD	-0.01685***	-0.00371***	-0.00031	-0.00248	-0.00513*
MDAX					
RD	-0.01405***	0.00500***	0.00882***	0.01099***	0.00800***
TD	-0.01909***	-0.00144	0.00462***	0.00910***	0.00662**
TecDAX					
RD	-0.04692***	0.00684	0.00427	0.00347	-0.02995***
TD	-0.06330***	-0.00069	0.00478	0.00310	-0.02980***
<i>B. Sales</i>					
DAX					
RD	0.00678***	-0.00206*	-0.00379*	-0.01532***	-0.02767***
TD	0.00672***	0.00259**	-0.00098	-0.00563*	-0.02282***
MDAX					
RD	-0.00013	-0.00862***	-0.01516***	-0.01748***	-0.02149***
TD	0.00538	-0.00552**	-0.01746***	-0.02153***	-0.02174***
TecDAX					
RD	0.00458	-0.00178	-0.01748***	-0.00785*	-0.02978***
TD	0.01122***	0.00057	-0.00945***	-0.01520***	-0.02179***

Note: This table presents the event study results for the DAX, MDAX, and TecDAX subsamples across chosen event windows. CAARs are determined with the market model as well as the constant mean return model as the asset pricing models. Panel A displays CAARs for purchases, Panel B - for sales. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

In contrast to the results observed for DAX companies, the MDAX subsample displays statistically highly significant large positive CAARs following the reporting of purchase transactions independent of the asset pricing model. Executives of MDAX companies can earn CAARs of up to 6.53% over the 20 days following the reporting. Still, only the constant mean return model underlines the fact that insiders act as contrarian investors (Lakonishok & Lee, 2001) since it provides proof of significant negative abnormal pre-event returns of -1.41%. However, as concerns market efficiency, the positive reaction to the purchase transaction starting on the day of the trade for MDAX companies' executives suggests that this already conveys the relevant information to the market with no need for the reporting itself. This is in contrast to the findings of an, at maximum, semi-strong efficiency of the German market in the overall HDAX sample. In contrast to the overall market reaction for the HDAX sample, it is noteworthy that sale transactions do lead to significant negative CAARs of -0.5% following their reporting for MDAX companies, but do not provoke insider profits over the longer holding periods or after the transaction

itself. Yet, the alternative asset pricing model suggests that the reporting of a sale immediately triggers CAARs of -0.86%, which decreases to -2.15% over the 20-day holding period. Similar results can be observed over the event windows following the sale itself. Although these results are only somewhat robust to either asset pricing model, this can be considered as general evidence for a negative correlation between firm size and reactions to sales, which states that the effect of insider sales is stronger in smaller companies (Fidrmuc et al., 2006). Overall, the MDAX subsample supports the observations from the HDAX sample that the market reacts more strongly to insiders' purchases than sales.

The comparison of the overall effects of the DAX as well as the MDAX subsamples is noteworthy since numerous studies for both international as well as the German markets find a negative relationship between firm size and abnormal returns to be earned by insiders (Berninger et al., 2017; Gregory et al., 1994; Lakonishok & Lee, 2001; Rau, 2004; Seyhun, 1986). While for the DAX purchase subsample no positive CAARs can be found, the respective MDAX subsample provides

proof that insiders can earn large positive CAARs by buying stock. This means that purchases conducted by managers in MDAX in contrast to DAX companies contain a significant amount of information as to predictions of the future development of the respective companies' fields of business. Thus, these results are in line with prior findings that a higher market capitalization, as found in the DAX, has a dulling effect on capital market reactions compared to smaller companies listed in the MDAX (Berninger et al., 2017). We assume according to the existing literature that the information asymmetry is larger in smaller firms due to lower levels of outside monitoring by analysts and investors (Lin & Howe, 1990) can be seen as a valid explanation for these differences as the DAX companies most certainly receive more public attention than MDAX companies. In addition to the level of liquidity in free float, the allocation of companies to the DAX or MDAX is based in particular on the market capitalization of companies in a free float as a proxy for firm size. Furthermore, given that the results provide evidence that sales have a small but still significant effect in MDAX companies, the assumption that firm size and information content of sales are negatively correlated and that thus sales are less motivated by diversification objectives in smaller companies can be supported to some extent (Gregory et al., 1994; Seyhun, 1986).

