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Inventor CEOs and market reaction : a tool for inside trading

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research dissertation

**INVENTOR CEOs AND MARKET REACTION :
A TOOL FOR INSIDE TRADING.**

Presented by: KOLADE DAVID OKE

Date: from 01/03/22 to 15/06/22

University advisor: Prof. RADU BURLACU

research dissertation

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SUMMARY

Inventor CEOs have supposedly superior understanding and information about the innovative output of the company they are leading, in contrast to non-inventor CEOs. Particularly, because they possess advanced technical knowledge and experience in producing inventions. In this study, the author examines to what extent the market incrementally values this superior information position when the CEO engages into trading the stock of the company. Using a dataset of the trading behaviour of a sample of 652 CEOs of US-listed companies, the dissertation assesses the cumulative abnormal returns (CAR) surrounding CEO stock buying and selling -events. The findings show that, in the case of inside stock purchases by CEOs, the market significantly positively values the superior technological information position that inventorship offers. Hence, the author is enticed to conclude that in case of stock purchases by CEOs, the market follows the lead of inventor CEOs more substantially.

KEYWORDS : Inventor CEOs, market reactions, cumulative abnormal returns, inside trading

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FOREWORD

This thesis was written for my master's degree in "Advances in Finance and Accounting" at the Institut d'Administration des Entreprises. Grenoble. The subject of this thesis is related to the behaviour of market participants to trades made by Chief Executive Officers of firms, in particular, officers that are regarded as "Inventors". Nowadays, the value of publicly traded companies can fluctuate simply based on "tweets" made by the CEO. It is fascinating to examine to what extent the market values the actions of the CEO. In the case of this dissertation, these actions will be limited to stock trading made by these CEOs.

Kolade David Oke

June 2022

INTRODUCTION

This dissertation was carried out with the aim of examining whether the market values superior technical knowledge and experience, induced by inventorship, when a CEO engages in buying or selling shares of the company they are leading. A significant number of valuable, US-listed companies are currently led by inventor CEOs (Bostan and Mian, 2019). Particularly their impact on the innovation efforts and output (Islam and Zein, 2020), their involvement in the transfer of technology (Grand, 1996) and their innovation-optimizing allocation of resources (Adler and Borys, 1996) has been shown empirically in literature. Furthermore, it has been shown that innovation output, measured as the number of patents cited, substantially increases when non-inventor CEOs are replaced by inventor CEOs (Wasserman, 2003; Bostan and Mian, 2019) and the other way around. Therefore, this thesis is interested in examining whether the inventorship of CEOs, arguably inducing substantial technical knowledge and experience, translates into foresight with respect to the innovation output of the company and by extent its future value.

To this end, the dissertation utilizes the publications of inside trading events to assess whether the market significantly values inventor CEOs foresight. Naturally, any CEO, including inventor CEOs, is an insider in their company (Seyhun, 1998). This research compares non-inventor CEOs to inventor CEOs, both of which are insiders who have more knowledge going beyond what the market knows (Ahuja, Coff and Lee, 2005). Being inventors, they have specific technical knowledge and foresight, which is why they are classified as a type of insider. The assumption here is that there is an expectation for insiders to be able to make more accurate predictions of future earnings. It is reasonable to assume inventor CEOs could make even more accurate predictions of these future earnings, as their knowledge is not only privileged, but also harder to understand by the market (Coff and Lee, 2003; Agrawal and Nasser, 2005). Furthermore, the regulatory aspects of insider trading are not trivial. Seyhun (1998) wrote that because of foreknowledge, trades by insiders need to be disclosed publicly and timely, preventing detriment to investors. Their empirical evidence shows that the market tends to follow or imitate the actions of insiders to gain positive abnormal returns.

As shall be argued in this dissertation that the market values superior technical knowledge and experience induced by inventorship, I, the author, posit that the CAR market reaction on announcement of trading by inventor CEOs will be significantly larger than for non-inventor CEOs. This

result allows the author to conclude whether the market significantly values superior technical knowledge and experience induced by CEO inventorship.

In order to test this assumption, the dissertation utilizes financial statements and market data for US listed companies. It further combines this with information on inside trading events and CEO background information. The dependent variable, CAR, contains a period of 10 days before and 10 days after the trade done by the CEO. The independent variable inventor CEO is defined as having at least one patent granted by the US patent office. The control variables are a combination of company specific characteristics and CEO specific characteristics. The correlation table confirms prior evidence found in the literature. For example, it shows a positive correlation between the CEO being an inventor and the company's R&D intensity, defined as R&D expenditures divided by total sales.

Using the statistical software Stata, the author performs linear regressions controlling for time- and industry fixed effects. Since it seems reasonable to expect a difference in market reaction between a purchase and a sale of shares, two separate regressions will be made for the two different cases. (Coff and Lee, 2003). Moreover, in line with prior literature, the regressions show that there is a substantial difference in the CAR market reaction looking at purchases versus sales.

The findings show that in case of a stock purchase by a CEO, the market significantly positively values whether the CEO is an inventor, suggesting that the market follows the buying actions of inventor CEOs more substantially. Moreover, it shows that the market appears to follow the buying actions of inventor CEOs more significantly by increasing the net stock-holding position in the period around the purchase by the inventor CEO. These findings are in line with the argument that the market values the presumed superior technical knowledge and experience induced by inventorship when expressing positive signals (buying stock) about the company.

