Insider trading with options

Matteo Vacca*

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Abstract

This paper examines employees' trading of own-company options. Using data from Finland, I show that current employees account for over 10% of all retail investors purchasing call options on own-company shares. Their call option buys contain price-relevant information: returns on the underlying stocks are approximately 50 basis points over one week. This informativeness is most evident before earnings announcements and extends across the firm's direct economic links. Financial motives likely contribute to this behavior: employees experiencing recent stock portfolio losses display a heightened tendency to purchase own-company options. My results show some employees leverage derivatives to exploit their information advantage.

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*Aalto University School of Business. Email: matteo.vacca@aalto.fi. I am grateful to Zhi Da, Clifton Green, Matti Keloharju, Tse-Chun Lin, Petri Sahlström, Jukka Sihvonen, Sascha Steffen, and Scott Yonker, as well as seminar and conference participants at Aalto University, the 2023 GSF Summer Workshop, and the 2023 Helsinki Finance Summit for valuable comments and suggestions. I used ChatGPT to edit the text. I thank the OP Group Research Foundation (grant no. 20220057) and the Finnish Foundation for Share Promotion (grant no. 2022-0032D) for financial support. All errors are my own.

Black (1975) argues that informed investors may prefer to trade derivatives because of the leverage they provide. A growing body of evidence highlights the extensive presence of unobserved informed trading in options (e.g., Augustin, Brenner, and Subrahmanyam, 2019). However, while recent studies focus on the role of institutional investors or examine large trades subsequently investigated by regulators,[1] less is known about the information content of retail option trades.

In this paper, I examine informed option trading based on employment relationships, motivated by evidence that employees have access to price-relevant information (e.g., Huddart and Lang, 2003) and that small option trades predict short-term stock returns (Bryzgalova, Pavlova, and Sikorskaya, 2022; Ge, Lin, and Pearson, 2016). My analysis leverages trading data from Finland as well as distinctive characteristics of its institutional setting. Numerous Finnish companies grant options to their executives and employees as part of their compensation packages. Contrary to the United States, these employee stock options (ESOs) are transferable and typically listed on the exchange. This setting allows me to use data from the stock exchange to infer the employment relationships of tens of thousands of individuals between 1995 and 2014, and ensures the availability of listed options on numerous firms throughout the sample period.

Open-market purchases of own-company call options predict future stock returns at short horizons.[2] The average market-adjusted weekly stock return following an own-company call option purchase is 53 basis points (corresponding to an annualized return of 31.6%). Several pieces of evidence suggest that these purchases are based on inside information. First, these trades are difficult to reconcile with utility-maximizing models in the absence of an information advantage, as rational risk-averse agents seek to reduce their exposure to employer-specific risk (e.g., Hall and Murphy, 2002; Lambert, Larcker, and Verrecchia, 1991). Second, four in five employees who purchase own-company call options refrain from buying call options written on other stocks.

[1] See, for example, Ahern (2017), Akey, Grégoire, and Martineau (2022), Kacperczyk and Pagnotta (2019), and Lowry, Rossi, and Zhu (2019).

[2] In this paper, "open-market purchases" are positive changes in the end-of-day balance of a given instrument, resulting from one or more purchases made on the open market by the account holder. Moreover, similar to Hvide and Nielsen (2022), I refer to "informed trading" or "insider trading" as trading in own-company securities that predicts stock returns over short horizons.

Third, when employees buy call options on other stocks, their trades do not predict stock returns. Fourth, employees' open-market purchases of own-company call options in the days preceding earnings announcements are extremely informative, with the underlying stocks earning an average of approximately 200 basis points over one week.

Current employees represent 10.2% of all retail investors purchasing options on the open market, accounting for 4.3% of retail buys. In contrast, the corresponding figures for purchases of underlying stocks are substantially lower (1.6% and 0.4%, respectively). Assuming that employees' trades represent the only source of inside information and that their option and stock trades are equally informative, my calculations suggest that aggregate retail option volumes contain six to ten times more information than aggregate retail stock volumes. Accounting for tipping, identified through correlated option trades, further increases the estimated share of informed retail traders in the option market up to 13.7%. I also find evidence of a substitution effect: employees are less likely to buy own-company shares when own-company options are available. The effect size is approximately one-third of the aggregate demand for own-company shares in a given month.

Besides trading in own-company options, employees could also exploit confidential inside information by trading the derivatives of their firm's supply chain partners. In other words, informed option trading could propagate through economic links (Cohen and Frazzini, 2008). To investigate this hypothesis, I examine derivative trades by employees at major suppliers and customers of Nokia. I find that their purchases of delta-positive Nokia options and warrants predict stock returns at short horizons. On the contrary, purchases by employees at other firms do not contain price-relevant information. I also show that these results are unlikely to be driven by industry-specific knowledge.

My results on the informativeness of own-company trades also hold for bank-issued warrants. This additional analysis represents a natural cross-market assessment of the role of own-company trading, simultaneously eliminating other factors that may influence investor behavior, such as ownership and salience. Specifically, I examine own-company purchases of Nokia warrants because Nokia is by far the most common underlying for this type of instrument and information regarding these warrants is readily available. I

find that the average weekly market-adjusted stock return after employees' purchases of call-like (put-like) warrants is 73 (-25) basis points. These findings are consistent with an information advantage story and demonstrate the generalizability of my main results to another type of derivative market.

What drives employees to buy own-company options? To answer this question, I use a logit model to examine which characteristics predict open-market purchases of options written on employer's stocks. The results reveal that the microfoundations of own-company option trading reflect a number of characteristics, such as habit, familiarity with the stock market, gender, and psychological status. In particular, employees who have recently experienced a sharp decrease in the market value of their stock holdings are more likely to buy own-company call options on the open market. This result is consistent with financial considerations shaping the decision to engage in own-company option trading. I also show that, conditional on trading, employee characteristics do not explain the information content of own-company call option buys. Moreover, my findings are not driven by top-ranked employees, who are likely to be executives subject to mandatory disclosure requirements.

Finally, I confirm the robustness of my results with a number of additional tests. Most conspicuously, I verify that the informativeness of own-company call option purchases is not driven by small option trades, by trades in Nokia options, nor by a few particularly active option traders.

This paper contributes to four strands of literature. First, I add to previous work examining the relationship between option markets and equity markets. A number of papers analyze aggregate data to show that option markets contain price-relevant information in the United States (Conrad, Dittmar, and Ghysels, 2013; Hu, 2014; Johnson and So, 2012; Pan and Poteshman, 2006; Roll, Schwartz, and Subrahmanyam, 2010; Weinbaum, Fodor, Muravyev, and Cremers, 2022), Taiwan (Lee and Wang, 2016), Korea (Woo and Kim, 2021), and internationally (Cao, Goyal, Ke, and Zhan, 2023). Notably, Ge et al. (2016) highlight that the most informative option volumes are from customers trading relatively small positions, and recent work provides evidence

suggesting that retail trades might contain firm-level information not yet incorporated into prices.[3] In contradistinction to previous work focusing on how institutional investors trade single-name options (Aragon and Martin, 2012; Lowry et al., 2019), my paper examines retail trading. In particular, I show that employees, leveraging their information advantage, contribute to the information content of the option market by trading own-company options. Employees in Finland represent between 4% and 10% of total retail option demand and, relative to other retail traders, they exhibit a much higher propensity for purchasing own-company options rather than own-company stocks.

Second, my paper contributes to the literature on informed trading using equity derivatives by shedding light on the trading behavior of individuals who have access to price-relevant information but are not primary insiders.[4,5] Options provide more bang for the buck and are likely to be the preferred instrument of traders with an information advantage (Black, 1975; Boyer and Vorkink, 2014; Chakravarty, Gulen, and Mayhew, 2004). While recent studies examine in detail insider trading cases involving purchases of single-name options and suggest inside information is embedded in option markets, prosecutors generally focus on large and infrequent trades.[6] In contrast, my results suggest undetected informed option trading is more frequent and widespread than

[3]Retail order imbalances in both equities and options predict short-term stock returns (Boehmer, Jones, Zhang, and Zhang, 2021; Bryzgalova et al., 2022), although demand for liquidity and hedging may also explain these patterns (see, e.g., Barardehi, Bernhardt, Da, and Warachka, 2023).

[4]While several studies focus on stock trades by primary insiders (Bhattacharya, 2014), most informed trading remains undetected (Augustin et al., 2019; Patel and Putniņš, 2020). Moreover, public disclosure of own-company option buys is extremely rare. In the United States, no derivative transactions were found within the 30-day window preceding 1,859 M&A announcements (Augustin et al., 2019). In Canada, 322 call option purchases by insiders were reported between January 1995 and April 2000 (R. Chen and Zhao, 2005). In Finland, Alho (2021) finds zero (101) reports of open-market derivatives (stock) transactions by Nokia's insiders between July 2016 and June 2019 (i.e., shortly after the end of my sample period). Few primary insiders hedge employer-specific risks with delta-negative derivative positions (Bettis, Bizjak, and Lemmon, 2001, 2010).

[5]Previous work shows that employees other than primary insiders have access to price-relevant information (e.g., Babenko and Sen, 2016; Green, Huang, Wen, and Zhou, 2019; K. Huang, Li, and Markov, 2020; Huddart and Lang, 2003; Hvide and Nielsen, 2022). In particular, the results of Hvide and Nielsen (2022) suggest the possibility of insider trading while acknowledging alternative explanations such as heterogeneity in the participation rates of stock purchase programs or in the timing of employee stock option exercises. My data allows me to examine the stock and option portfolios of employees and to focus on trades that occur on the open market and are clearly of a speculative nature.

[6]Ahern (2017), Akey et al. (2022), and Kacperczyk and Pagnotta (2019) examine insider trading cases filed by the Securities and Exchange Commission and the Department of Justice. Bondarenko and Muravyev (2022) suggest trading on inside information can explain the relationship between option-based measures and stock returns.

previously documented. Some rank-and-file employees engage in speculative derivative trades, with their purchases of own-company call options predicting weekly stock returns. Moreover, this type of trading is relatively common when listed options are available: in some firms, over 5% of all employees who receive equity-linked compensation buy own-company call options on the open market. To the extent that insider trading regulations exist to ensure market efficiency and fairness, my results suggest publicly disclosing option trades by all individuals linked to a company may result in a more level playing field.[7]

Third, I add to the literature studying informed trading in economically-linked firms. Recent work examining aggregate data suggests primary insiders may use their private information to trade stocks of their firm's supply chain partners as a way to circumvent insider trading restrictions (Ayres and Bankman, 2001; J. Chen, Liao, Wu, Yang, et al., 2019; Mehta, Reeb, and Zhao, 2021; Tookes, 2008). In particular, Deuskar, Khatri, and Sunder (2022) find that primary insiders in India become more likely to profitably trade stocks in the same industry after insider trading regulations become stricter. I extend this literature by showing that employees are privy to price-relevant information within the supply chain and exploit their advantage by trading derivatives of economically-linked firms.

Fourth, I contribute to the literature on the determinants of individual option trading. Retail option trading is becoming increasingly important (Bryzgalova et al., 2022; Eaton, Green, Roseman, and Wu, 2023). Previous research that utilizes account-level trading data either examines index options (Han, Lee, and Liu, 2009; Hu, Kirilova, Park, and Ryu, 2022) or restricts the analysis to clients of a single brokerage firm (Bauer, Cosemans, and Eichholtz, 2009). In contrast, I take advantage of comprehensive account-level trading data on single-name options, along with potential sources of information on the underlying stocks. My results provide empirical support to Black (1975) who writes: *"since an*

[7]While many researchers agree that insider trading laws are critical to ensuring fair and efficient financial markets (e.g., Ausubel, 1990; Benabou and Laroque, 1992; Bhattacharya and Daouk, 2002; Easley and O'Hara, 2004; Fishman and Hagerty, 1992), some believe that restricting insider trading undermines the informative value of financial market prices based on fundamental analysis (e.g., Cornell and Sirri, 1992; Leland, 1992).

investor can usually get more action for a given investment in options than he can by investing directly in the underlying stock, he may choose to deal in options when he feels he has an especially important piece of information."