Since, by virtue of its nature, the TecDAX is composed as a sector-based index including the 30 biggest technology companies following the DAX, conducting an analysis on industry levels differentiated by SIC codes within the TecDAX is not considered reasonable. Yet, carrying out an overall analysis of the effect directors' dealings have on TecDAX companies reveals some relevant findings. Post-reporting returns of purchases are highly statistically significant for the market model, which means that insiders are able to earn positive CAARs of up to 16.68% by buying stock from their respective TecDAX company. Similar effects can be observed after the transaction but are not robust to the alternative asset pricing model as the constant mean return model does not yield statistically notable effects across most event windows. Still, this outcome suggests that insiders' purchase transactions contain a very large amount of relevant information about the future performance development of technology companies. This strongly underlines the findings of Berninger et al. (2017), who describe that, especially in technology-driven firms, information asymmetries are higher, and thus high abnormal returns deriving from insider transactions occur. In terms of market efficiency, it becomes apparent that for both the MDAX and the TecDAX subsamples, the German capital market seems strongly efficient under the market model since positive market movements can be observed upon the purchase transaction itself. This result again is not robust to the constant mean return model. For TecDAX sales, there are differences between the asset pricing models chosen. While for the constant mean return model, negative post-reporting CAARs are all significant for the 5-, 10-, and 20-day holding periods and reach -2.98% after 20 days, the market model yields significantly positive CAARs following both the transaction and

reporting of a sale. Similar to the HDAX MAR subsample, positive CAARs following directors' sales in the TecDAX are counterintuitive and have not been reported by any prior research. There does not appear to be much economically reasonable explanation for this observation. A potential cause may be the composition of the TecDAX itself. Despite its name, the Tec(hnology)DAX does not only consist of purely "technological" companies in their literal sense, such as e.g., classical IT-companies, but also lists companies in the fields of finance (e.g., FinTechs) or pharmaceuticals (e.g., Biotech) that make other technological products as well as services. They can rather be described as "technology-oriented" or not. This circumstance may also relativize the assessment of the relevance of R&D investments and disproportionate growth prospects in riskier industries since companies in the TecDAX could well be assigned to more "classic" industries. Also, event clustering may be another potential cause of these adverse effects, which could be addressed in further research.

Generally, the analysis of the effects of directors' dealings for the overall HDAX sample supports the major findings of prior research in the field of purchase transactions. They are placed after major downturns in stock performance and present positive CAARs for the respective insider post-reporting for the overall market. Also, a negative relationship between firm size and insider profits can be supported. In contrast, the effects, as well as the degree of information content of insider sales, depend on the asset pricing model and the sample selection. While for the overall HDAX sample as well as the DAX subsample it is not possible to report strong effects for sales transactions, the MDAX offers small negative CAARs after-sales whereas in the TecDAX the opposite reactions can be observed, which disproves initial assumptions. Surprising results in terms of positive market reactions to sales can also be observed for the HDAX MAR subsample. Other than that, by comparing effects under different yet similar legal frameworks, it becomes apparent that the information content of purchase transactions has decreased under European legislation, which leads to the assumption that the slightly stricter regulatory framework has served its purpose of lowering informational asymmetries between in- and outsiders.

All in all, the findings of the subsample analyses are in line with the results reported by Berninger et al. (2017). While for DAX companies there are no significant information asymmetries resulting in positive (negative) abnormal returns earned by insiders after purchase (sale) transactions, directors of smaller MDAX companies are able to heavily profit from their knowledge. This also supports the international outcome of a negative correlation between firm size and abnormal returns as a result of insider transactions. For TecDAX companies, this paper finds even stronger results than prior research. Being driven by technological progress and innovation, higher information asymmetries than in other indices allow executives to strongly profit when buying the stock of their respective companies. This evidence provides another basis for the hypothesis that market reactions to directors' dealings are stronger in

industries with larger information asymmetries than in those with stronger information symmetries.

Table 6 (market model) and Table 7 (constant mean return model) display the event study results of executives' purchases and sales on an industry level for the overall HDAX sample. In contrast to the general HDAX analysis, purchase transactions across all industries are neither preceded by statistically significant negative CAARs nor followed by significant positive CAARs. From a sales perspective they not only convey relevant information to the market on an index level, but the market's reaction is also unobservable indicating that, on an industry level, sales do not reveal negative predictions of the future performance of the industries either. The immediate effect of the reporting of all insider transactions of both kinds is insignificant for all sectors without exception. These results are robust on the asset pricing model applied and hold for both the analysis with the reporting as well as the transaction date as the event set. While the general trends of the underlying overall HDAX sample display positive CAARs after purchases, this cannot be confirmed on an industry level as none of the industrial sectors are CAARs statistically different from zero. This implies that insider purchases do not have a positive

signaling function for especially the three high R&D industries since they display no significant effects of purchases whatsoever. These findings explicitly contradict prior research on industry effects of directors' dealings (Dardas & Güttler, 2011) building on a similar hypothesis as the one formulated in this paper. Based on the examination of the overall effects of directors' dealings on HDAX companies, it can be ruled out that the HDAX sample for the given time period underlies different general trends than those used in other analyses. Generally, these results do not allow for a confirmation of the hypothesis that effects of purchases are stronger in industries with large investments in R&D. So, neither for insiders in Manufacturing - including numerous pharmaceutical companies, which are expected to demonstrate especially high information asymmetries - nor in Finance and Services, which are the three industries with the strongest R&D initiatives, can the possibility to gain abnormal returns by trading on the basis of directors' internal knowledge be proven. Thus, as for their purchases, when investigated on an industry level, the signaling effect of sales does not exist in any industry regardless of the level of R&D investments, which means that the initial hypothesis cannot be supported.