PART 1 :
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LITERATURE REVIEW

CHAPTER 1 – VALUE OF THE INVENTOR CEO

A starting point in understanding the role and value of the inventor CEO to companies is clarifying the term. Although there might be different opinions on who can be classified as an inventor CEO, this research work will follow the description given by Islam and Zein (2020). They define an inventor CEO as a Chief Executive Officer who has been awarded at least one registered patent in their name. Based on this definition, a large number of companies led by inventor CEOs can be identified. Bostan and Mian (2019) wrote that since 2017, the cumulative market value of companies led by Inventor CEOs exceed 25% of the total market capitalization of the New York Stock Exchange (NYSE). They note that these CEOs lead some of the most valuable companies active in the high-tech sector. Some examples given are Jeffrey P. Bezos of Amazon, Sergey Brin of Google, Hoyt M. Wells of Goodyear, Theodore W. Waitt of Gateway, Leslie L. Vadasz of Intel, Steven A. Ballmer of Microsoft and Lawrence J. Ellison of Oracle.

Plenty of research has been done to identify and highlight the importance of such CEOs over the lifecycle of a company. Grant (1996) wrote that when a company is led by an inventor, knowledge moves more efficiently from lower echelons of the innovation process towards the upper echelons. They note that this enables CEOs to improve their assessments of opportunities and limitations of various research and development projects carried out in their company. This efficient transfer of knowledge in turn leads to greater resource allocation and alignment of incentives for the investors (Adler and Borys, 1996). Also, as noted by Manso (2011), by being involved in the company's innovation process, the inventor-CEO is likely more aware of the risks and long-term horizon of this process. They remark that this allows inventor-CEOs to choose to go for projects that appear having higher risk short term, but have the potential to produce higher returns in the long run. For example, increases in adjusted patent citations compared to total assets, have a positive correlation with company's future revenue and stock returns (Gu, 2005; Lee, Kim, Bae, 2020).

Another reason why inventor CEOs could be valuable, is the notion that they spur innovative thinking within their company. Since pay for performance and similar financial incentives are not always enough to spur innovation, especially in start-ups and small-tech companies (Manso, 2011), a company's actual drive for innovation could possibly come from the inventor CEO. They value innovation itself and do not carry out research projects exclusively for reasons such as increased financial rewards or increased market value. This intrinsic motivation is geared towards purpose-driven research and development. This can enable inventor CEOs to facilitate an environment in which innovation is stimulated, meaning that company-wide experimentation and calculated risk taking are encouraged. On the other hand, it is also possible that inventor CEOs hinders useful innovation

because of single-mindedness and obsessing over R&D for its own sake, to the detriment of different parts of their company (Rothwell, 1977). This implies that the innovation process will be geared towards projects that may satisfy the CEO, but may be of little commercial value or even insignificant to the company itself.

Wasserman (2003) was able to demonstrate that inventor CEOs who are also founders, play a crucial role in the performance of the start-up companies they run. This conclusion was further corroborated by Jayaraman et al. (2000), who found that for young and small companies, having an innovative founder CEO correlates significantly positive with stock performance. Regardless, Wasserman (2003) pointed out that as time passes and as the company grows larger, such CEOs are more likely to be replaced by professional CEOs. These are people who have proven administrative skills, but generally do not have the technical background that comes with being an inventor. This typically happens because the shareholders may feel the inventor/founder CEOs lacks the necessary managerial skills. Shareholders are known to favour professional CEOs in the long run, even if the founder CEO was able to develop new products or secure external financing for the company (Wasserman, 2003).

The next segment of this thesis examines the existing literature explaining the significance of an inventor CEO over a CEO that does not have registered patents. This discussion is then followed by an examination of the different controversies regarding insider trading.

I. FROM CEOS WITHOUT REGISTERED PATENTS TO INVENTOR CEOS

It is not unusual for shareholders/investors to replace founder CEOs with professional CEOs. Contemporary literature does however show that companies managed by inventor CEOs outperform companies led by professional CEOs. For example, Bostan and Mian (2019) examined the difference in companies' innovation when they are managed by professional CEOs without a registered patent, versus when they are managed by inventor CEOs. The results of their research show that companies lead by inventor CEOs innovate significantly more often than companies led by a non-inventor CEO. When a company moves from a non-inventor CEO towards an inventor CEO, their number of patents is increased by between 13% and 31%. Using difference-in-difference and fixed-effect analysis, they showed that companies who made a transition from a CEO that does not have any registered patents to an inventor CEO, experienced significant improvements in the outcome of their innovation efforts in the period following the transition. They also found that companies established by inventors derive better innovation results than other companies, even after taking into account company characteristics such as R&D expenses and industry classification. Perhaps most importantly, they

concluded that companies who transition from non-inventor CEOs to inventor-CEOs, gain abnormal stock returns of 7.0% in a period of one year and 15.4% over a two-year period.

Lee et al. (2020) looked at the difference between a founder CEO and their replacement. They found a significant difference in performance between companies led by their founder and companies led by non-founder CEOs. This difference is not only apparent in case the founder CEO is replaced, but also when the founder CEO dies. Based on a dataset on U.S. publicly listed companies that experienced sudden deaths of CEOs between 1979 and 2002, they investigated the relationship between changes in founder CEOs and innovation. They concluded a sudden transition from a founder CEO to a non-inventor CEO led to a 43.8% decrease in a company's citation-weighted patent count, even when accounting for research and development spending. This result suggests founder CEOs are better innovation managers than their replacements. To improve their understanding of the differences in company performance, these researchers explored the possible reasons that may cause this variation in innovation output. Their analyses show that companies led by their founder are more likely to produce innovations and explorative patents compared to companies led by non-founder CEOs. Moreover, they noticed that replacing a founder CEO has shown to cause higher turnover of employee-inventors. They conclude that this implies that founder CEOs are better at keeping innovative employees in the company as opposed to their replacements.