1 Institutional setting and data

In this section, I introduce the institutional setting, explain how I identify employment relationships, and discuss some summary statistics.

1.1 Single-name equity derivatives in Finland

Employee stock options represent an important part of corporate compensation in Finland. The first executive stock options were introduced in Finland in 1988 and, by 2001, over 80% of listed companies had issued one or more series of employee stock options. Ikäheimo, Kuosa, and Puttonen (2006) and Liljeblom, Pasternack, and Rosenberg (2011), among others, provide additional details on the institutional setting.

Contrary to most other countries, ESOs in Finland are transferable and often listed on the exchange. Some option series are targeted exclusively at company executives, and others to both executives and rank-and-file employees. I take advantage of this unique institutional setting using data on the holdings of both stocks and options listed in Finland from 1995 to 2014 to infer the employment relationships of over 40,000 individuals. These data are from Euroclear Finland (see, e.g., Grinblatt and Keloharju, 2000) and allow me to observe when options are assigned to employees and when they become listed on the exchange. Identifying information on hundreds of employee and executive stock option plans issued in Finland is from Alexander Incentives (Keloharju and Lehtinen, 2018).[8]

The primary focus of this paper is on listed ESOs as they are widely available across multiple firms and I have access to information on the specific details of the contracts.[9]

[8] I include all option series that allow me to infer the employment relationship of an employee at a given firm.

[9] All ESOs are call options. Moreover, ESOs within a given series have the same option characteristics. Thus, investors usually have no or limited choice about the moneyness and maturity of the option they buy. Furthermore, as there is a secondary market for the ESOs, not all option sales are made by employees: half of all open-market option sells are made by other investors.

These call options represent one of the two most common types of single-name equity derivatives in Finland, together with bank-issued instruments. Many of these instruments, generally referred to as warrants, have payoff structures akin to call and put options. Thus, they represent a natural setting to test the generalizability of my results to other instruments with option-like payoffs. For these reasons, in Section 3, I also examine in detail employees' trades in Nokia warrants.

1.2 Institutional background

Insider trading laws were introduced in Finland in 1989. Similar to many other countries in Europe, the laws are modeled after US insider trading regulations. Specifically, according to the 1989 Securities Markets Act (SMA), any individual who obtains non-public information that is likely to have a material effect on the value of publicly listed securities is prohibited from exploiting this information to obtain financial benefits. The Finnish Financial Supervisory Authority regulates financial markets in Finland and seeks to enforce the law by monitoring insider trading.

While the misuse of inside information is prohibited for all investors, the requirement to publicly disclose insider trades applies only to investors specified in the SMA. Generally, these individuals are employed by the issuing company, holding positions such as managing directors, board members, and auditors, or regularly obtain inside information and have the right to make decisions on the future development of the company's business operations. Kasanen (1999) reports that, at the end of 1997, there were 80 companies on the Helsinki Securities and Derivatives Exchange, employing a total of about 1,500 insiders (i.e., an average of fewer than 20 insiders per company).

In addition to the above laws against insider trading, primary insiders face further restrictions in their trading activity in three ways: first, by formal guidelines issued by the Finnish Association of Securities Dealers; second, by official recommendations from the stock exchange; third, by additional constraints on the trading by primary insiders that are issued directly by the firms. Internet Appendix A provides more details about insider trading regulations and enforcement in Finland.

1.3 Identifying employment relationships

Option cancellations allow me to infer changes in employment before the options vest. However, I have limited information on when employees leave the company afterwards. Thus, I use a strict definition of employment relationship to identify option trades that are almost certainly carried out during an employment period. For example, for employee i at firm j who receives ESOs from two option series, I consider the employment to start when the ESOs from the first series are assigned and to end by the vesting date from the second (and last) option series assigned to that employee. Following this methodology, I obtain a clean sample of option trades by current employees that allows me to identify the stock returns associated with own-company option trading.

1.4 Identifying tipping

A broader question of general interest is whether other retail accounts—that do not belong to current employees—are also informed. In fact, employees who have access to private information may disseminate this inside information to family members, friends, or other acquaintances who can then use it to trade within their own accounts. This form of indirect insider trading is usually called "tipping" (see, e.g., Ahern, 2017).

My data does not allow me to directly observe personal connections or trace the flow of inside information. To navigate this limitation, I employ an algorithm that capitalizes on correlated trading behavior to help detect trades that are likely to be motivated by inside information. First, I identify all non-employee accounts ("matched accounts") that buy the same option on the same day as a current employee ("matching trade"), requiring these correlated open-market call option purchases to occur at least k times. If an account is matched with multiple employees, I select the pair(s) with the highest number of matching trades. Second, to filter out false positives, I exclude matched accounts belonging to very active option traders. I do this by requiring that the matching trades represent at least a fraction p of all call option purchases on the same stock conducted by the matched account during the matched employee's employment period (as defined in Section 1.3).

In my baseline specification, I set $k = 2$ and $p = 0.10$.[10]

The above methodology is based on the assumption that the trading activity of an insider and of the recipients of their tipped information will exhibit a certain degree of synchronization. This approach proves particularly convenient in a relatively illiquid market, such as the one for equity derivatives, where matching trades are unlikely to occur by coincidence so that a pattern of correlated trading between two accounts can serve as a strong indicator of a possible information link and offers a viable means to identify potentially informed accounts. Naturally, I do not expect to detect *all* tipping. Instead, my objective is to identify a lower bound for informed retail trading that goes beyond the activities of employees.

1.5 Open-market purchases of own-company call options

To examine speculative trades in own-company derivatives, I focus on purchases of delta-positive instruments. The advantages of this approach are twofold. First, Ge et al. (2016) find that purchases of call options are the strongest predictor of weekly stock returns. Second, call option purchases in my sample are clearly speculative and are difficult to explain in the absence of inside information.[11]

I identify 2,659 trades by 738 employees at 43 firms. Table 1 provides additional information on these transactions. The median (average) purchase value is €1,795 (€9,081).[12] Over 80% of the option positions are either fully or partially sold, as opposed to being exercised or held until maturity. Traders in my sample are mainly rank-and-file employees: the median (average) employee rank within the company is 109 (541). Most employees who buy own-company options are males in their thirties and

[10]Consider, for example, a Nokia employee who is linked with both Account A and Account B because they all both bought the same Nokia call options on the same two distinct days. Now, while the employee is working at Nokia, Account A (B) makes a total of 5 (30) separate Nokia call option purchases. In this situation, Account A will be considered a matched account, whereas Account B will not.

[11]Lambert et al. (1991) are among the first to show that risk-averse employees want to diversify their exposure to employer-specific risk.

[12]Dollar profits from insider trading are generally small. Cziraki and Gider (2021) find the median primary insider in the United States earns $464 per year. Although options tend to contain large amounts of embedded leverage, the euro values of option trades in my sample and of the potential gains associated with these trades are also relatively small. For example, own-company option positions held for less than a month earn a median (average) realized profit of approximately €100 (€600).

forties. As discussed in detail in Section 2, these purchases are associated with an average market-adjusted weekly stock return of 53 basis points. The stock returns are slightly skewed to the right, with over one-quarter of the trades having a value above 3%.[13] Table B1 presents the definitions of the main variables used in this paper. Table B2 shows how own-company call options buys are distributed among different employees.

2 Own-company option trading by employees

This section examines whether open-market buys of own-company call options are associated with positive stock returns. Additionally, it analyzes the prevalence of own-company option trading and its relationship with purchases of own-company shares.

2.1 Stock returns after own-company call option buys

Figure 1 shows that purchases of own-company call options are associated with particularly high short-horizon stock returns compared to a number of benchmarks (other call option buys, own-company call option sells, and other call option sells). I focus on short horizons because previous studies find that option markets mainly contain information about short-term stock returns (e.g., Ge et al., 2016; Johnson and So, 2012; Pan and Poteshman, 2006).

In Table 2, I confirm that open-market own-company call option buys are a particularly informative type of derivative trade by comparing the weekly market-adjusted stock returns associated with different types of trades. Following the approach detailed in Brown and Warner (1985) to examine stock returns over short horizons, I define abnormal stock returns by using the difference between actual and market returns. Moreover, I follow Deuskar et al. (2022) and cluster standard errors at the stock-trade date level.

The results reported in Table 2 show that open-market purchases of own-company

[13] I do not observe the time of day in which trades occur. Thus, throughout the paper, I compute close-to-close stock returns based on the closing price on the day of the trade.

call options are associated with weekly abnormal stock returns of 53 basis points. The outperformance vis-à-vis various benchmarks ranges between 52 and 70 basis points. Specifically, Panel A shows that own-company call option buys outperform other call option buys by 52 basis points. Employees' trades in options on non-employer stocks contain no price-relevant information. Panel B shows the outperformance vis-à-vis other call option sells is 64 basis points. In Panel C, I compare stock returns following the buying and the (first) selling decision of the same trade. Panel C shows the average stock return after the 2,215 own-company call option buys that are followed by a sale decision (as opposed to exercising or holding until maturity) is 62 basis points over five trading days. The average weekly stock return following the first selling decisions is negative and small (-7 basis points).[14]

Finally, another important insight from Figure 1 is that employees' selling decisions following open-market own-company call option buys contain some price-relevant information, but only at very short horizons (i.e., up to two days). Over longer periods, selling decisions are generally less informative than buying decisions, a result in line with previous work on insider trading (e.g., Alldredge and Cicero, 2015; Brochet, 2010; Cheng and Lo, 2006; J. Kallunki, Kallunki, Nilsson, and Puhakka, 2018) and investor behavior (e.g., Cohen, Frazzini, and Malloy, 2008; Grinblatt, Keloharju, and Linnainmaa, 2012).

2.2 Employees trading options before earnings announcements

Corporate events represent an important opportunity for traders who have an information advantage (Augustin and Subrahmanyam, 2020). Previous work shows that option markets contain price-relevant information before mergers, takeovers, and earnings announcements (Augustin et al., 2019; Chan, Ge, and Lin, 2015; Truong and Corrado, 2014). In particular, I focus on earnings announcements to ensure an adequate number of relevant observations, as listed firms have to periodically disclose their earnings news. Moreover, liquidity tends to increase before earnings announcements, so that the probability of observing informed trading is higher (Kacperczyk and Pagnotta,

[14] In Section 5.4, I show the results are not driven by specific firms and individuals, nor by small trades.

2019). Generally, retail investors lose money when purchasing options before earnings news (de Silva, Smith, and So, 2022). However, to the extent that own-company call option buys in my sample are based on employees' private information about their employer, I expect these purchases to be highly informative when executed just before an information event.

Figure 2 compares the average weekly market-adjusted stock returns following own-company call option buys and other option purchases in the month before and after an earnings announcement. I find compelling evidence of informed option trading around earnings announcements. Own-company option buys in the week preceding an earnings news are highly informative (one-week returns of around 200 basis points, corresponding to an annualized return of over 180%). On the contrary, returns around other firms' earnings announcements are negative (approximately -150 basis points).[15] Table 3 shows that, even with a relatively small sample size, consisting of 361 call option purchases made by 198 employees before over 175 earnings announcements, the difference in stock returns is statistically significant at the 1% level. This additional evidence from call option purchases made before earnings news shows that some employees actively engage in informed option trading around corporate events. Employees who trade own-company options contribute to the informativeness of option-based measures around earnings announcements and other corporate events (see, among others, Augustin et al., 2019; Johnson and So, 2018; Roll et al., 2010).

The evidence reported in Figure 2 also suggests that employees help process newly-released information. In fact, in the days following an earnings announcement, the difference in stock returns remains positive (around 70 basis points), although not statistically significant. The informativeness of open-market own-company option buys and other option buys is more similar when far away from information events, further supporting an information advantage story.

[15] Further interpreting this negative figure is challenging because it is based on a limited sample of 163 transactions carried out by 80 different individuals.