Table 6. Event study results for HDAX sample per industry, market model

Industry		[-5, 0]	[0, 1]	[0, 5]	[0, 10]	[0, 20]
A. Purchases						
Construction	RD	-0.03107	-0.00089	-0.00470	0.01262	-0.02508
	TD	-0.02991	-0.00505	-0.00896	0.00632	-0.02578
Finance	RD	0.05583	0.02554	0.07165	0.13313	0.25938
	TD	0.05195	0.02084	0.06879	0.12561	0.24792
Manufacturing	RD	-0.01045	0.00499	0.01079	0.01297	0.00921
	TD	-0.01441	-0.00088	0.00859	0.01207	0.00969
Mining	RD	-0.04657	-0.00164	-0.01446	-0.02620	-0.05914
	TD	-0.04941	-0.02132	-0.01474	-0.02762	-0.07021
Retail	RD	-0.02682	0.00185	0.01090	0.01670	0.01920
	TD	-0.04229	-0.01035	-0.00604	0.00830	0.01184
Services	RD	-0.02014	0.01014	0.01643	0.02344	0.02606
	TD	-0.03731	0.00381	0.01518	0.02260	0.02286
Transport_PublicUtil	RD	-0.01942	0.00056	-0.00290	-0.00087	-0.00350
	TD	-0.02514	-0.00599	-0.00684	-0.00424	-0.00688
Wholesale	RD	0.03999	0.01465	0.02971	0.03734	0.04932
	TD	0.03581	0.02979	0.04882	0.05377	0.07453
B. Sales						
Finance	RD	0.02102	0.00051	0.01194	0.04095	0.08142
	TD	0.01768	0.00021	-0.00062	0.01714	0.05308
Manufacturing	RD	0.01918	-0.00038	-0.00196	-0.00095	-0.00143
	TD	0.02277	0.00418	0.00238	0.00248	0.00420
Retail	RD	-0.00442	-0.00563	0.01220	0.03136	0.03273
	TD	0.00063	-0.01676	-0.01833	-0.00098	0.02474
Services	RD	-0.00070	-0.00149	-0.00667	0.00060	-0.00467
	TD	0.00152	-0.00033	-0.00369	-0.00476	-0.00389
Transport_PublicUtil	RD	0.03992	0.00757	0.01898	0.04694	0.10163
	TD	0.04816	0.01325	0.02789	0.05625	0.11183

Note: This table presents the event study results for the HDAX sample across chosen event windows. CAARs are determined with the market model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

Table 7. Event study results for HDAX sample per industry, constant mean return model

Industry			[-5, 0]	[0, 1]	[0, 5]	[0, 10]	[0, 20]
<i>A. Purchases</i>							
Construction	RD		-0.02469	0.00133	0.00192	0.02413	-0.00374
	TD		-0.02347	-0.00280	-0.00219	0.01827	-0.00370
Finance	RD		-0.02184	-0.00038	-0.00605	-0.00920	-0.01227
	TD		-0.02307	-0.00418	-0.00628	-0.01202	-0.01500
Manufacturing	RD		-0.01390	0.00384	0.00736	0.00666	-0.00243
	TD		-0.01802	-0.00207	0.00503	0.00552	-0.00248
Mining	RD		-0.02825	0.00498	0.00419	0.00771	0.00553
	TD		-0.03100	-0.01469	0.00406	0.00644	-0.00500
Retail	RD		-0.03283	-0.00016	0.00491	0.00571	0.00072
	TD		-0.04860	-0.01246	-0.01236	-0.00318	-0.00756
Services	RD		-0.02857	0.00734	0.00798	0.00793	-0.00398
	TD		-0.04536	0.00114	0.00718	0.00799	-0.00537
Transport_PublicUtil	RD		-0.01486	0.00207	0.00165	0.00752	0.01299
	TD		-0.02033	-0.00437	-0.00202	0.00463	0.01056
Wholesale	RD		0.02481	0.00959	0.01459	0.00965	-0.00304
	TD		0.02095	0.02478	0.03395	0.02640	0.02273
<i>B. Sales</i>							
Finance	RD		-0.00554	-0.00830	-0.01455	-0.00752	-0.01117
	TD		-0.00048	-0.00580	-0.01883	-0.01616	-0.01024
Manufacturing	RD		0.01152	-0.00298	-0.00966	-0.01477	-0.02779
	TD		0.01543	0.00167	-0.00514	-0.01101	-0.02135
Retail	RD		-0.00278	-0.00514	0.01373	0.03310	0.03729
	TD		0.00157	-0.01641	-0.01746	0.00048	0.02680
Services	RD		-0.00924	-0.00433	-0.01525	-0.01501	-0.03400
	TD		-0.00738	-0.00326	-0.01257	-0.02101	-0.03467
Transport_PublicUtil	RD		0.00190	-0.00504	-0.01898	-0.02267	-0.03136
	TD		0.01006	0.00064	-0.01002	-0.01335	-0.02120

Note: This table presents the event study results for the HDAX sample across chosen event windows. CAARs are determined with the constant mean return model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

Similar results can be observed for the subsamples as well. While under the market model no significant and meaningful capital market reactions can be observed for directors' transactions on an industry level within the DAX, the MDAX

subsample displays some statistically relevant positive CAARs both after the reporting as well as the purchase transaction for mining (Table 8 and Table 9).