Relative to non-inventor CEOs, inventor CEOs create an environment that is better suitable for significant innovations (Islam and Zein, 2020). When high-tech companies are led by inventor CEOs, they see higher levels and higher quality of innovation. This may be as a result of a number of factors, such as the inventor-CEOs' willingness to invest into technologies which are new and potentially risky. Such appetite for risks is more pronounced in younger CEOs than it is in older CEOs (Matta and Beamish, 2008).

Inventor-CEOs are by definition managers within their company, meaning any share transaction carried out by such CEOs can be classified as insider trading. This implies that even though they may possess superior non-public information regarding companies' innovative outputs, state and national security laws limit the extent to which they may trade company shares based on this non-public information. Several works of research have been carried out to explain how insider trading affects share prices and how insider-traders may benefit by trading on non-public information. In this regard, the next part of this section examines the existing literature on insider trading and how they affect market prices.

II. INVENTOR CEOS AS INSIDER TRADERS

The term insider trading can be defined as stock transactions done by officers, directors and large shareholders of a company (Seyhun, 1998). The securities laws in the U.S. define insiders as officers, directors, and owners of more than 10% of any equity class of securities and thus. On this group they impose certain restrictions. In this segment of the research, inventor-CEOs will also be classified as insiders. This means that any stock trading carried out by them will be classified as insider trading. As mentioned higher, several works of research have been carried out to examine the abnormal returns on stocks based on trading by insiders who have non-public information. Earlier academic research examining the relevance of insider trading was carried out by Smith F.P. (1940). They examined insider transactions from 1935 to 1939 and concluded that insiders were exploiting non-public information they had for their own benefit. They emphasize that it is important to note that even market professionals have difficulty distinguishing between information motivated and liquidity motivated insider trading.

Ahuja et al. (2005) state that managers may create information asymmetry by the foresight they possess of the future value of their company. Technical information about companies is typically non-transferable, which amplifies the information asymmetry between the managers and the investors (Kogut and Zander, 1992). In addition, while the fair value of a company's physical assets can be relatively easily ascertained, their intangible counterparts on the other hand, can only be valued using market models with complex assumptions. This can easily be exploited by management, who may inflate the value of the company's intangible assets, possibly in combination with understating the extent of its intangible liabilities for their benefit.

John and Lang (1991) note that not only can managers benefit from adjusting asset values, they can also trade on this superior information which they possess. Such trading does not necessarily appear maleficent and are consequently often overlooked by market authorities. As a matter of fact, trading by managers happens all the time. These researchers were able to show that managers can take advantage of the superior information they have when they make their trades. Ke, Huddert and Petroni (2003) point out that managers have significant foresight about future returns based on the insider knowledge they have. They found that these insiders are able to make accurate estimates of the impact of this information up to two years before the excess returns are made public. Uninformed and under-informed investors are likely to consider these types of managerial trades as an indication of the company's perspectives (Coff and Lee, 2003). The assumption of investors may be that the managers can identify breakthrough innovations and would trade based on this knowledge (Ahuja et al., 2005). This indicates that managerial trading plays an important role in returns appropriation.

Furthermore, trading behaviour of managers can suggest which patent or innovative breakthrough can create the most profit for the company.

Meulbroek (1992) investigated the effects of insider trading on stock prices. They showed that trades by insiders contributed to the accuracy of stock prices by moving the value closer to its true value. In their research they found that trade volumes around inside trading moments were significantly higher and consisted in large part out of insider trades. In addition, two economic researchers, Chung and Charoenwong (1998), investigated the intertemporal and cross-sectional relation between the bid-ask spread and insider trading. They found that larger spreads are established in the presence of transactions of unusually large proportions. Also, their study found that spreads have positive correlations with risk and negative correlations with trading volume, the number of exchange listings, share price and company size.

Besides information on innovative outputs, inventor-CEOs/insiders may also be in possession of information on corporate transactions like mergers, acquisitions, and takeovers. Using difference-in-difference regressions of several insider-trading measures, Agrawal and Nasser (2012) found no evidence of insiders increasing their purchasing levels before takeovers are announced. On the contrary, these insiders decrease their purchases. However, the researchers found that the insiders decrease their share sales at a higher degree. As such, they increase their net purchase levels. The researchers note that this passive insider trading style is the same for different insider groups and is more evident in particular subgroups with lower levels of ambiguity about the odds of takeovers being completed. Moreover, they remark that registered insiders of target companies usually stay away from active trading prior before the takeovers are announced. This result is contrary to the expectation that insiders will take part in trading before corporate takeovers are announced. Hence, the study demonstrates the successfulness of private as opposed to public enforcement of regulations on insider trading.

Subsequent to the findings of Agrawal and Nasser (2012), three other researchers, Qin, Liu and Wang (2014) examined transactions by insiders around the period in which important patents are filed. This information about the innovation output is non-public but nonetheless essential. They also found that insiders do not purchase more before important patents are filed. However, also in this study the insiders do reduce the amount they sell below average levels. This implies that insiders defer selling their shares until after important patents are filed.