2.3 The prevalence of own-company option trading

A number of papers, such as Cremers and Weinbaum (2010) and Xing, Zhang, and Zhao (2010), suggest informed traders primarily exploit their information advantage in the option market. To examine this proposition, I present some back-of-the-envelope calculations regarding the prevalence of employees' trading in Finland across different markets. More specifically, I examine the degree of employees' trading in stocks and options relative to other retail traders.

Figure 3 shows that own-company trading by current employees constitutes a significant component of retail investors' demand for options, representing 10.2% of retail accounts and 4.3% of open-market retail purchases. The corresponding figures for stocks are much lower (1.6% and 0.4%, respectively). In other words, potentially informed trading by employees is around six to ten times more common in the option market than in the stock market. These calculations indicate that aggregate retail option volumes are more likely to convey price-relevant information than aggregate retail stock volumes.[16]

To the extent that employees' trades are the only source of inside information, the evidence presented in Figure 3 suggests that aggregate retail option volumes contain substantially more information than aggregate retail stock volumes. Naturally, these back-of-the-envelope calculations depend on the assumption that own-company call option buys are not significantly less informative that own-company stock buys.[17] Table B5 shows that the information content of employees' own-company option and stock purchases is similar. Specifically, Table B5 compares weekly market-adjusted stock returns following own-company call option buys and own-company stock buys.[18] Column (1) includes

[16]Table B3 shows how the percentages are computed. Moreover, one may be worried that these relative frequencies are affected by the way I infer employment periods. I address this concern in two ways. First, in Table B4, I also include periods in which I do not observe any employment relationship for a given firm. The results in Table B4 are qualitatively similar to the ones in Table B3. Second, I repeat this analysis focusing on Nokia warrants (see Section 3).

[17]Following the reasoning of Black (1975), one may even expect own-company option trades to be more informative than own-company stock trades. However, differences in liquidity may deter informed trading in options (Kacperczyk and Pagnotta, 2019). Moreover, not all employees understand what options are. For example, Babenko and Sen (2014) find over 5% of surveyed employees consider out-of-the-money stock options completely worthless.

[18]I drop singletons when including fixed effects in linear regressions (see Correia, 2015).

firm-year fixed effects, which effectively control for a firm's amount of private information during a given year. Column (2) includes employee-year fixed effects to account for private information stemming from an employee's role within the firm during a given year. In this second specification, the coefficient of interest is identified by the trades of employees who purchase both own-company options and own-company stocks during the same calendar year. Although looking at within-employee variation across instruments is an interesting exercise, it is also important to emphasize that trades by employees who buy own-company options but not own-company stocks contain the most price-relevant information. The average one-week market-adjusted stock return associated with the over 700 own-company option purchases made by 306 employees who never buy own-company stocks on the open market is almost 100 basis points. This latter result suggests some highly informed traders prefer trading derivatives, further confirming the basic intuition of Black (1975). Overall, Table B5 shows that the difference in stock returns following employees' purchases of call options and of stocks is not statistically significant and unstable across specifications. The fact that own-company stock purchases predict short-term stock returns is in line with evidence from Norway (Hvide and Nielsen, 2022).

2.4 Tipping

Next, I turn my attention to tipping. The approach discussed in Section 1.4 allows me to detect a large number of additional informed option trades. Table 4 shows that, using the baseline parameters ($k = 2$ and $p = 0.1$), I identify 260 investors who execute 2,684 open-market purchases of call options that are written on stocks for which these matching accounts are likely to be indirectly informed. None of the 260 accounts belong to underage individuals so that there is no overlap with the informed trading identified by Berkman, Koch, and Westerholm (2014).

Correlated trading contains price-relevant information. The average market-adjusted weekly stock return following matching buys is 80 basis points. Non-matching buys are also associated with positive stock returns at weekly horizons (51 basis points). These results confirm that I am able to detect accounts that are likely to have indirect access to

price-relevant information.[19]

Panel B of Table 4 shows that matching option buys are a particularly informative subset of the 2,659 trades included in my main sample. These matching buys are associated with market-adjusted average stock returns of 80 basis points over five days. In contrast, the subsequent average return for the remaining own-company option buys stands at approximately 40 basis points. Drawing parallels from the mutual fund industry might help explain this disparity. Mutual fund managers often exude a high degree of conviction and enthusiasm when discussing their top investment picks (Antón, Cohen, and Polk, 2020). Similarly, employees, when armed with promising trading opportunities, might not only be inclined to capitalize on these insights but also to share them with their acquaintances. This dual approach——self-profiting and sharing——could be a manifestation of their confidence in the perceived value of the trading opportunity at hand. However, it must also be underlined that the difference in stock returns is not statistically significant (p-value of 0.28).

Table 4 also shows that matched accounts represent 3.6% of all retail option traders and 4.4% of all buys. Therefore, after accounting for tipping, potentially informed trading constitutes an even larger fraction of retail option demand. On aggregate, trades by employees and matched accounts represent approximately 14% of retail investors and 9% of open-market purchases in the option market.

2.5 The availability of own-company options and the decision to purchase own-company stocks

I also conduct two additional analyses to ascertain whether the introduction of call options on a specific stock is associated with a decrease in employees' trading of own-company shares.[20] First, I examine firm-level dynamics using the following specification:

$$Y_{j,t} = \alpha + \beta OptionListed_{j,t} + \gamma_t + \delta_j + \epsilon_{j,t}, \tag{1}$$

[19]Table B6 reports the results for more stringent criteria ($k = 3$ and $p = 0.1$; $k = 3$ and $p = 0.25$; $k = 5$ and $p = 0.25$). As k and p increase, the number of trades decreases and their informativeness increases further.

[20]In Table 5, coefficients are multiplied by 100 to ease interpretation.

for firm j in month t. $Y_{j,t}$ is the fraction of total retail stock buying volume (based on daily holding balances) represented by employees. $OptionListed_{j,t}$ is an indicator variable equal to one if there are listed options written on firm j, and zero otherwise. γ_t and δ_j indicate the fixed effects. Column (1) of Table 5 reports the results of this analysis. On average, employees account for 0.87% of the total retail stock buying volume in a given month. When there are listed options on a given stock, this share decreases by approximately one-third.

Second, I assess the look within-employee effect of listed options, using the following specification:

$$Y_{i,j,t} = \alpha + \beta OptionListed_{j,t} + \gamma_i + \epsilon_{i,j,t}, \tag{2}$$

for employee i in firm j in month t. Here, $Y_{i,j,t}$ is an indicator variable equal to one if employee i purchases own-company options in month t, and zero otherwise. $OptionListed_{j,t}$ is defined as above, and γ_i are employee fixed effects. Own-company stock buys occur on average for 1.1% of all employee-month observations. In Column (2) of Table 5, we see that the probability of buying own-company stocks at the individual level also decreases by approximately one-third when own-company options are available.

These results are consistent with employees having a preference for own-company options. However, one must caution the reader against interpreting them in a causal sense. The listing of call options in my sample is to some extent endogenous, even though the average rank-and-file employees is unlikely to be directly involved in this company-wide decision. Moreover, $OptionListed_{j,t}$ is associated with equity-linked compensation being issued to at least some of the employees of firm j. Nevertheless, the evidence reported in Table 5 reveals an intriguing association that is consistent with a negative relationship between the availability of own-company options and the propensity to buy own-company stocks.

3 Evidence from Nokia

Below, I further leverage the Finnish institutional setting to provide compelling evidence on the mechanisms behind informed option trading. I build on the historical and economic importance of Nokia to present two main results. First, I demonstrate that informed option trading propagates through economic links. Second, I show that my results on the informativeness of own-company trades are not limited to listed ESOs but also hold for bank-issued derivatives.

3.1 The Nokia cluster

Employees could potentially exploit confidential inside information not just through own-company option trading, but also by purchasing the derivatives of their company's supply chain partners. To examine whether informed option trading spreads through economic links, I analyze derivative trades by employees in Nokia's key supplier and customer firms.

Unlike in the United States, investigating the financial implications of economic links in small countries often presents challenges due to the typically sparse customer-supplier relationships among publicly listed companies. However, I am able to leverage my institutional setting by examining the so-called Nokia cluster. This ICT cluster includes Nokia's suppliers, customers, and partners, and is recognized for driving innovation and growth in the Finnish economy. The term gained popularity in the early 2000s, when Nokia was the largest mobile phone manufacturer in the world and a leading supplier of digital mobile and fixed networks globally.

The Nokia cluster is a great example of tight industry linkages and has been studied extensively by economists and policymakers (e.g., Hertog, Bergman, Charles, Remoe, et al., 2001; Hira, 2012). As discussed by Ali-Yrkkö, Paija, Reilly, and Ylä-Anttila (2000), Nokia's local suppliers were involved in the manufacturing of components and of ICT equipment, whereas its key local customers were telecommunications service providers.[21]

[21] Using information from Ali-Yrkkö et al. (2000) and Lovio (2006), I identify the following supplier and customer firms for which I have access to employment information in my sample: Aspocomp, Comptel, Efore, Elcoteq Network, Elisa Communications, JOT Automation Group, Novo Group, Perlos, PKC Group, PMJ Automec, Sonera, Tecnomen, and Tietoenator.

3.2 Results on economic links

Table 6 shows that open-market purchases of delta-positive Nokia derivatives by employees in customer and supplier firms are associated with market-adjusted weekly stock returns of around 50 basis points. These purchases contain significantly more price-relevant information than similar buys by employees in other firms.[22] To show that this result is not driven by a specific type of instrument, Table B7 reports the results of this analysis separately for purchases of options and call-like warrants. Despite a modest sample size, the difference in stock returns for option buys is nearly significant (p-value of 0.13). For purchases of call-like warrants, the difference vis-à-vis other employees in my sample is statistically significant at the 5% level.

One may be worried that the results in Table 6 merely reflect employees' industry-specific knowledge rather than an information advantage. While this would contradict previous evidence from Norway showing that employees who invest in professionally close stocks tend to underperform (Døskeland and Hvide, 2011), I nevertheless examine this possibility in the Nokia cluster. Specifically, I analyze stock returns after cluster employees' open-market purchases of options on firms operating within the cluster. To properly identify the differential effect of direct economic links vis-à-vis industry knowledge, I exclude own-company trades, as well as trades by Nokia employees (who are the only individuals having direct economic links to all firms in the cluster). Effectively, the empirical tests reported in Table B8 allow me to examine how the informativeness of option trades varies in the presence of direct economic links. Specifically, Column (1) of Table B8 shows that option trades in economically-linked firms are more informative. However, the effect is not statistically significant (the sample size is rather limited). When including investor fixed effects in Column (2), both the magnitude of the coefficient and its t-statistic increase. Finally, Column (3) shows that, when I look at the effect of economic links within investor-year—i.e., holding constant not only who makes the trade, but also her level of experience in the financial

[22] The purchase of delta-negative derivatives in economically-linked firms may be motivated by hedging motives (especially if put-like warrants written on employer stocks are not available). For this reason, I restrict my analysis to delta-positive derivatives.

markets—the coefficient is positive, large (comparable in magnitude to the difference in stock returns presented in Table 3), and statistically significant at the 5% level.

In conclusion, my results are consistent with certain employees having access to price-relevant information along the supply chain. This effect is unlikely to be driven by industry-specific knowledge but rather arises as a consequence of direct economic links between the employer and the other firm. Some employees trade derivatives written on economically-linked firms and their delta-positive purchases contain price-relevant information.

3.3 Employees' trades in Nokia warrants

In Section 2, my primary focus was on listed call options due to their prevalence across numerous firms and the availability of detailed information, for example on the underlying stocks. However, as discussed in Section 1.1, listed ESOs are not the only type of single-name equity derivative listed on the HEX. There are also warrants, which are bank-issued instruments with put-like or call-like payoffs.