Table 8. Event study results for MDAX subsample per industry, market model

Industry			[-5, 0]	[0, 1]	[0, 5]	[0, 10]	[0, 20]
<i>A. Purchases</i>							
Construction	RD		-0.03107	-0.00089	-0.00470	0.01262	-0.02508
	TD		-0.02991	-0.00505	-0.00896	0.00632	-0.02578
Finance	RD		0.03099	0.02178	0.06467	0.11263	0.20380
	TD		0.02750	0.01582	0.05834	0.10726	0.19996
Manufacturing	RD		-0.00259	0.00898	0.02288	0.03484	0.04676
	TD		-0.00733	0.00091	0.01767	0.03252	0.04623
Mining	RD		0.02297	0.02485***	0.03116	0.04523*	0.11096**
	TD		0.04758*	0.01314	0.04171**	0.05665***	0.10215**
Retail	RD		-0.02682	0.00185	0.01090	0.01670	0.01920
	TD		-0.04229	-0.01035	-0.00604	0.00830	0.01184
Services	RD		-0.01190	0.01233	0.00959	0.00800	0.02829
	TD		-0.02655	0.00167	0.00366	0.00453	0.01239
Transport_PublicUtil	RD		0.00447	0.00486	0.00403	0.02015	0.05144
	TD		0.00150	0.00276	0.00248	0.01887	0.04598
Wholesale	RD		0.03999	0.01465	0.02971	0.03734	0.04932
	TD		0.03581	0.02979	0.04882	0.05377	0.07453
<i>B. Sales</i>							
Finance	RD		0.02444	-0.00070	0.01269	0.04655	0.10268
	TD		0.02430	-0.00195	0.00426	0.02744	0.08594
Manufacturing	RD		0.00503	-0.00703	-0.01231	-0.02034	-0.02567
	TD		0.01092	-0.00329	-0.01336	-0.02003	-0.02350
Retail	RD		-0.00442	-0.00563	0.01220	0.03136	0.03273
	TD		0.00063	-0.01676	-0.01833	-0.00098	0.02474
Services	RD		-0.01732	-0.01387	-0.02642	-0.02576	-0.05891
	TD		-0.01849	-0.00334	-0.02183	-0.02541	-0.05564
Transport_PublicUtil	RD		0.06160*	0.01060	0.02351	0.05640	0.15883**
	TD		0.08538**	0.01917	0.03131	0.06342	0.16182**

Note: This table presents the event study results for the MDAX subsample across chosen event windows. CAARs are determined with the market model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

Table 9. Event study results for MDAX subsample per industry, constant mean return model

<i>Industry</i>		<i>[-5, 0]</i>	<i>[0, 1]</i>	<i>[0, 5]</i>	<i>[0, 10]</i>	<i>[0, 20]</i>
<i>A. Purchases</i>						
Construction	RD	-0.02469	0.00133	0.00192	0.02413	-0.00374
	TD	-0.02347	-0.00280	-0.00219	0.01827	-0.00370
Finance	RD	-0.02155	0.00425	0.01208	0.01618	0.01961
	TD	-0.02502	-0.00168	0.00572	0.01079	0.01572
Manufacturing	RD	-0.01506	0.00483	0.01046	0.01205	0.00410
	TD	-0.01992	-0.00325	0.00516	0.00956	0.00311
Mining	RD	-0.01214	0.01318	-0.00398	-0.01909	-0.01150
	TD	0.01316	0.00169	0.00727	-0.00649	-0.01818
Retail	RD	-0.03283	-0.00016	0.00491	0.00571	0.00072
	TD	-0.04860	-0.01246	-0.01236	-0.00318	-0.00756
Services	RD	-0.01049	0.01277	0.01099	0.01060	0.03334
	TD	-0.02330	0.00274	0.00690	0.01045	0.02380
Transport_PublicUtil	RD	-0.00662	0.00113	-0.00715	-0.00022	0.01149
	TD	-0.00950	-0.00090	-0.00859	-0.00134	0.00686
Wholesale	RD	0.02481	0.00959	0.01459	0.00965	-0.00304
	TD	0.02095	0.02478	0.03395	0.02640	0.02273
<i>B. Sales</i>						
Finance	RD	-0.00629	-0.01094	-0.01802	-0.00968	-0.00459
	TD	-0.00343	-0.01122	-0.02362	-0.02353	-0.01117
Manufacturing	RD	0.00354	-0.00754	-0.01376	-0.02294	-0.03063
	TD	0.00949	-0.00377	-0.01479	-0.02254	-0.02826
Retail	RD	-0.00278	-0.00514	0.01373	0.03310	0.03729
	TD	0.00157	-0.01641	-0.01746	0.00048	0.02680
Services	RD	-0.00824	-0.01078	-0.01726	-0.00893	-0.02670
	TD	-0.00938	-0.00023	-0.01263	-0.00852	-0.02329
Transport_PublicUtil	RD	0.00561	-0.00803	-0.03241	-0.04607	-0.03700**
	TD	0.02926	0.00051	-0.02468	-0.03930	-0.03453*