Finally, trading by insiders may not only involve company-specific non-public information, but also non-public information about other companies within the market. Goergen, Renneboog and Zhao (2019) analysed the interaction of insider trades and the extensiveness of the networks of executive

and non-executive directors in UK listed companies. They found that information which is not company-specific, for example on other companies or on industry and market trends, are instrumental in insider trading attitude and results. The researchers observe that well-networked insiders trade shares of the companies they are considered insiders in less often and in smaller amounts. However, they notice that the profitability of these trading activities is higher, particularly when making purchases in several companies on whose boards they are present. And so they conclude that generally, well-networked insiders outperform insiders whose networks are less well-developed.

As shown so far, trading on non-public information can bring abnormal returns to inside trades. Questions have been raised as to whether such an advantage should be accepted in the market. To this extent, certain aspects of insider trading are prohibited in most stock markets worldwide. To make explicit what makes insider trading legal or not, the following part of this section examines the limitations and misconceptions on trading on non-public information.

III. INSIDER TRADING: SHADY OR SMART?

Seyhun (1998) identified the two most common misconceptions about insider trading. The first one is that many investors wrongly assume that all insider trading is illegal. The second misunderstanding has to do with the kind of insider-trading information that is regulated. Some investors wrongly assume that if insiders make profits, then it must be illegal. However, this assumption is wrong because the law only prohibits certain specific types of transactions by insiders, while most insider trading falls within legal bounds. As mentioned earlier, the securities laws in the U.S. define insiders as officers, directors, and owners of more than 10% of any equity class of securities. Hence, to be considered an insider for the purpose of insider-trading regulations, the equity-holder must have decision-making authority that affects the company. A key characteristic of these insider-trading regulations involves disclosure. This implies that all insiders must report all their stock transactions in their companies and the stock exchanges where the transaction took place to the Securities and Exchange Commission within a given time frame. Failure to report these transactions in due time violate these securities laws which penalizes by means of fines and/or incarceration.

The second assumption is false because, contrary to what a lot of people assume, profitable trading by insiders is not necessarily illegal. Seyhun (1998) remarks that what makes trading by insiders illegal is when they have material non-publicly disclosed information which motivates their trading. This is what the law is generally set up to stop insiders from doing. However, neither the U.S. Congress nor the SEC has ever clearly defined what constitutes as material non-publicly disclosed information. As a result, it is subject to interpretation by both these institutions. This implies that there is no unambiguous definition of illegal insider trading.

There are also forms of non-public information trading which may be carried out by non-insiders, but are still tagged as illegal. Federico (2019) lists several such practices. For example, tipping is an illegal practice which involves sharing price sensitive non-public information. This then leads to tippee trading, which is trading by the tippee. Recommending a certain operation to investors without sharing the underlying information, a concept known as *tuyautage*, is also illegal. Another prohibited trading technique is scalping, which means profiting from a price manipulation. For example, inflating the demand for a security owned, thereby making the price rise and then take a profit on the sale of such security. Finally, there are *gun jumping* and *front running*. *Gun jumping* implies an early recipient of disclosed information immediately trades on such information as soon as it becomes public. *Front running* on the other hand is a situation whereby brokers are aware that block transactions are coming up, which will influence the price of an equity, and anticipates it. This allows for brokers to generate abnormal returns. Another situation in which this is the case, is when brokers buy shares of a company right before they strongly recommend the purchase of these shares to their network.

Determining the effects of insider trading on stocks is essential in identifying how widespread it is, as well as to figure out how to best regulate it. Using data on illegal insider trading from the Securities and Exchange Commission, Meulbroek (1992) observed that the stock market enables informed trading and incorporates it into stock prices. They found that the abnormal returns on an insider trading day are on average 3%, and about half of the pre-announcement stock price increase observed before takeovers occurs on insider trading days. Observing the types of trades done by insiders allows markets to identify informed trading.

Moreover, for uniform traders, information concerning innovation is difficult to evaluate, because to do that you would need to create and apply economic theories to determine in what direction companies or the industries they are operational in are evolving (Hirshleifer, Hsu, and Li, 2012). Furthermore, it is necessary to analyse the process from patents to final products on the market. The value of this process is often hard to pin down and potentially requires observing the process over a significant period. This type of complex information is likely to be undervalued, barring the existence of other factors which have an inverse impact on equity value. This invariably gives the insider an edge over the uniformed trader. Insiders possess more accurate and more detailed information, allowing them to better estimate the profitability of their company's innovations.

Since not all forms of profitable trading by insiders can be tagged as illegal, a question that arises is how public investors generate positive returns on stock trades with the expectation that insiders have superior information. An example of such strategy would be to copy trades by insiders. However, as I will show in the following part, this strategy is not necessarily profitable and may even be counterproductive.

IV. THE IMITATION GAME: ABNORMAL RETURNS TO INSIDERS VS OUTSIDE INVESTORS

Since insiders have shown they are able to make profitable trades which are not necessarily illegal, a possible approach for other traders is to imitate trades carried out by insiders. This is a much apparent choice considering that, as mentioned earlier, insiders/inventor CEOs possess information which is usually knowledge-based and is thus intangible. Since most of this information is intangible, investors/outside traders will have greater difficulty in processing them and will thus be unable to correctly value the innovative output of companies. Hirshleifer, Hsu, & Li (2012) wrote that the potential return of inventions is often hard to anticipate, because the value of inventions depends on the strategies which companies deploy. They say this implies that the legacy of companies' innovation efficiency is possibly less discernible to the market compared to information regarding the potential of specific research and development activities which companies are developing. An example they give is that the market often focuses on analyst reports concerning the possible results of clinical phase trials undertaken by biotech and pharmaceutical companies; on the other hand, the company's track records on research and development projects attracts less coverage. However, analysing and trading by imitating insiders has shown to have mixed outcomes for the uniformed traders.