Examining own-company warrant trades represents a natural cross-market test on the informed trading of derivatives by employees. In light of my results on own-company option buys, it would be surprising to find that employees' purchases of derivatives with similar payoff structures contain no information, or that employees are relatively less likely to buy own-company warrants than own-company shares (using as baselines all retail investors in Finland trading similar instruments). Analyzing warrants can also shed additional light on other aspects of own-company derivative trading. First, while all listed ESOs are call options, some warrants have put-like payoffs. This allows me to compare the informativeness of own-company purchases of delta-positive and delta-negative derivatives. Second, warrants are different from options in other dimensions: employees do not own warrants unless they buy them first, and the degree of salience of a warrant issuance is similar for both employees and the general population. Thus, my additional analysis allows for an even cleaner test on the role of private information by removing additional factors that may contribute to differences in the trading decisions of

employees and of other retail investors.[23]

Generally, bank-issued warrants are written only on the most liquid stocks. In particular, a very large fraction of all warrants, especially in the first half of my sample period, are written on Nokia shares.[24] Moreover, there is little overlap between firms that have listed warrants and firms for which I can infer employment relationships in the most recent part of my sample, so that I cannot identify any own-company warrant trade in the final years of my sample period. For these two reasons, I restrict my analysis to 2,475 own-company warrant trades made by 202 Nokia employees in the early 2000s (I cannot observe employment relationships for Nokia employees later in my sample).

Using the definition of employment relationship described in Section 1.3, I identify 2,475 open-market warrant purchases made by 202 Nokia employees between December 2000 and January 2004.[25] Over 70% of the purchases are in call-like warrants, and the remaining are in put-like warrants. My analysis of employees' trades in Nokia warrants has two main advantages. First, it allows me to perform an additional test on the robustness of my results. In fact, it would be difficult to explain a lack of price-relevant information in employees' warrant trades. Second, and most conspicuously, some of the Nokia warrants are delta negative, having a put-like payoff. Thus, I can compare stock returns following employees' buys of call-like and put-like instruments on the same underlying asset.

The results on employees' trades in Nokia warrants are reported in Table 7. The average market-adjusted stock return after employees' purchases of Nokia of call-like (put-like) warrants is 73 (-25) basis points over five trading days. The results are consistent with an information advantage story. Specifically, the market-adjusted weekly stock returns after purchases of call-like warrants are positive, generally in line with the stock returns after call option buys (discussed in Section 2), and much higher than the stock returns

[23]For example, both ownership and salience may affect investment decisions (e.g., Frydman and Wang, 2020; Hartzmark, Hirshman, and Imas, 2021).

[24]For instance, on March 11, 2002, the Nasdaq OMX Group reported 51 covered warrants with non-zero trading volume on that day (see http://www.omxgroup.com/HEXArchive/history/kl02/kl_200203 11.html). Out of these 51 warrants, 39 had a security identifier starting with NOK.

[25]The sample is restricted to dates for which I observe at least an employment relationship for Nokia. My analysis begins on the day when covered warrants started to trade in Finland (December 8, 2000).

after employees' purchases of put-like warrants.

Table 7 shows that employees' purchases of put-like warrants are relatively less informative than purchases of call-like warrants. This result is consistent with previous work finding that purchases of call options are more informative than purchases of put options (Ge et al., 2016). Moreover, some uninformed employees may buy delta-negative derivatives to hedge their firm-specific human capital (Becker, 1962). Finally, it is interesting to note that some employees also engage in volatility trading (i.e., long straddles and strangles): while such instances are too few to examine in detail, this observation is in line with previous work on informed trading on stock volatility in the option market (Ni, Pan, and Poteshman, 2008).

3.4 The prevalence of own-company warrant trading

Section 2.3 shows that, relative to other retail traders, employees are more likely to trade own-company options than own-company stocks. This result is consistent with a large literature suggesting some informed traders prefer to exploit their information advantage using derivatives (e.g., Augustin et al., 2019; Chan et al., 2015; Cremers and Weinbaum, 2010; Jin, Livnat, and Zhang, 2012; Lowry et al., 2019; Xing et al., 2010).

To verify the robustness of my result, I repeat my analysis comparing how often Nokia employees trade in own-company warrants and stocks vis-à-vis the population of all Finnish investors who trade the same instruments. Also in this sample, I find that the frequency of employees' open-market purchases relative to other retail investors is higher in own-company derivatives than in own-company shares. Table B9 shows that Nokia employees accounted for 5.1% of all retail accounts buying Nokia warrants, but only 2.2% of retail accounts purchasing the underlying stock. The evidence presented in Table B9 reinforces the notion that own-company trades are relatively more frequent in the option market than in the stock market, corroborating the idea that informed traders tend to favor instruments with a high degree of embedded leverage.

4 Employee characteristics and own-company option trading

This section explores which characteristics are associated with the decision to buy own-company options. Moreover, I examine how these characteristics affect the informativeness of own-company option buys.

4.1 Who buys own-company options?

I now investigate which employee characteristics shape the decision to participate in own-company option trading. Specifically, I examine the determinants of the decision to purchase an own-company call option from the open market using a logit model. The regressors include measures of familiarity with options and with the stock market in general, as well as various employee characteristics. The unit of analysis is employee-firm-month observations, and I only include months in which own-company options are listed on the exchange.

The logistic regression results presented in Table 8 provide valuable insights suggesting the microfoundations of insider trading reflect a number of characteristics, such as habit, financial literacy, gender, and psychological status.[26] First, purchasing own-company options is a habitual behavior: having done it in the recent past is associated with doing it in the future. However, familiarity with option trading in general seems to matter less. This result is consistent with the fact that four in five employees who purchase own-company options never buy call options written on other stocks.

Second, a number of proxies for familiarity with stock trading (both in own-company shares and in other stocks) are positively correlated with purchasing own-company call

[26]In line with results from the insider trading literature (e.g., Cziraki and Gider, 2021; Elliott, Morse, and Richardson, 1984), purchases of own-company shares and options on the open market are infrequent. Specifically, own-company stock (option) buys occur in approximately 1% (0.1%) of employee-month observations. Thus, one may be worried that own-company call option buys are too infrequent to use a logit model. However, it is important to underline that most of the issues described by King and Zeng (2001) arise from having a very small number of rare outcomes, rather than from the rarity of the events (see, e.g., Allison, 2012; Van Smeden et al., 2016). Moreover, Table B10 shows that my findings are robust to the use of rare events logit (Tomz, King, and Zeng, 2003).

options from the open market. Stock market participation is correlated with financial literacy (Van Rooij, Lusardi, and Alessie, 2011), a trait that may help identify and exploit price-relevant information, especially using derivatives.

Third, women are less likely to buy own-company options. This gender gap is in line with survey evidence from Betz, O'Connell, and Shepard (1989), who find that the willingness to engage in insider trading is nearly twice as high among males.[27] Similar gender differences have also been observed among primary insiders (Inci, Narayanan, and Seyhun, 2017).

Fourth, the probability of purchasing own-company call options increases with recent portfolio losses. Specifically, employees whose stock portfolios have lost more than 5% of their value in the previous month are more likely to buy own-company call options. The magnitude of this effect is large and comparable to that of a recent purchase of own-company call options. This result suggests the existence of a psychological motive behind insider trading and is consistent with prospect theory. According to Kahneman and Tversky (1979), *"a person who has not made peace with his losses is likely to accept gambles that would be unacceptable to him otherwise."* To the extent that a loss-averse employee holding losing stocks does not close the bracket of prior outcomes, she will become less cautious after a loss and willing to take on more risk (see, e.g., Imas, 2016; Smith, Levere, and Kurtzman, 2009). In my setting, these risks can be pecuniary, but also reputational and even judicial. Furthermore, this result implies an inverse association between the performance of the stock market and the frequency of own-company trading. The observed pattern is consistent with evidence from Bogousslavsky, Fos, and Muravyev (2022), who find that informed trading intensity peaks in 2000 and 2009 (i.e., around the dot-com bubble and the Global Financial Crisis).

Table 9 provides additional evidence on the heterogeneous effect of large recent losses in an employee's stock portfolio on the decision to purchase own-company derivatives. The results indicate that substantial percentage losses influence the decision to purchase own-company options, but only when the corresponding euro value is large enough. Moreover,

[27] As discussed in Section 4.2.2, own-company call option buys by male and female employees are equally informative.

large losses tend to strongly motivate habitual own-company option buyers, but not other employees (this latter effect is negative but only marginally significant). A similar pattern can be observed for own-company stock buyers. Finally, the effect is concentrated among lower-ranked employees, who are generally not subject to disclosure requirements.

The results in Table 9 suggest that the effect of financial considerations is not uniform within an organization, but is driven by certain subgroups of employees. This evidence contributes to a broader understanding of informed trading behavior, highlighting that lower-ranked employees and habitual own-company option buyers may play a relatively more important role in periods of general market downturns. More broadly, these results may help regulators to more effectively target and monitor accounts prone to informed trading, particularly those bearing large recent losses.

4.2 Employee characteristics and the informativeness of own-company option trades

Next, I turn my attention to identifying potential predictors of informed option trading. Specifically, I examine whether the type of employee making the own-company call option purchases impacts the degree of informativeness of these transactions.

4.2.1 Rank effects

I begin by discussing how the informativeness of open-market own-company call option buys varies with the rank of an employee within the firm. This analysis is particularly important because the informativeness may be driven by the purchases of executives and top managers within a company. Legislators around the world usually mandate these individuals to disclose their own-company trades. However, recent evidence suggests that insiders below the top and rank-and-file employees have also access to price-relevant information (see, for example, Babenko and Sen, 2016; Green et al., 2019; Hvide and Nielsen, 2022).

Figure 4 shows that my findings are not exclusively driven by primary insiders. As of 1997, the average company listed in Finland had approximately 20 insiders (Kasanen,

1999).[28] However, purchases by individuals ranked among the top 20 grantees of a given firm contain almost no information (less than 20 basis points over one week). On the contrary, purchases by employees just below the top and by rank-and-file employees are associated with the highest stock returns, between 50 and 70 basis points over five days.

Why are option trades by individuals who play more prominent roles in a company less informative than purchases by rank-and-file employees? While it is important to underline that the differences in average stock returns are not statistically significant at conventional levels, at least three factors might contribute to this result. First, primary insiders are not allowed to trade in the days leading up to an interim report. Accordingly, I find that trades by top-ranked employees are less frequent in the days immediately before an earnings announcement (during which own-company call option buys are associated with particularly high stock returns, as discussed in Section 2.2). Second, higher-ranked employees may have more reputation concerns than lower-ranked employees, preventing the former group to exploit short-term information soon incorporated into stock prices. Third, heterogeneous investment horizons across employee ranks represent a plausible explanation for the differences in stock returns. Figure B1 shows that, after purchasing own-company options, top-ranked employees close their positions later than other employees. For example, top-ranked employees hold onto their options for a median of 84 days, whereas the median for individuals with *Employee rank* above 500 holds is 37 days. Overall, the evidence in Figure B1 suggests top-ranked employees might trade own-company options based on lower-frequency information (if any), and they tend to have longer investment horizons than lower-ranked employees. These findings are consistent with the notion that mandatory disclosure requirements shape the information content of own-company option trades.

The results in Figure 4 mirror the main findings of Hvide and Nielsen (2022) who examine own-company stock trades in Norway. On the one hand, trades by primary insiders are not very informative. On the other hand, trades by managers below the top and by rank-and-file employees predict future stock returns. However, Hvide and

[28] For privacy concerns, the data provider does not allow me to identify individual accounts by merging the trading data set with information on announced trades by primary insiders.

Nielsen (2022) find that stock trades by managers below the top contain somewhat more information than trades by employees. This pattern does not emerge from Figure 4. The discrepancy may be due to the fact that I can identify only employees who receive ESOs from their employer and these individuals are likely to be part of the right tail of the general population of Finnish employees.[29]

4.2.2 Additional characteristics

To examine whether the informativeness of own-company call option buys varies with a number of other employee characteristics, I employ a simple linear model:

$$Y_{i,j,t} = \alpha + \beta X_{i,t-1} + \epsilon_{i,j,t}, \tag{3}$$

where $Y_{i,j,t}$ are weekly market-adjusted stock returns after employee i working at firm j purchases own-company call options on day t, and $X_{i,t-1}$ are employee characteristics.