Note: This table presents the event study results for the MDAX subsample across chosen event windows. CAARs are determined with the constant mean return model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

However, as mentioned above, these results are not conclusive as this industry group only consists of one firm in the entire sample. These subsample results are generally robust to the asset pricing model for both purchases and sales. For sales, the evidence is in line with prior findings that sales do not contain any relevant information pertaining to future performance and are mainly motivated by diversification or liquidation (Fidrmuc et al., 2006; Lakonishok & Lee, 2001; Rozeff & Zaman, 1988) except for the 20-day holding CAARs for Transportation and Public Utilities - which are positive under the market model, which again opposes the general effects of sales - yet negative under the constant mean return model. Both of these subsamples again pose a severe challenge to

the hypothesis and therefore to prior research stating that higher information asymmetries, in this case, measured by R&D investments, yield higher abnormal returns on an industry level (Dardas & Güttler, 2011).

Due to the fact that the overall analysis of differences in stock market reactions before and after the shift in legislation on directors' dealings from WpHG to MAR in 2016 illustrates that directors' ability to profit from purchase transactions has decreased over time, it is equally interesting to examine industry effects before and after the change in legislation. For the HDAX WpHG subsample, no significant post-disclosure CAARs for purchases can be observed for any sector (Table 10 and Table 11).

Table 10. Event study results for HDAX WpHG subsample per industry, market model

Industry			[-5, 0]	[0, 1]	[0, 5]	[0, 10]	[0, 20]
A. Purchases							
Construction	RD		-0.04098	-0.00660	-0.00181	0.03950	0.02274
	TD		-0.04454	-0.01419	-0.00987	0.03138	0.01741
Finance	RD		0.08063	0.03420	0.09452	0.17902	0.35026
	TD		0.07399	0.02827	0.08846	0.16652	0.32789
Manufacturing	RD		-0.00575	0.00655	0.01867	0.02898	0.03733
	TD		-0.00983	-0.00230	0.01250	0.02259	0.03341
Mining	RD		-0.07076	-0.01086	-0.03033	-0.05104	-0.11830
	TD		-0.08315	-0.03330	-0.03437	-0.05693	-0.13016
Retail	RD		0.00098	0.00227	0.02093	0.02884	0.05107
	TD		-0.01204	-0.00312	0.00709	0.02817	0.05657
Services	RD		-0.00680	0.01297	0.02298	0.02921	0.03604
	TD		-0.01759	0.00136	0.02073	0.02713	0.03340
Transport_PublicUtil	RD		-0.02114	0.00254	0.00034	0.00358	-0.00732
	TD		-0.02734	-0.00726	-0.00471	-0.00119	-0.01107
Wholesale	RD		0.04347	0.01493	0.03010	0.03833	0.05064
	TD		0.03904	0.03123	0.05048	0.05580	0.07728
B. Sales							
Finance	RD		0.02087	0.00013	0.01211	0.04359	0.08454
	TD		0.01656	-0.00030	-0.00200	0.01750	0.05319
Manufacturing	RD		0.01421	-0.00167	-0.00623	-0.00822	-0.01493
	TD		0.01870	0.00203	-0.00192	-0.00498	-0.00874
Retail	RD		-0.01907	-0.00482	0.01267	0.03737	0.01631
	TD		-0.01372	-0.02322	-0.02807	-0.00639	0.00238
Services	RD		-0.00648	-0.00263	-0.00684	0.00544	-0.00312
	TD		-0.00324	-0.00200	-0.00504	-0.00261	-0.00328
Transport_PublicUtil	RD		0.04495	0.00864	0.02007	0.04799	0.10799
	TD		0.05357	0.01273	0.02748	0.05743	0.11698

Note: This table presents the event study results for the HDAX WpHG subsample across chosen event windows. CAARs are determined with the market model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

Table 11. Event study results for HDAX WpHG subsample per industry, constant mean return model