Cornell and Sirri (1992) reported that the way in which markets interpret insider trading is further complicated because stock prices increase over 20% during the insider buying period. They also pointed out that, as a result of both noise trading and trading by the falsely informed, the incorporation of informed traders to the market does not always lower market liquidity or cause the widening of the bid-ask spread. They continue by saying that this implies that noise traders are not just attracted by informed trading, but that they are also significantly influenced by falsely informed traders.

By examining the database of all available insider-trades in the United States between 1975 and 1996, Seyhun (1998) was able to explore if outside investors can get abnormal returns on their stock portfolios using publicly available information on insider trades. Taking into account reporting delays and transaction costs, outsiders interested in imitating insiders must be willing to hold on to their positions for at least three months. They examined if insider trading can predict future stock returns, as well as overall market movements and the takeover status of bidder and target companies. Furthermore, they also examined if following the lead of insider traders was still allowing investors to generate abnormal returns, considering the reporting delays on insider trades and transaction costs. The results of their study confirm earlier research.

In their book, Seyhun (1998) gave an example of failed imitation of insiders. In this instance, a majority of the investment newsletters at the close of the 20th century made recommendations based on analysis of insider-trading activity were overwhelmingly beaten by a passive market index. For instance, portfolio of stocks recommended by the Insiders, an insider-trading newsletter, gained 118.9% from January 1, 1985, to June 30, 1992. Within this time frame, the Wilshire 5000 index, a broad market index comprising 5,000 stocks, gained 197.6%. This suggests about 80 percentage-point underperformance for the insider-trading newsletter. Furthermore, the insider-trading portfolio had 1.9 times the market risk indicating that the underperformance was even more pronounced on a risk-adjusted basis. This evidence denotes that even professional and sophisticated market newsletters are unable to meaningfully interpret insider-trading.

By taking into account the findings of the earlier academic research discussed so far, this thesis seeks to examine the stock trading patterns of inventor CEOs to identify level of added benefit which their superior information may confer on them. This led to the formation of the following hypothesis:

Stock trading by inventor CEOs leads to significant positive CAR market reactions

PARTIE 2

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DATA AND METHODOLOGY

CHAPITRE 2 – DATA AND METHODOLOGY

I. DEPENDENT VARIABLE – CUMULATIVE ABNORMAL RETURNS

Initially, financial statement data were merged from Compustat with CEO background information retrieved from the BoardEx dataset of the Wharton School Research Data Services (WRDS) platform. Next, a dataset on the trading behaviour by inside CEOs was retrieved via Thomson Reuters Eikon DataStream. Both datasets were linked resulting in a final dataset of trading events by CEO insiders, with relevant control variables from both Compustat and BoardEx. Thereafter, the dataset were linked to the inventor dataset of the United States Patent and Trademark Office (USPTO) to classify which CEOs are inventors. Matching of names was performed utilizing first, middle and last names retrieved from the BoardEx dataset. Lastly, the event study function of the WRDS website was utilised to obtain the cumulative abnormal returns from the Centre for Research in Securities Prices (CRSP) over a window of 10 days around the respective events. The window of observation of cumulative trade was 10 days prior and 10 post trades. In total, stock returns were available for 19,704 observations.

II. INDEPENDENT VARIABLE – INVENTOR STATUS

To determine the effect of the presence of an Inventor CEOs on stock returns, a dummy variable was created which is coded as one if the corresponding CEO is an inventor and zero otherwise (is a professional CEO). Inventor CEOs in this case are CEOs whose name was listed in the inventor section of a granted patent at the US patent office. In total, 652 different CEOs were included in the dataset.

III. CONTROL VARIABLES

Several control variables both at the CEO level and the company level were included. This way, the effects of other potential stock return determinants are accounted for, depicted fully in table 1 below. At the company level, R&D intensity and Market Value, which is measured as the company's market capitalization, are included. The variables which signified the average share price of trade and the deviations from the average price were the price of trade and volatility, respectively. At the CEO level, CEO age is included, measured in years since birth year. In addition, the number of shares held by the CEO were included as Insider holdings. Also, the absolute value (regardless of sale or purchase direction) of the number of shares traded by the CEO divided by the number of share outstanding was included and codified as % of shares traded. A series of binary variables were also included : First, founder status which takes the value of one if the CEO was the company's founder and zero otherwise. Also, there is the MBA status, which takes the value of one if the CEO has an MBA and zero otherwise. A final dummy variable takes the value of one if a company is managed by the founder, and zero if not.

Finally, time fixed-effects and industry fixed-effects were included. The former are based on the year in which the trade was done, the latter on the first two letters of the SIC code of the company. These variables were derived from CRSP and the Compustat of the Wharton School.