Table B11 shows the results of this analysis. Generally, employee characteristics do not explain the information content of employees' own-company call option purchases. In Columns (1)-(8), I find that familiarity with options, familiarity with stocks, and psychological factors do not predict the informativeness of own-company call option buys.

I also examine whether the information content of own-company call option buys is different for female and male employees. As discussed in Section 4.1, women are less likely to buy own-company options than men. Nevertheless, women (men) could be on average more (less) informed but choose to trade own-company options less (more) often. The results in Column (9) of Table B11 speak against this narrative: own-company call option buys by female and male employees are equally informative.

Finally, Column (10) reports the results of a multivariate regression. Also in this specification, the explanatory power is limited. Only the effects of the number of non-employer stock and option purchases in the previous year are marginally significant.

[29] For example, ESO grants are concentrated in the Greater Helsinki Area in both absolute and relative terms (Keloharju and Lehtinen, 2018).

5 Additional results on option trades

This Section presents several additional results, including evidence on monthly stock returns and subsample analyses.

5.1 Option buys by former and possible employees

Do the option trades of former employees contain price-relevant information? The answer to this question is not obvious ex ante. On the one hand, these individuals might retain firm-specific information after they leave the company. They could also be able to extract some valuable information from former colleagues within their professional network. On the other hand, company-specific information that can be exploited over very short horizons is likely to become stale quickly. Additionally, it is worth noting that insider trading cases brought forth by the SEC against former employees are exceptionally rare.[30]

In Table B12, I examine the information content of option buys by former and possible employees. Specifically, I focus on trades that are not included in my main sample because they occur after the final vesting date of an employee's ESOs. It is important to underline that the stock returns associated with option buys by former employees discussed below are, if anything, overestimated. In fact, my analysis is likely to still include some potentially informed trades. For example, although job separations spike after ESOs vest (Aldatmaz, Ouimet, and Van Wesep, 2018), some transactions by employees who have not yet left the firm are probably included.

My results suggest ex-employees possess little useful information. Specifically, Table B12 repeats the analysis presented in Table 2 considering trades by former and possible employees. Contrary to the main sample, market-adjusted stock returns after own-company call option purchases are negative and similar to the various benchmarks. Taken together, these results suggest that option buys by former employees contain little, if any, price-relevant information over short horizons.

[30]For one such example, see "SEC v. Cherif" (1991).

5.2 Risk-adjusted returns

In Table B13, I verify my results using a three-factor model (Fama and French, 1992). Reassuringly, the informativeness of own-company option trades persists also using risk-adjusted returns. Weekly excess returns after own-company call option buys are approximately 70 basis points. Moreover, differences in stock returns relative to the previously employed benchmarks are positive and statistically significant at conventional levels.

5.3 Monthly returns

This paper primarily focuses on weekly stock returns because previous research shows option markets mainly contain information about short-term stock returns (e.g., Johnson and So, 2012; Pan and Poteshman, 2006). Nevertheless, I also examine what happens over a longer horizon. Table B14 shows that purchases of own-company call options continue to be generally informative also at monthly horizons. However, the degree of informativeness appears to somewhat decrease over time. The average market-adjusted one-month stock return after own-company buys is 71 basis points, just 18 basis points higher than the average stock return in the first week after the purchase. The difference in stock returns is statistically significant against other buys and other sells, but not against own-company sells (p-value of 0.20). Moreover, stock returns after own-company sells are positive, suggesting that selling decisions do not contain price-relevant information over longer horizons.

5.4 Subsample analyses

I perform various additional robustness tests to show that the informativeness of own-company option buys is not driven by certain types of trades that frequently occur within my sample. First, I show that own-company option trades remain relatively informative over time. Specifically, Figure B2 shows that the difference in weekly market-adjusted stock returns after own-company call option buys and other buys ranges between 45 and

75 basis points across four consecutive and non-overlapping subsamples.

Second, I examine whether my results are substantially influenced by trades in Nokia options. Given that Nokia represents the most frequently occurring company in my sample—Nokia option purchases comprise approximately 30% of all own-company call option buys—it is essential to ensure that the informativeness of option trades is not driven solely by its employees. Reassuringly, Table B15 shows that the information content of own-company option trades is not driven by transactions in Nokia options.

Third, my results may be driven by a limited number of individuals who possess price-relevant information and frequently trade own-company options. To address this concern, I exclude the 100 most active own-company call option buyers in my sample. Table B16 reports the results of this analysis. Reassuringly, I find that, if anything, excluding very active option traders strengthens my results. These results are consistent with infrequent own-company option buys being the most informative and echo arguments from the insider trading literature suggesting that deviations from expected patterns are highly informative (Akbas, Jiang, and Koch, 2020; Cohen, Malloy, and Pomorski, 2012; S. Huang, Lin, and Zheng, 2022).

Finally, I also investigate whether the information content of own-company option buys is concentrated among smaller option purchases. I find that this is not the case. Table B17 shows that trades with a value above €1,000 contain price-relevant information and outperform the various benchmarks by up to 70 basis points over five trading days.

6 Conclusion

As suggested by the normative theory of DeMarzo, Fishman, and Hagerty (1998), financial regulators generally tend to focus on large trades (Augustin and Subrahmanyam, 2020). The role of small trades, typical of retail investors, is often overlooked. In this paper, however, I show that between 4% and 10% of all retail demand in the market for single-name equity derivatives in Finland can be attributed to individual investors who are highly likely to be informed. Using a conservative approach to account for tipping raises this estimate up to 14%.

Employees' purchases of own-company options contain price-relevant information. They are associated with stock returns of 53 basis points over one week (corresponding to an annualized return of 31.6%). Furthermore, consistent with an information advantage story, the informativeness of employees' option trades peaks prior to information events and extends across the firm's direct economic links. I also show that these transactions are likely driven by financial motives, as employees with recent portfolio losses display an increased propensity to purchase own-company options.

More generally, this paper contributes to the debate on the disclosure of informed trades.[31] My results provide direct evidence of informed option trading by employees, with potential implications for regulators. Enhanced oversight of employee activity in the options market and of small option trades in general may ensure greater efficiency and fairness in financial markets.

[31]Several previous studies examine informed trading in stocks—but not in options—using data from Nordic countries (e.g., Berkman, Koch, and Westerholm, 2020; Berkman et al., 2014; Hvide and Nielsen, 2022; J. Kallunki et al., 2018; J. P. Kallunki, Mikkonen, Nilsson, and Setterberg, 2016; J. P. Kallunki, Nilsson, and Hellström, 2009).

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Figure 1: Average market-adjusted stock returns at various horizons

This figure shows the average market-adjusted stock returns after own-company call option buys, after other call option buys, and after the first sell following an own-company call option buy.

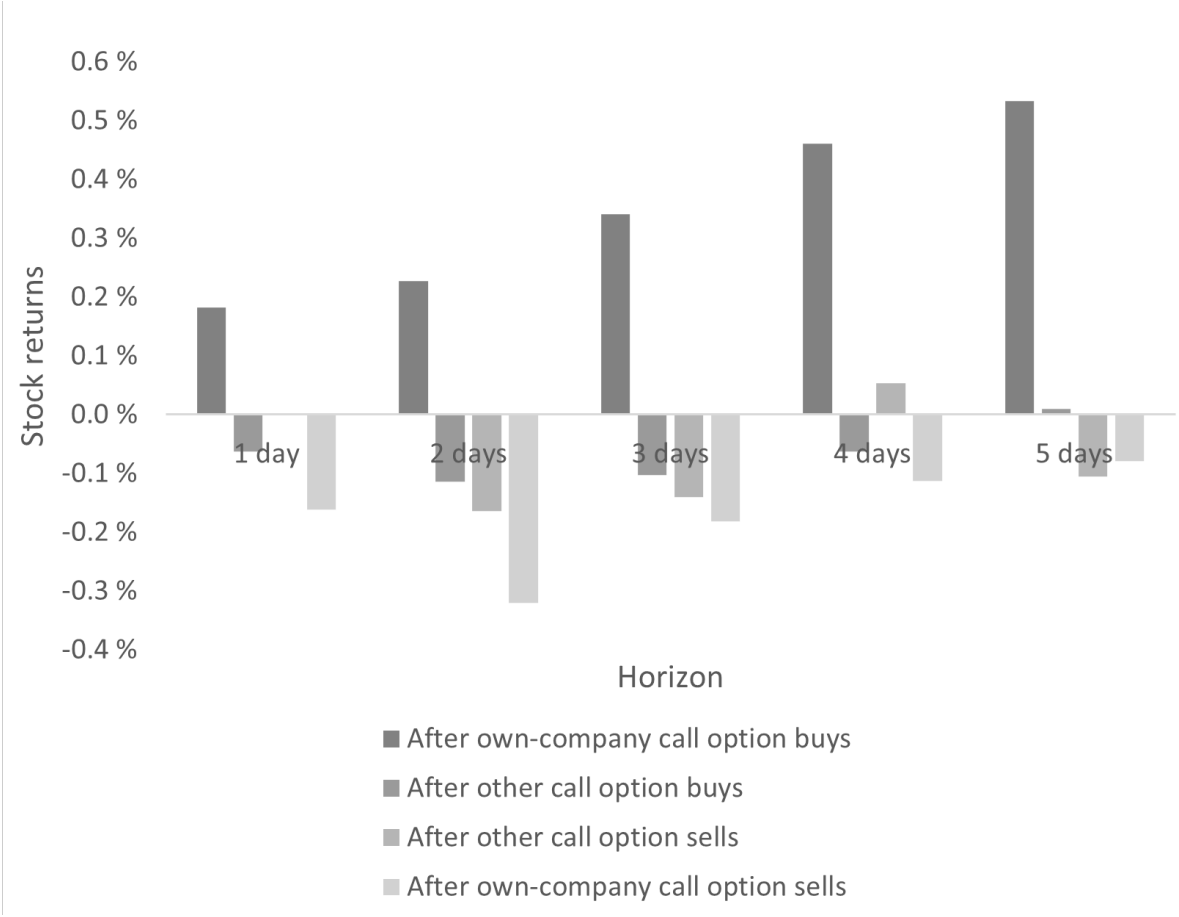

Figure 2: Own-company call option buys around earnings announcements

This figure shows the average market-adjusted stock returns after own-company call option buys for trades initiated in the month before and after an earnings announcement. Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following option buys by employees. 95% confidence intervals are based on standard errors that are clustered at the stock-trade date level.