Industry			[-5, 0]	[0, 1]	[0, 5]	[0, 10]	[0, 20]
A. Purchases							
Construction	RD		-0.05363	-0.01067	-0.01425	0.01624	-0.02219
	TD		-0.05719	-0.01831	-0.02214	0.00847	-0.02695
Finance	RD		-0.02555	-0.00122	-0.01160	-0.01538	-0.02081
	TD		-0.02725	-0.00548	-0.01278	-0.01907	-0.02667
Manufacturing	RD		-0.01771	0.00257	0.00673	0.00711	-0.00440
	TD		-0.02113	-0.00605	0.00123	0.00192	-0.00602
Mining	RD		-0.03386	0.00212	0.00703	0.01703	0.01145
	TD		-0.04636	-0.02038	0.00294	0.01094	-0.00041
Retail	RD		-0.01419	-0.00274	0.00593	0.00116	-0.00181
	TD		-0.02750*	-0.00821	-0.00823	0.00020	0.00307
Services	RD		-0.02137	0.00811	0.00829	0.00230	-0.01535
	TD		-0.03189	-0.00340	0.00642	0.00096	-0.01674
Transport_PublicUtil	RD		-0.01183	0.00566	0.00964	0.02065	0.02516
	TD		-0.01759	-0.00397	0.00507	0.01675	0.02307
Wholesale	RD		0.02736	0.00957	0.01407	0.00896	-0.00491
	TD		0.02328	0.02593	0.03473	0.02679	0.02237
B. Sales							
Finance	RD		-0.00638	-0.00891	-0.01507	-0.00615	-0.01046
	TD		-0.00147	-0.00626	-0.02007	-0.01555	-0.00964
Manufacturing	RD		0.00990	-0.00316	-0.01060	-0.01586	-0.02947
	TD		0.01476	0.00064	-0.00607	-0.01224	-0.02237
Retail	RD		-0.00991*	-0.00187	0.02168	0.05245*	0.04676*
	TD		-0.00535	-0.02040	-0.01984	0.00854	0.02993
Services	RD		-0.01759	-0.00632	-0.01804	-0.01493	-0.04221
	TD		-0.01489	-0.00582	-0.01667	-0.02393	-0.04398
Transport_PublicUtil	RD		0.00517	-0.00456	-0.01966	-0.02485	-0.03120
	TD		0.01370	-0.00047	-0.01221	-0.01545	-0.02236

Note: This table presents the event study results for the HDAX WpHG subsample across chosen event windows. CAARs are determined with the constant mean return model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

The HDAX MAR subsample, similar to the MDAX subsample, displays signs of the positive information content of insider purchases in the Mining industry under the market model as well as for Construction under the constant mean

return model (Table 12 and Table 13). Again, given the small group size of both of these industries, it should be kept in mind that neither result can be considered conclusive.

Table 12. Event study results for HDAX MAR subsample per industry, market model

Industry			[-5, 0]	[0, 1]	[0, 5]	[0, 10]	[0, 20]
A. Purchases							
Construction	RD		-0.01832	0.00644	-0.00842	-0.02193	-0.08657
	TD		-0.01109	0.00671	-0.00780	-0.02589	-0.08130
Finance	RD		0.00301	0.00708	0.02292	0.03535	0.06578
	TD		0.00500	0.00499	0.02689	0.03844	0.07756
Manufacturing	RD		-0.02029	0.00172	-0.00571	-0.02060	-0.04975
	TD		-0.02402	0.00211	0.00040	-0.00996	-0.04003
Mining	RD		0.02297	0.02485***	0.03116	0.04523*	0.11096**
	TD		0.04758*	0.01314	0.04171**	0.05665***	0.10215**
Retail	RD		-0.06017	0.00135	-0.00113	0.00215	-0.01905
	TD		-0.07859	-0.01904	-0.02180	-0.01554	-0.04184
Services	RD		-0.04551	0.00474	0.00398	0.01247	0.00709
	TD		-0.07481	0.00847	0.00463	0.01400	0.00282
Transport_PublicUtil	RD		-0.01683	-0.00244	-0.00780	-0.00759	0.00227
	TD		-0.02182	-0.00408	-0.01006	-0.00885	-0.00055
Wholesale	RD		-0.01386**	0.01037	0.02365	0.02200	0.02890
	TD		-0.01422**	0.00743	0.02308	0.02238	0.03202
B. Sales							
Finance	RD		0.02399	0.00783	0.00864	-0.00980	0.02121
	TD		0.03928	0.00999	0.02589	0.01016	0.05100
Manufacturing	RD		0.04516	0.00635	0.02036	0.03702	0.06911
	TD		0.04402	0.01543	0.02483	0.04142	0.07180
Retail	RD		0.03954	-0.00806	0.01076	0.01332	0.08198
	TD		0.04369	0.00262	0.01091	0.01525	0.09181
Services	RD		0.01259	0.00112	-0.00626	-0.01056	-0.00824
	TD		0.01247	0.00349	-0.00058	-0.00970	-0.00531
Transport_PublicUtil	RD		-0.00407	-0.00178	0.00944	0.03773	0.04595
	TD		0.00080	0.01776	0.03141	0.04588	0.06679

Note: This table presents the event study results for the HDAX MAR subsample across chosen event windows. CAARs are determined with the market model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

Table 13. Event study results for HDAX MAR subsample per industry, constant mean return model