Tableau 1: Variable definition

<i>Name of Variable</i>	<i>Definition</i>
CAR	CAR or Cumulative Abnormal Return is the sum of all abnormal returns in the period ten days before and ten days after the trade by the insider.
R&D intensity	The company's R&D expenditures divided by the total sales.
% of shares traded	Absolute value of the total number of shares traded by the insider, divided by the numbers of shares outstanding (in millions).
Price of trade	The price per share of the trade.
Volatility	Yearly volatility of the share traded
Market value	Market value of the company (in millions).
Insider holdings	Number of shares held by the insider trader.
Founder status	Dummy variable, 1 = insider trader is the company's founder, 0 = insider trader is not the company's founder
MBA status	Dummy variable, 1 = insider trader has an MBA, 0 = insider trader does not have an MBA
CEO age	The age of the insider-trader-CEO of the company.
Inventor status	Dummy variable, 1 = insider trader has a registered patent, 0 = insider trader does not have a registered patent

PARTIE 3

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PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

CHAPITRE 3 – PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

I. SUMMARY STATISTICS

In table 2 below, the distribution of the independent and control variables of the dataset are reported. In terms of R&D intensity, on average, the ratio of R&D expenses to total sales was 0.242. This indicates that typical companies in the sample data spent just under 25% of their total sales on R&D. In addition, the total volume of shares traded by the inventor CEOs of the company was 0.1% of the total shares outstanding. The average price per share of the shares traded was just over 35 dollars. The maximum price of trade was almost 191 dollars, while the minimum was about a cent. Furthermore, the volatility of the price of shares traded was typically around 45 dollars. The average value of shares held by the CEOs was 686,537 USD, while the average market value of the companies in the sample data set was 5,170,000 USD. By factoring out duplicates, table 3 shows that 9.4% of the CEOs in the data set can be categorised as inventor CEOs, meaning that just under one in ten CEOs has a patent registered in their own name at the USPTO. 10.9% of the CEOs in the dataset were founders of their company. 42% of these CEOs had an MBA. All values except for the dummy variables and CEO age are winsorized at the 1st and 99th percentiles.

Tableau 2: Variable Statistics

<i>Descriptive statistics</i>	<i>mean</i>	<i>sd</i>	<i>min</i>	<i>p25</i>	<i>p50</i>	<i>p75</i>	<i>max</i>
<i>R&D intensity</i>	0.242	0.782	0.000	0.000	0.041	0.155	5.187
<i>% of shares traded</i>	0.001	0.002	0.000	0.000	0.000	0.000	0.018
<i>Log (% of shares traded)</i>	-9.362	2.057	- 14.897	-10.680	-9.322	-7.973	-4.011
<i>Price of trade</i>	35.224	36.417	0.010	10.441	24.670	45.800	190.850
<i>Log (Price of trade)</i>	3.037	1.152	-0.598	2.346	3.206	3.824	5.332
<i>Volatility</i>	45.445	17.705	18.940	32.920	42.000	53.900	113.000
<i>Log (Volatility)</i>	3.748	0.368	2.944	3.494	3.738	3.987	4.727
<i>Market value</i>	5170.266	9962.639	18.485	517.669	1677.638	5034.073	76891.234
<i>Log (Market value)</i>	7.333	1.720	2.917	6.249	7.425	8.524	11.250
<i>Insider holdings (in thousands USD)</i>	686.537	2190.393	0.001	16.222	58.687	281.606	14142.344
<i>Log (Insider holdings)</i>	11.129	2.201	5.814	9.694	10.980	12.548	16.780
<i>Founder status</i>	0.154	0.361	0.000	-	-	-	1.000
<i>MBA status</i>	0.423	0.494	0.000	-	-	-	1.000
<i>CEO age</i>	54.401	7.329	34.000	50.000	54.000	59.000	80.000
<i>Inventor status</i>	0.101	0.301	0.000	-	-	-	1.000

The N (number of observations) for every variable is 10245.

Tableau 3: Variable Statistics after excluding duplicates

<i>Descriptive statistics</i>	<i>mean</i>	<i>sd</i>	<i>min</i>	<i>p25</i>	<i>p50</i>	<i>p75</i>	<i>max</i>
<i>Founder status</i>	0.109	0.312	0.000	-	-	-	1
<i>MBA status</i>	0.391	0.488	0.000	-	-	-	1
<i>Inventor Status</i>	0.094	0.291	0.000	-	-	-	1

The N for all these variables is 652, meaning there are 652 unique CEOs in the dataset.

In table 4, there is indication of positive correlation between cumulative abnormal returns and percentage of shares traded. Hence, as returns increase, the percentage of shares traded also increases. This relationship is inverted for R&D intensity and percentage of shares traded. A logical explanation for this could be that companies which spend more on R&D, have higher expenses and lower EBITDA in the present, but would reap the yields of their discoveries in the future. So, holding out for share trades to future dates would be more beneficial. This is consistent with the findings of Manso (2011). A lower price impacts returns negatively, as can be seen in the correlation between log (price of trade) and cumulative abnormal returns. Volatility also shows a positive correlation with percentage of shares traded. As more shares are traded, we would expect more variation in prices, in other words, the higher the value of volatility.

In addition, there is a negative correlation between log (market value) and R&D intensity. Since R&D investments are treated as expenses, they drive down the value of the EBITDA and thereby decrease the market value of the company. In line with expectations, companies with higher market value can command more price when traded. Observed is a positive correlation between price of trade and market value, confirming the expectations. Furthermore, there is a positive correlation between log (market value) and inventor status, implying that higher value companies are more often run by inventors (Bostan and Mian, 2019).

Perhaps an even more notable correlation pattern is between inventor status and R&D intensity. As depicted in the table, there is a positive correlation between the two variables, indicating that companies led by Inventor CEOs are more likely to have higher R&D intensity. This is a consistent result to the finding of Islam and Zein (2020). There is also a positive correlation between both inventor status as well as founder status, and insider holdings. This suggests that inventor and Founder CEOs are more

likely to hold shares of the company which they run. Rothwell (1977) found the same positive correlation between log(volatility) and inventor status as in this research. This could be a consequence of the positive correlation between R&D intensity and inventor status, as higher investments in R&D lead to more volatile outcomes.