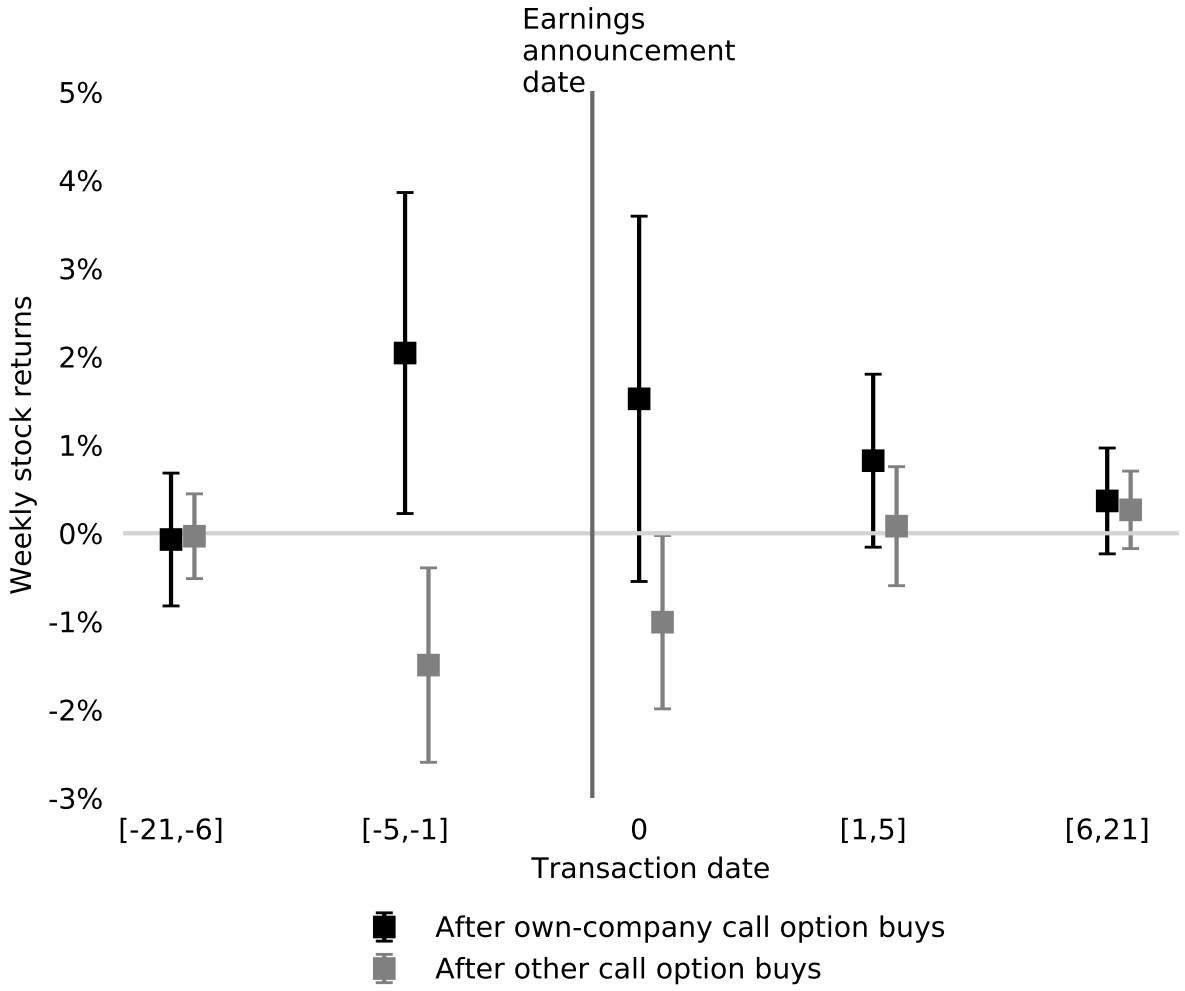

Figure 3: Own-company trading in options and stocks

This figure summarizes the fraction of retail accounts and trades (defined at the investor-security-trade date level) that are carried out by employees in the option and stock markets. Table B3 shows how these percentages are computed.

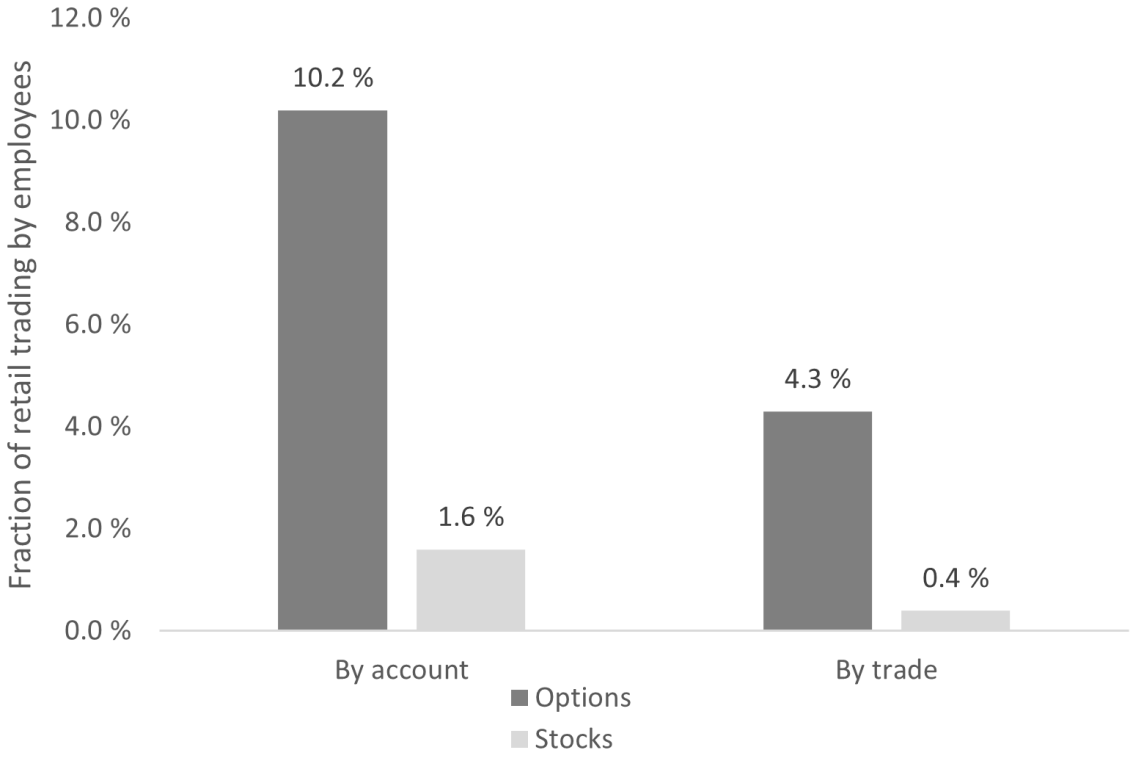

Figure 4: Weekly market-adjusted stock returns by employee rank

This figure shows the average market-adjusted stock returns after own-company call option buys for different employee ranks. *Employee rank* is defined as the best (i.e., lowest) within-series rank obtained by employee i in firm j in my sample. 95% confidence intervals are based on standard errors that are clustered at the stock-trade date level.

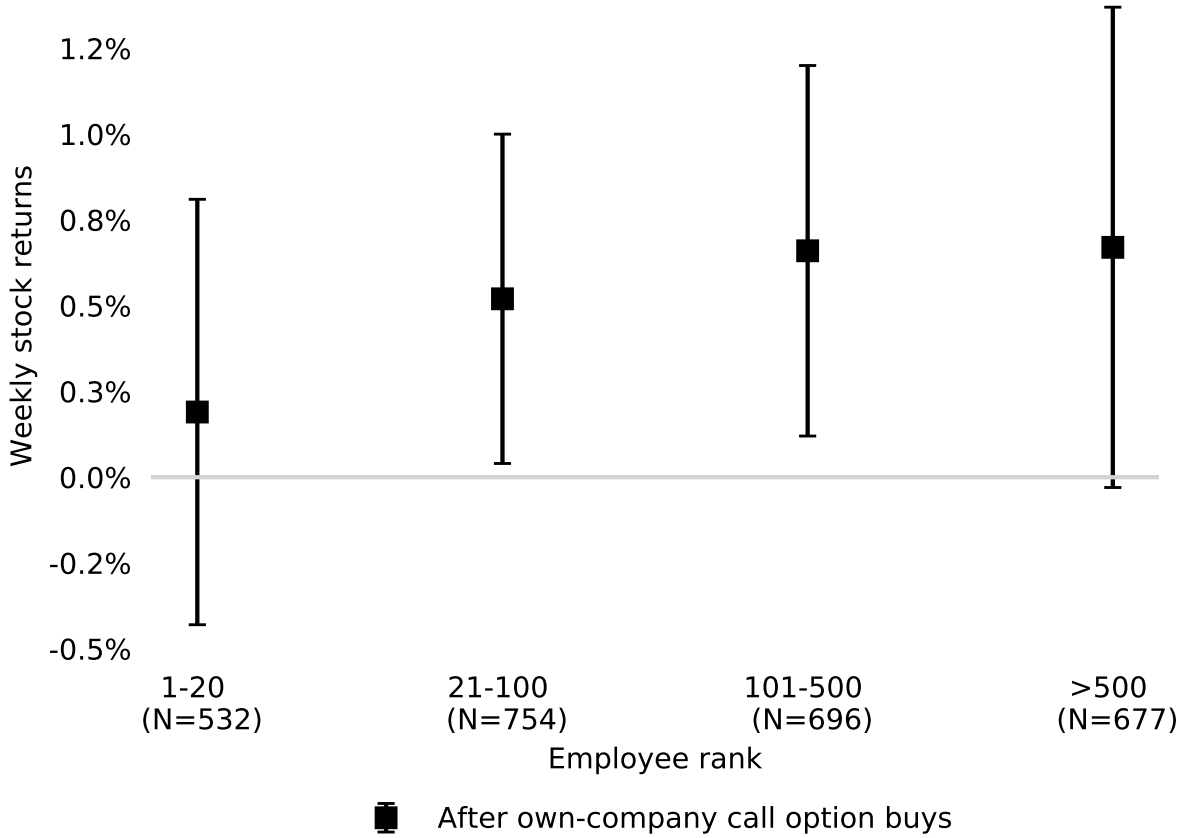

Table 1: Summary statistics on own-company call option purchases

This table presents summary statistics on 2,659 open-market call option purchases made by 738 employees in 43 firms. Information on the euro value is missing for three option buys. Similarly, data on age and/or gender is missing for some employees.

	N	Average	SD	Skewness	P25	P50	P75
Value of the option purchase (€)	2,656	9,081	85,123	38.71	626	1,795	4,723
Trading days until first sale	2,216	133	179	2.02	10	50	202
Employee rank	2,659	541	1,240	4.45	43	109	561
Age	2,507	41	8	0.49	36	40	46
Female	2,511	0.05	0.22	4.20	0.00	0.00	0.00
Market-adjusted weekly stock return	2,659	0.53	5.78	0.37	-2.14	0.09	3.16

Table 2: Market-adjusted weekly stock returns

Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option buys and sells by employees. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Own-company buys and other buys

	Average	N
After own-company call option buys	0.53	2,659
After other call option buys	0.00	2,103
Difference	0.52***	
p-value	0.009	

Panel B: Own-company buys and other sells

	Average	N
After own-company call option buys	0.53	2,659
After other call option sells	-0.10	1,663
Difference	0.64***	
p-value	0.002	

Panel C: Own-company buys and own-company sells

	Average	N
After own-company call option buys	0.62	2,215
After own-company call option sells	-0.08	2,215
Difference	0.70***	
p-value	0.001	

Table 3: Option purchases before earnings announcements

This table examines in detail the stock returns associated with open-market call option purchases that occur in the five days leading up to an earnings announcement. Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following option buys by employees. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

	Average	N
Own-company earnings announcements	2.05	198
Other earnings announcements	-1.49	163
Difference	3.52***	
p-value	0.000	

Table 4: Tipping

The procedure to identify tipping is described in Section 1.4. To compute the relative frequency of tipping, I exclude firms for which I do not have any employment information, as well as periods in which I do not observe any employment relationship for a given firm. Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option purchases by matched accounts. Returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. The null hypothesis is that there are no excess stock returns. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Quantifying tipping

	N	% of all retail accounts/buys
Matched accounts	260	3.6%
No. of option buys	2,684	4.4%

Panel B: Stock returns after matching buys

	Average	N
After matching call option buys	0.80**	915
p-value	0.029	

Panel c: Stock returns after non-matching buys

	Average	N
After non-matching call option buys	0.51***	1,769
p-value	0.003	

Table 5: Availability of own-company options and own-company stock purchases

This table reports the results of two OLS regressions. In Column (1), the unit of analysis is firm-month observations, the dependent variable is the fraction of total retail stock buying volume (based on daily holding balances) represented by employees, and t-statistics are based on standard errors that are clustered at the firm-year level. In Column (2), the unit of analysis is employee-firm-month observations, the dependent variable is an indicator equal to one if the employee buys own-company stocks (and zero otherwise), and t-statistics are based on standard errors that are two-way clustered at the employee and at the firm-month level. In both columns, the main independent variable, defined at the firm-month level, is an indicator equal to one if there are listed options (and zero otherwise). Coefficients are multiplied by 100. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent variables	Employees' fraction of buy volume	Buys stock
	(1)	(2)
Option listed	-0.339**	-0.350*
	(-2.55)	(-1.84)
Month FE	Yes	No
Firm FE	Yes	No
Employee FE	No	Yes
Number of observations	12,359	1,411,378
R-squared	0.075	0.150

Table 6: Economic links

Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market purchases of delta-positive Nokia instruments by non-Nokia employees. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

	Average	N
By employees in customer/supplier firms	0.49	1,328
By employees in other firms	0.12	1,960
Difference	0.36**	
p-value	0.023	

Table 7: Own-company trades in Nokia warrants

This table examines in detail the stock returns associated with open-market warrant purchases made by Nokia employees. Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following warrant buys by Nokia employees. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

	Average	N
Call-like warrants	0.73	1,795
Put-like warrants	-0.25	680
Difference	0.98***	
p-value	0.000	

Table 8: What explains the decision to buy own-company call options?