Industry			[-5, 0]	[0, 1]	[0, 5]	[0, 10]	[0, 20]
A. Purchases							
Construction	RD		0.01253	0.01676	0.02271*	0.03428	0.01997
	TD		0.01988	0.01714	0.02347*	0.03088	0.02620
Finance	RD		-0.01392	0.00142	0.00577	0.00397	0.00591
	TD		-0.01417	-0.00140	0.00757	0.00301	0.00988
Manufacturing	RD		-0.00592	0.00651	0.00868	0.00573	0.00172
	TD		-0.01149	0.00629	0.01300	0.01308	0.00495
Mining	RD		-0.01214	0.01318	-0.00398	-0.01909	-0.01150
	TD		0.01316	0.00169	0.00727	-0.00649	-0.01818
Retail	RD		-0.05520	0.00292	0.00368	0.01117	0.00375
	TD		-0.07392	-0.01756	-0.01731	-0.00723	-0.02031
Services	RD		-0.04225	0.00590	0.00739	0.01864	0.01766
	TD		-0.07098	0.00977	0.00862	0.02138	0.01625
Transport_PublicUtil	RD		-0.01945	-0.00333	-0.01040	-0.01230	-0.00537
	TD		-0.02447	-0.00497	-0.01271	-0.01366	-0.00833
Wholesale	RD		-0.01479	0.00993	0.02264	0.02038	0.02587
	TD		-0.01530*	0.00695	0.02191	0.02040	0.02831
B. Sales							
Finance	RD		0.01081*	0.00341	-0.00453	-0.03387	-0.02477
	TD		0.01852	0.00305	0.00507	-0.02794	-0.02179
Manufacturing	RD		0.02002	-0.00204	-0.00480	-0.00909	-0.01901
	TD		0.01893	0.00706	-0.00028	-0.00457	-0.01607
Retail	RD		0.01861	-0.01498	-0.01012	-0.02497	0.00889
	TD		0.02233	-0.00446	-0.01030	-0.02368	0.01743
Services	RD		0.00997	0.00024	-0.00882	-0.01521	-0.01512
	TD		0.00988	0.00261	-0.00313	-0.01430	-0.01325
Transport_PublicUtil	RD		-0.02672	-0.00917	-0.01304	-0.00356	-0.03278
	TD		-0.02177	0.01037	0.00914	0.00500	-0.01107

Note: This table presents the event study results for the HDAX MAR subsample across chosen event windows. CAARs are determined with the constant mean return model as the asset pricing model. Panel A displays CAARs for purchases, Panel B - for sales. Please also note that in both panels only those industries are listed for which relevant events exist within the sample. The analysis is conducted for both the reporting date (RD) of directors' dealings and the transaction date (TD) itself. Industry classification is based on 2-digit SIC codes. Where there is statistical significance ***, **, and * represent the 1%, 5%, and 10% significance levels, respectively.

The results for both purchases and sales on an industry level for all samples and subsamples imply that when isolating the effects of directors' dealings by industry, no statistically significant values can be found. These results present a major challenge to the hypothesis that R&D-intensive

sectors possess stronger information asymmetries, which are reflected in the market's reaction to insider trades. Our hypothesis that the higher the information asymmetries (measured by R&D investments) between directors companies and their shareholders in an industry sector, the greater

the abnormal returns that can be achieved, cannot be confirmed. Our analysis of the effects of both directors' purchases as well as sales on an industry level in relation to R&D investments shows that for investors there is no additional value in monitoring directors' dealings on an industry level since trends cannot be identified and conclusions of potential signaling effects of directors' dealings do not provide additional value. Thus, investing time and transaction costs into this endeavor is not plausible for investors.

It is noteworthy that for manufacturing, which over the past five years has displayed the highest average annual R&D investment per company, no results can be considered significant for either purchases or sales. Also, Finance and Services, being the next most R&D-intensive sectors, do not provide any evidence supporting the hypothesis. A possible explanation for the difference in results compared to prior research can be that most studies including industry effects have analyzed these by a multivariate regression rather than with the event study methodology. Such an event study, isolating the effects for every sector rather than also including numerous other factors that could potentially add any explanatory power to the equation, can more precisely investigate the results and elevate them from a firm to an industry level. If there really were significant results, they would become all the more apparent through the event study analysis. What remains unclear though with reference to Aboody and Lev (2000), who find strongly significant results for a group of R&D firms compared to non-R&D firms, is why their results do not hold on an industry level as well. Reasons for this may be the data examined since they analyze transactions disclosed to the SEC covering the US market over a much longer time period (1985-1997), resulting in a much larger sample of transactions. Moreover, unlike in this paper, companies for which no data on R&D could be obtained were simply classified as non-R&D companies. In this analysis, many companies are included that per se do not report any investments in this area since they do not have any due to their business activities. Nevertheless, they are still included in every industry and thus lower the average annual R&D investments per company. This could be the reason why the energy sector as part of Transportation and Public Utilities does not rank high on R&D expenditures and therefore shows different results than the high signaling power of transactions within this sector as identified in prior research (Dardas & Güttler, 2011). However, the fact that numerous companies do not report any R&D investments is no limitation to this analysis since the ranking of industries by R&D expenditures is done according to the average annual R&D investment per company within each sector. Also, considering that Dardas and Güttler (2011) examine a much earlier time period (2003-2009), it may well be the case that developments have occurred causing the diverse effects in their analysis. For example, the authors put forward the idea that the energy sector possesses a strong signaling effect due to an increasing demand for its products and the easy predictability of future performance even for someone with little insider knowledge. Today, this may be different if viewed from an economic perspective. It is possible that the demand for

products like oil, for example, has declined since public interest in reusable resources has increased significantly. On the other hand, the future development of this sector is uncertain given the major shift in this field especially due to persistent topics such as climate change and sustainable energy resources. However, the latter should much rather lead to larger information asymmetries than to more symmetry because, in order to develop innovative and sustainable energy sources, more R&D investments are necessary and thus intuitively should result in stronger abnormal returns, which is not the case.