Additionally, it can also be observed that there is a negative correlation between CEO age and volatility, as well as MBA status. This implies that companies led by older CEOs are less likely to experience many variations in share price. This might be the case because older CEOs take fewer risks thereby limiting changes in perceived market value of the company (as suggested by Matta and Beamish, 2008). This line of thought is further enhanced given that the positive correlation between CEO age and market value, possibly due to more experience on the side of the CEO.

In this table, there is no evidence for a significant correlation between inventor status and CAR. This makes sense as this table does not distinguish between a purchase and a sale of shares, the effects of which are potentially not the same.

Tableau 4: Pairwise correlation table

<i>Variables</i>	<i>(1)</i>	<i>(2)</i>	<i>(3)</i>	<i>(4)</i>	<i>(5)</i>	<i>(6)</i>	<i>(7)</i>	<i>(8)</i>	<i>(9)</i>	<i>(10)</i>	<i>(11)</i>
<i>(1) CAR</i>	1.000										
<i>(2) R&D intensity</i>	0.012	1.000									
<i>(3) Log (% of shares traded)</i>	0.031*	-0.019*	1.000								
<i>(4) Log (Price of trade)</i>	-0.024*	-0.216*	-0.120*	1.000							
<i>(5) Log (Volatility)</i>	0.007	0.294*	0.153*	-0.557*	1.000						
<i>(6) Log (Market value)</i>	-0.006	-0.190*	-0.304*	0.586*	-0.507*	1.000					
<i>(7) Log (Insider holdings)</i>	-0.021*	0.014	0.317*	-0.190*	0.152*	-0.015	1.000				
<i>(8) Inventor status</i>	-0.003	0.066*	-0.056*	-0.060*	0.015*	0.069*	0.085*	1.000			
<i>(9) Founder status</i>	0.019*	-0.040*	0.085*	-0.060*	0.049*	-0.070*	0.073*	0.010	1.000		
<i>(10) MBA status</i>	-0.011	0.032*	-0.012	0.082*	-0.079*	0.037*	-0.046*	-0.106*	-0.209*	1.000	
<i>(11) CEO age</i>	0.013	-0.055*	-0.011	0.063*	-0.147*	0.141*	0.019*	0.055*	0.155*	-0.018*	1.000

*** p<0.01, ** p<0.05, * p<0.1

II. PANEL REGRESSION

Table 5 and table 6 are the result of linear regression analyses with multiple fixed effects run on the sample data set, with the cumulative normal returns (-10, +10) as the dependent variables alongside the predefined control variables. The first table shows the base model, excluding the independent variable Inventor Status. The first regression (1) in the table concerns the CAR in case of a purchase of stocks by the insider trader, the second regression (2) concerns the CAR in the case of a sale of stocks by the insider.

Examining the control variables, we can see that companies' R&D intensity is negatively correlated with the cumulative abnormal returns in the case of share purchase and a positive impact in the case of share sale. Taking into account the sample collected, we can infer that R&D intense companies have negative returns at purchase (discounted) given that the payoff of the research is not certain and even if certain, the yields are enjoyed at a more later date hence investors would want to pay less at the present value thereby causing negative returns. The reversed scenario can be observed when the insider makes a share sale. As seen below, higher market value of the company is positively correlated with abnormal returns when insiders sell shares.

Tableau 5: Baseline regression model

	(1)	(2)
	<i>CAR purchase</i>	<i>CAR sale</i>
<i>R&D intensity</i>	-0.0308*** (-3.33)	0.0138*** (2.77)
<i>Log (% of shares traded)</i>	0.00364* (1.88)	0.00241*** (2.71)
<i>Log (Price of trade)</i>	-0.00196 (-0.38)	-0.0293*** (-6.21)
<i>Log (Volatility)</i>	-0.0292* (-1.66)	-0.00345 (-0.32)
<i>Log (Market value)</i>	0.0123 (1.60)	0.0319*** (6.48)

<i>Log (Insider holdings)</i>	-0.00353** (-2.00)	-0.00323*** (-4.09)
<i>Founder status</i>	-0.0379* (-1.68)	0.00649 (0.62)
<i>MBA status</i>	-0.000383 (-0.02)	0.00728 (1.11)
<i>CEO age</i>	0.00126 (1.49)	0.000462 (1.11)
<i>Constant</i>	0.0569 (0.55)	-0.104* (-1.69)
<i>Time fixed effects</i>	Yes	Yes
<i>Industry fixed effects</i>	Yes	Yes
<i>N</i>	2121	6645
<i>R²</i>	0.2854	0.1396

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

The percentage of shares traded increases the abnormal returns when an insider sells shares. This is an expected outcome given that there is a significant and positive correlation between percentage of shares traded and volatility. Typically, as more shares are traded, the market would expect more variation in prices thereby increasing the likelihood of having abnormal returns. This result is corroborated with the negative effect insider holdings has on abnormal returns when an insider trades shares. As insider holdings increase, the percentage of shares traded decreases, thereby causing a reduction to abnormal returns.