This table reports the results from two logit regressions investigating the determinants of the decision to purchase own-company call options from the open market. The unit of analysis is employee-firm-month observations. I exclude observations in which own-company options are not listed on the exchange. Column (2) only includes observations in which the employee held stocks one month before the observation date. LTM stands for Last Twelve Months. t-statistics are based on standard errors that are two-way clustered at the employee and at the firm-month level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Table B1.

Dependent variable: Buys option		
	(1)	(2)
Familiarity with options		
No. of own-company option buys in LTM	0.411***	0.435***
	(6.54)	(7.29)
No. of other option buys in LTM	0.020	0.032*
	(0.86)	(1.77)
Familiarity with stocks		
No. of own-company stock buys in LTM	0.025	0.022
	(1.52)	(1.26)
No. of other stock buys in LTM	0.017***	0.017***
	(3.67)	(3.36)
Ln(1 + own-company stock portfolio value)	0.029***	0.025**
	(2.53)	(2.14)
Ln(1 + other stock portfolio value)	0.116***	0.095***
	(8.20)	(5.39)
Psychological factors		
Large losses	0.411***	0.358***
	(3.70)	(3.20)
Large gains	0.117	0.060
	(0.94)	(0.52)
Employee characteristics		
Employee rank	-0.000***	-0.000***
	(-3.20)	(-3.01)
Female	-1.575***	-1.552***
	(-5.92)	(-4.82)
Age	0.152***	0.129**
	(2.66)	(2.09)
Age squared	-0.002***	-0.002***
	(-3.27)	(-2.65)
Number of observations	1,211,725	639,301
Pseudo R-squared	0.175	0.154

Table 9: Financial considerations

This table reports the results from four logit regressions. The unit of analysis is employee-firm-month observations. I only include observations in which own-company options are listed on the exchange and the employee held stocks one month before the observation. *Higher-ranked employees* have *Employee Rank*<= 20, and *Lower-ranked employees* have *Employee rank*> 20. *Controls* include all regressors in Table 8, except *Large losses*. *t*-statistics are based on standard errors that are two-way clustered at the employee and at the firm-month level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: Buys option				
	(1)	(2)	(3)	(4)
Large losses (less than €1,000)	0.120			
	(0.91)			
Large losses (over €1,000)	0.533***			
	(4.11)			
Large losses (No. of own-company option buys in LTM = 0)		-0.233*		
		(-1.66)		
Large losses (No. of own-company option buys in LTM > 0)		2.621***		
		(13.79)		
Large losses (No. of own-company stock buys in LTM = 0)			-0.125	
			(-1.04)	
Large losses (No. of own-company stock buys in LTM > 0)			1.211***	
			(7.86)	
Large losses (Higher-ranked employees)				0.091
				(0.50)
Large losses (Lower-ranked employees)				0.442***
				(3.29)
Controls	Yes	Yes	Yes	Yes
Number of observations	639,301	639,301	639,301	639,301
Pseudo R-squared	0.155	0.184	0.164	0.155

Internet Appendix for: "Insider trading with options"

A Insider trading regulation in Finland

A.1 The 1989 Securities Markets Act

According to the Securities Markets Act (SMA), which came into force in 1989, individuals who gain access to undisclosed information regarding publicly traded securities that is likely to have a material effect on the value of those securities are forbidden from exploiting such information for their own benefit. Similarly, individuals who possess inside information are not allowed to advise others, either directly or indirectly, on using such information for their personal gains in the trading of securities. Insider trading laws in Finland were first enforced in 1993. The penalty for misuse of inside information is a fine or imprisonment of up to two years.

The restriction against the inappropriate use of inside information applies to all investors, while the obligation to disclose share transactions is limited to those individuals explicitly mentioned in the SMA. The disclosure requirement aims to ensure that the public's trust and confidence in the markets remain intact. Under the SMA, everyone can access comprehensive details on insiders' securities trades and, if necessary, can obtain copies of records maintained by companies. The ownership of publicly traded securities in Finnish listed companies and information about insider trade executions must be made public if the owner is any of the following:

- the owner is employed by the issuing company as, for example, managing director, board member, or auditor;
- the owner is employed by a brokerage firm or investment firm and his or her duties include the processing of orders or research work in respect of shares;
- the owner is an employee of the central securities depository Suomen Arvopaperikeskus Oy (now Euroclear Finland Oy) or of the Helsinki Securities and Derivatives Exchange (HEX, now Nasdaq Helsinki);
- the owner is a corporate entity or foundation in which an insider exercises controlling power, either alone or together with another insider;
- or the owner is employed by the Finnish Financial Supervisory Authority.

The SMA has been updated several times over the years. A translated version as of December 2012 (i.e., towards the end of my sample period) is available online.[1]

A.2 Additional regulations for primary insiders

Besides the SMA, trading by primary insiders in Finland is also limited by additional regulations from the Finnish Association of Securities Dealers (FASD, now part of the Federation of Finnish Financial Services), the HEX, and—in some cases—by the employers.

A.2.1 Finnish Association of Securities Dealers

In addition to the above laws against insider trading, Finnish insiders are further restricted in their trading activity by formal guidelines issued by the Finnish Association of Securities Dealers. These guidelines were introduced on March 1, 2000, and have undergone several revisions to comply with financial legislation updates. The guidelines establish a broad prohibition against individuals or entities with access to valuable inside information from passing on such information or from trading based on this information. Additionally, a blackout period of 14 days is imposed on insiders, during which they are not allowed to trade their company's shares before scheduled information releases, such as interim and annual reports.

A.2.2 Helsinki Securities and Derivatives Exchange

In addition, the HEX recommends that permanent insiders should invest in securities issued by the listed company as long-term investments and that they schedule the trading of these securities as close as possible to the moment when the markets have the most accurate about factors affecting the value of the security (e.g., after the disclosure of financial reports). Moreover, according to the Guidelines for Insiders of the HEX, a listed company must define the period, of at least 14 days, during which primary insiders may not trade in own-company stocks or derivatives prior to the publication of an interim

[1] See https://www.finlex.fi/fi/laki/kaannokset/2012/en20120746_20130258.pdf.

report and financial statement bulletin of the company.

A.2.3 Company-specific rules

Apart from the insider trading laws and guidelines described above, most publicly listed companies in Finland have also implemented their own guidelines on internal insider trading, which can be more stringent than those of the Exchange and the FASD. For example, some firms impose blackout periods that exceed the 14-day requirement mandated by the HEX.

A.3 Enforcement

There have been numerous fraud suspicions in Finland over the years. However, enforcement of insider trading regulations has been relatively lax. For instance, in 2013, the Finnish Financial Supervisory Authority turned four investigation requests over to the police, issued two public warnings, and imposed six misdemeanour fines. In the same year, the number of independent enforcement actions by the US Securities and Exchange Commission (covering a much larger market) was 676, of which 132 were delinquent filings.

Rank-and-file employees have been sometimes involved in insider trading cases. For example, in 2005, an employee of a telecommunications company advised a man to invest heavily in his employer before the announcement of its acquisition (the realized profits were around €50,000). The man was sentenced to five months in prison.

B Additional results

Figure B1: Employee rank and holding period

This figure shows how the holding period of own-company options varies with *Employee rank*. For each group of employees, the column shows the percentage of own-company call option buys that are followed by a sale in a given period of time. The line, plotted on the secondary axis, shows the median holding period of own-company options. For each own-company call option buy, only the first sale is considered. I exclude own-company call option buys that are not followed by a sale (i.e., options that are exercised or held until maturity).

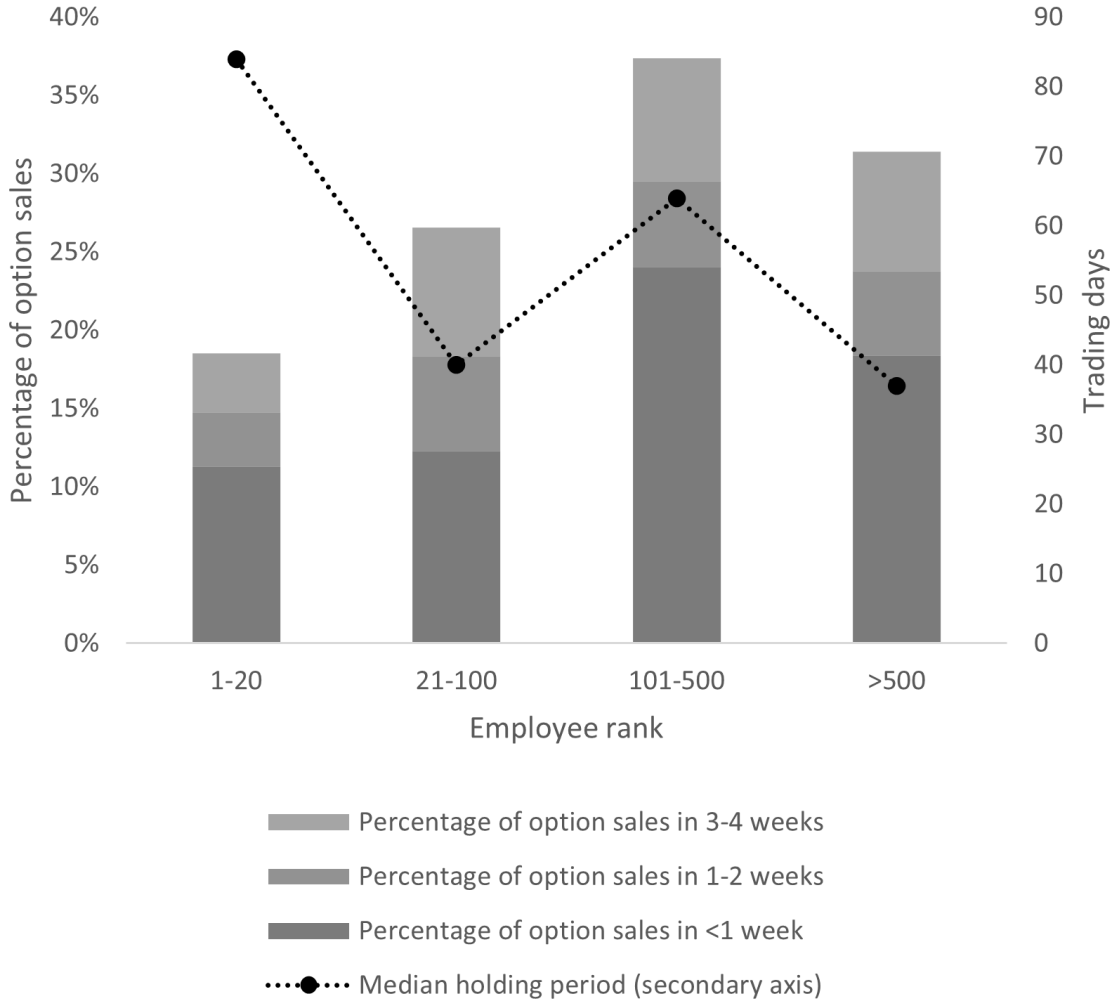

Figure B2: Outperformance over time

This figure shows the difference in weekly market-adjusted stock returns after open-market own-company call option buys and after other open-market call option buys made by employees in four consecutive subsamples. The first call option buy in my sample occurs in 1998. The first subsample includes 108 (21) own-company (other) open-market call option buys. The second subsample includes 1,619 (1,528) own-company (other) open-market call option buys. The third subsample includes 426 (222) own-company (other) open-market call option buys. The fourth subsample includes 506 (332) own-company (other) open-market call option buys. 95% confidence intervals are based on standard errors that are clustered at the stock-trade date level. The confidence interval in the first subsample, identified using relatively few observations, is not displayed to avoid cluttering the figure.