Our findings contradict almost all prior research in this field, which often does not seem to offer much transparency on how the respective results are obtained and thus does not provide an opportunity for reproducibility. This paper shows that the former findings that the market reacts more strongly to insider transactions in R&D intensive firms compared to non-R&D firms (Aboody & Lev, 2000) only hold on a firm yet not on an industry level. Also, the results of Berninger et al. (2017), stating that more technology-driven and innovative sectors offer opportunities for insiders to earn higher abnormal returns than other industries, only apply on an index level. Moreover, the findings of Dardas and Güttler (2011), putting forward a positive relationship between insider profits and R&D activities, are challenged by these results. A transparent analysis checking for general trends that align with both prior international as well as German research on positive (negative) reactions to insider purchases (sales) also with respect to firm size and capital market efficiency cannot deliver any support for the hypothesis that the public disclosure of insider sales (purchases) yields higher negative (positive) returns in industries with larger information asymmetries, proxied by higher average annual R&D investments per company.

5. CONCLUSION

Our paper aims to examine the industry effects of directors' dealings on the German stock market. An event study is conducted for all companies listed in the HDAX between January 2013 and August 2018, firstly on an overall level and secondly on an industry level within the HDAX. The same analyses are conducted for numerous subsamples, such as the DAX, MDAX, and TecDAX, as well as for an HDAX WpHG subsample, covering events before the change to European legislation in 2016, and an HDAX MAR subsample, including events afterwards.

The overall effects of directors' dealings on the German capital market are in line with prior research. Insiders act as contrarian investors and time their transactions. Furthermore, the German stock market appears to be mostly semi-strongly efficient as information revealed by directors' dealings is usually only incorporated in prices after the disclosure of the trade to the BaFin. In general, there is a negative relationship between stock market reactions towards directors' dealings and firm size for, especially purchases. Thus, abnormal returns are likely to be earned in companies with a smaller market capitalization as found in the MDAX compared to DAX companies. With reference to the shift in the regulatory framework

from German to European regulations in July 2016, there is evidence that excess returns for purchases under MAR have disappeared in comparison to those under WpHG, corresponding to evidence of decreasing information content over time since the introduction of European insider trading regulations (Husmann & Fieberg, 2014). However, for sales under MAR as well as in TecDAX, positive market reactions can be observed, but which might be a result of the TecDAX composition itself. In addition, we show that companies listed in the TecDAX have larger information asymmetries and thus larger abnormal returns following insider trades than companies listed in cross-industry indices.

On an industry level, no significant proof can be obtained supporting the hypothesis that larger information asymmetries as proxied by R&D investments lead to larger insider gains on an industry level. This is surprising as previous research confirms higher abnormal returns for companies intensively investing in R&D (Aboody & Lev, 2000; Dardas & Güttler, 2011). Still, these results hold only on a company yet not on an industry level. Moreover, evidence from Dardas and Güttler (2011) for industry effects in relation to R&D investments cannot be supported.

Our paper shows that the public disclosure of insider sales (purchases) yields higher negative (positive) returns in industries with higher R&D investments and thus larger information asymmetries than the disclosure of transactions in industries with lower R&D investments and therefore smaller information asymmetries.

Therefore, analysts and investors do not gain added economic value in observing the industry effects of directors' dealings. Transaction costs should not be devoted to this endeavor since directors' dealings only reveal relevant information to the stock market on the firm-specific but not on the industry level.

Nevertheless, our results are to be regarded also against the background of some limitations. 1) In the context of event studies the question always arises, how the duration of observation period before and after the event is applied. We oriented ourselves with our event study at comparable studies in this area in order to be able to compare the results better. However, different results can be determined if the time periods are set differently. 2) We use the level of R&D investment as a measure of information asymmetry in industries according to Dardas and Güttler (2011). Even if this measure proves to be suitable, it is only a proxy, since information asymmetry is only measured indirectly and not directly. This approach can lead to biases in our results but is accepted since no better proxy is known to estimate the information asymmetry in our context. 3) The determined abnormal returns are not adjusted for transaction costs. We assume that for the exploitation of the abnormal returns depending upon investor type also different transaction cost rates would have to be considered. In general, however, it should be noted that the transaction cost rates in such an efficient stock market as Germany are low even for non-professional investors and therefore exploitation of the abnormal returns could be possible also for non-professional investors.

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