Tableau 6: Regression table with the Independent Variable Inventor Status

	(3)	(4)
	<i>CAR purchase</i>	<i>CAR sale</i>
<i>R&D intensity</i>	-0.0332*** (-3.56)	0.0138*** (2.77)

<i>Log (% of shares traded)</i>	0.00367* (1.90)	0.00242*** (2.71)
<i>Log (Price of trade)</i>	-0.00216 (-0.42)	-0.0294*** (-6.23)
<i>Log (Volatility)</i>	-0.0297* (-1.68)	-0.00275 (-0.25)
<i>Log (Market value)</i>	0.0125 (1.63)	0.0318*** (6.47)
<i>Log (Insider holdings)</i>	-0.00359** (-2.04)	-0.00322*** (-4.08)
<i>Founder status</i>	-0.0326 (-1.44)	0.00769 (0.72)
<i>MBA status</i>	0.00640 (0.39)	0.00646 (0.96)
<i>CEO age</i>	0.000966 (1.12)	0.000424 (1.00)
<i>Inventor status</i>	0.0402** (1.97)	-0.00539 (-0.57)
<i>Constant</i>	0.0679 (0.65)	-0.103* (-1.67)
<i>Time fixed effects</i>	Yes	Yes
<i>Industry fixed effects</i>	Yes	Yes
<i>N</i>	2121	6645
<i>R²</i>	0.2869	0.1396

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

With regard to the core of this thesis, another regression was carried out with the inclusion of the independent variable, that is, inventor status. Table 6 (above) is the result of the regression analysis run on the sample data set, with the cumulative normal returns (-10, +10) as the dependent variables and the inventor status as the independent variable alongside the defined control variables. The R²

values are significant, explaining over 28% of variation. However, the difference made by adding the dependent variable inventor status is limited to 0,15 percent of variation explained.

There is a positive effect of inventor status on CAR , but only if the CEO purchases shares. In fact, when CEOs sell shares, the entire model only explains about 14% of the variance in CAR and the inventor status of the CEO no longer has a significant effect on CAR. This result is consistent with the previous literature. For example, Ahuja et al (2005) suggested that investors expect insiders to trade on accurate information most of the time (that is, insiders ought to identify breakthroughs ex-ante). Hence, a share purchase could indicate that the inventor CEO anticipates an increase in the market value of the company and ultimately an increase in returns.

Based on these findings, I can only reject the null hypothesis and give credence to the alternate hypothesis when the inventor CEO purchases stocks, not when they sell them. That is, **stock purchasing by inventor-CEOs leads to significantly positive CAR market reactions.**

CONCLUSION

This thesis examines the supposedly superior information position for share trading induced by the inventorship of CEOs. To this end, the focus is on assessing to what extent the stock market values whether the CEO is an inventor (has a patent to their name) when buying or selling shares of the company they are leading.

It therefore looks at the cumulative abnormal returns (CAR) surrounding inside trading events of CEOs, examining whether CEO inventorship leads to significantly larger CAR in the stock market. In the search for a baseline model for the thesis, a literature review was carried out. First, this thesis commenced with a description of how relevant an inventor CEO may be to their company. Companies led by inventor CEOs account for a significant amount of market listed companies, making it worthwhile to study these individuals (Bostan and Mian, 2019). These individuals enhance the upstream movement of knowledge through the organisation thereby improving processes that drive innovation (Grand, 1996). A CEO who is in the know about their company's innovation efforts can better drive its company towards projects with the right risk/reward payoffs. Both changes away from and towards inventor CEOs show that the inventor CEO has a significant impact on the number of patent citations and abnormal stock returns favouring the inventor- over the professional CEO (Bostan and Mian, 2019).

Furthermore, this thesis focused on the issue of inventor CEOs who trade securities of the companies they lead. Just like any person with insider information, inventor CEOs may use their knowledge for personal gains when it comes to security trading, often to the detriment of security holder who only have access to public information. There is plenty of evidence for insider traders adjusting their trading behaviour based on knowledge of future patents, mergers, acquisition, etcetera (Ke et al., 2003). In some cases, this means increased buying, but often it mostly means holding off on selling shares until the insider information becomes public. (Agrawal and Nasser, 2012; Qin et al, 2014). Insider trading is regulated but more widely allowed than a lot of investors are aware (Seyhun,1998; Federico, 2019). As such, this thesis looked at abnormal profits an inventor CEO may gain from trading company shares. Such share-trading is done with the assumption that the inventor CEO has non-market expectation of future company performance based on insights within the company (Goergen et al., 2019). For the baseline model, the thesis extended upon the model used by Coff and Lee, 2003. Of course, in contrast to theirs, this thesis used inventor status as the independent variable and included several other control variables related to insider traders.

The thesis was based on an analysis of a sample of 652 different CEOs. The correlation table showed a positive and significant correlation between R&D intensity, which is a measure of innovative

output, and inventor status. This is in line with the findings by Manso (2011). With higher R&D intensity, it would make sense that the volatility of the company is higher, in line with Rothwell (1977). This is confirmed by the correlation table, as it shows that the two have a significant positive correlation. This table also shows a positive correlation between market value and inventor status, which is in line with the research by Bostan and Mian (2019). In addition, from the panel regression it was shown that stock trading by inventor CEOs leads to significant CAR market reaction, however only in the case of a purchase. This infers that in case of a purchase by inventor CEOs, the market follows their lead by increasing their net stock positions in the company. The two options available to the market is that they either defer selling or increase their purchase levels. So, in the case of a purchase by the inventor CEO, the market seems to value their more advanced insider knowledge. However, in the case of a sale by the inventor CEO, the market does not react in any direction. Further research could look into reasons why the market does not value the advanced knowledge of the inventor CEO in case of a sale.

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ABBREVIATIONS AND ACRONYMS USED

CEO : Chief Executive Officer

CAR: Cumulative Abnormal Returns

R&D: Research and Development

WRDS : Wharton School Research Data Services

CRSP : Centre for Research in Securities Prices

USPTO : United States Patent and Trademark Office