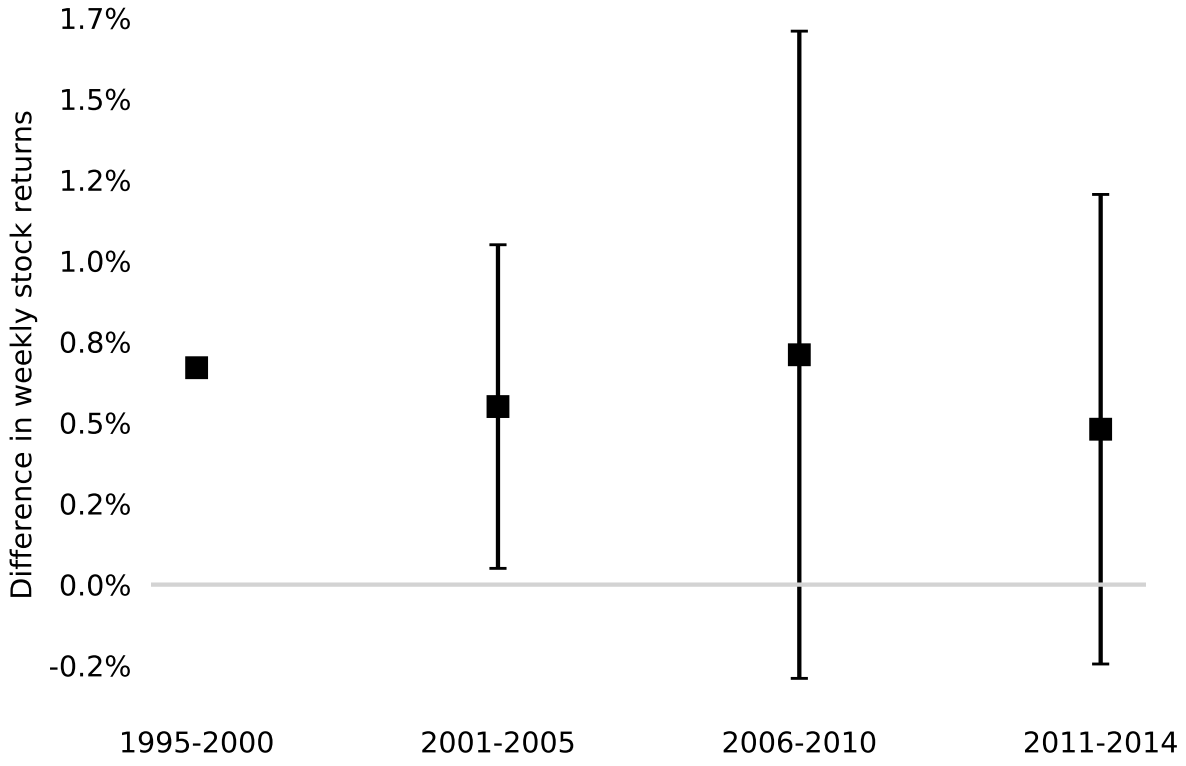

Table B1: Variable definitions and other nomenclature
This table reports the definitions of the main variables used in this paper.

Age	The age of the grantee at the time of the observation.
Age squared	The square of *Age*.
Buys stock	An indicator variable equal to one if the employee buys own-company stocks in a given month, and zero otherwise.
Employee rank	The best (i.e., lowest) within-series rank obtained by employee i in firm j. The employee receiving the most ESOs in a given series is assigned a value of 1. A lower (higher) value indicates that the employee received more (less) ESOs.
Employee's fraction of buy volume	The fraction of total retail stock buying volume (based on daily holding balances) represented by employees.
Female	An indicator variable equal to one if the individual is a female, and zero otherwise.
Large gains	An indicator variable equal to one if the portfolio held by an employee one month ago has increased in value by 5% or more, and zero otherwise.
Large losses	An indicator variable equal to one if the portfolio held by an employee one month ago has decreased in value by 5% or more, and zero otherwise.
Ln(1 + other stock portfolio value)	The natural logarithm of one plus the market value of all direct investments in non-employer shares.
Ln(1 + own-company stock portfolio value)	The natural logarithm of one plus the market value of all direct investments in own-company shares.
Market-adjusted stock returns	Raw returns for stock j between time t and time $t+n$, net of market (OMX Helsinki All Share Index) returns for the same period.
No. of other option (stock) buys in LTM	The number of non-employer options (stocks) bought on the open market by the individual in the twelve months before the time of the observation.
No. of own-company option (stock) buys in LTM	The number of own-company options (stocks) bought on the open market by the individual in the twelve months before the time of the observation.
Option listed	An indicator variable equal to one if if there are listed options on that stock in a given month, and zero otherwise.
Returns after other call option buys	Returns for stock j in the n days following the purchase of non-employer options on the open market.
Returns after other call option sells	Returns for stock j in the n days following the sale of non-employer options on the open market.
Returns after own-company call option buys	Returns for stock j in the n days following the purchase of own-company options on the open market.
Returns after own-company call option sells	Returns for stock j in the n days following the sale of own-company options on the open market.
Trading days until first sale	The number of trading days between the purchase of the asset on the open market and its sale.
Value of the option purchase	The number of options bought by employee i in day t, times the closing price of the option in day t.

Table B2: Distribution of open-market own-company call option buys

This table shows the distribution of open-market own-company call option buys. *Own-company call option buys* identifies the range of distinct purchases made by each employee. The table enumerates the number of investors in each range (and the corresponding percentage) under the column *Total investors*, and shows the total number of transactions made in the respective categories (and the corresponding percentage) under *Total trades*.

Own-company call option buys	Total investors		Total trades	
	N	%	N	%
1	369	50%	369	14%
2-5	268	36%	779	29%
6-10	60	8%	468	18%
11-20	25	3%	392	15%
>20	16	2%	651	24%
Total	738	100%	2,659	100%

Table B3: Own-company trading in options and stocks

Panel A summarizes the number of accounts that made at least one open-market purchase of options and/or of the underlying stocks between 1995 and 2014. Panel B summarizes the number of open-market purchases (at the investor-security-trade date level) of options and of underlying stocks between 1995 and 2014. I exclude firms for which I do not have any employment information. I also exclude periods in which I do not observe any employment relationship for a given firm.

Panel A: By account

	Options		Stocks	
	N	%	N	%
All retail traders	7,262	100.0%	369,528	100.0%
- Of which current employees	738	10.2%	5,954	1.6%

Panel B: By trade

	Options		Stocks	
	N	%	N	%
All retail buys	61,387	100.0%	4,810,471	100.0%
- Of which by current employees	2,659	4.3%	21,197	0.4%

Table B4: Own-company trading in options and stocks - Robustness

Panel A summarizes the number of accounts that made at least one open-market purchase of options and/or of the underlying stocks between 1995 and 2014. Panel B summarizes the number of open-market purchases (at the investor-security-trade date level) of options and of underlying stocks between 1995 and 2014. I exclude firms for which I do not have any employment information. I include periods in which I do not observe any employment relationship for a given firm.

Panel A: By account

	Options		Stocks	
	N	%	N	%
All retail traders	8,922	100.0%	522,950	100.0%
- Of which current employees	738	8.3%	5,954	1.1%

Panel B: By trade

	Options		Stocks	
	N	%	N	%
All retail buys	94,613	100.0%	12,466,891	100.0%
- Of which by current employees	2,659	2.8%	21,197	0.2%

Table B5: Options vs. stocks

This table compares weekly market-adjusted stock returns following open-market own-company call option buys and own-company stock buys. The sample consists of employees' purchases of own-company options and of own-company stocks. *Own-company stock buy indicator* is an indicator equal to one if the employee bought own-company stocks, and zero if she bought own-company options. All returns and differences between returns are multiplied by 100. t-statistics are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: Weekly market-adjusted stock returns		
	(1)	(2)
Own-company stock buy indicator	-0.017	0.200
	(-0.16)	(0.58)
Firm-year FE	Yes	No
Employee-year FE	No	Yes
Number of observations	23,742	17,904
R-squared	0.049	0.286

Table B6: Tipping - Robustness

The procedure to identify tipping is described in Section 1.4. Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option purchases by matched accounts. All returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. The null hypothesis is that there are no excess stock returns. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: $k = 3$ and $p = 0.1$

Matched accounts	120
No. of matching option buys	564
Average stock returns after matching buys	0.75*
p-value	0.090
No. of non-matching option buys	1,264
Average stock returns after non-matching buys	0.55***
p-value	0.005

Panel B: $k = 3$ and $p = 0.25$

Matched accounts	55
No. of matching option buys	225
Average stock returns after matching buys	0.95*
p-value	0.097
No. of non-matching option buys	231
Average stock returns after non-matching buys	0.66*
p-value	0.098

Panel C: $k = 5$ and $p = 0.25$

Matched accounts	13
No. of matching option buys	82
Average stock returns after matching buys	1.07
p-value	0.148
No. of non-matching option buys	95
Average stock returns after non-matching buys	0.97*
p-value	0.059

Table B7: Economic links - Option and warrant buys by non-Nokia employees

Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option and warrant buys by non-Nokia employees. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Purchases of Nokia call options

	Average	N
By employees in customer/supplier firms	0.16	143
By employees in other firms	-0.51	173
Difference	0.68	
p-value	0.134	

Panel B: Purchases of Nokia call-like warrants

	Average	N
By employees in customer/supplier firms	0.52	1,185
By employees in other firms	0.18	1,787
Difference	0.34**	
p-value	0.049	

Table B8: Economic links vs. industry knowledge

This table compares weekly market-adjusted stock returns following open-market call option buys by employees in the Nokia cluster. The sample is restricted to trades on options written on stocks of firms that are part of the Nokia cluster. I exclude own-company trades as well as trades by Nokia employees. *Direct economic link* is an indicator equal to one if the employee trades options on her employer's supplier or customer, and zero otherwise. All returns and differences between returns are multiplied by 100. *t*-statistics are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: Weekly market-adjusted stock returns			
	(1)	(2)	(3)
Direct economic link	0.704	2.151	3.932**
	(0.76)	(1.39)	(2.07)
Employee FE	No	Yes	No
Employee-year FE	No	No	Yes
Number of observations	236	220	207
R-squared	0.003	0.257	0.264

Table B9: Own-company trading in warrants and stocks

Panel A summarizes the number of accounts that made at least one open-market purchase of Nokia warrants and/or stocks between December 8, 2000 and January 2, 2004. Panel B summarizes the number of open-market purchases (at the investor-security-trade date level) of Nokia warrants and stocks in the same period.

Panel A: By account

	Warrants		Stocks	
	N	%	N	%
All retail traders	3,983	100.0%	87,183	100.0%
- Of which current employees	202	5.1%	1,925	2.2%

Panel B: By trade

	Warrants		Stocks	
	N	%	N	%
All retail buys	62,464	100.0%	431,181	100.0%
- Of which by current employees	2,475	4.0%	8,619	2.0%

Table B10: Rare events logistic regressions

This table reports the results from rare events logistic regressions investigating the determinants of the decision to purchase own-company call options from the open market. The unit of analysis is employee-firm-month observations. I exclude observations in which own-company options are not listed on the exchange. Column (2) only includes observations in which the employee held stocks one month before the observation date. LTM stands for Last Twelve Months. t-statistics are based on standard errors that are clustered by employee. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: Buys option		
	(1)	(2)
Familiarity with options		
No. of own-company option buys in LTM	0.411***	0.434***
	(6.71)	(7.55)
No. of other option buys in LTM	0.021	0.033*
	(0.97)	(1.86)
Familiarity with stocks		
No. of own-company stock buys in LTM	0.026	0.023
	(1.59)	(1.31)
No. of other stock buys in LTM	0.017***	0.017***
	(3.69)	(3.38)
Ln(1 + own-company stock portfolio value)	0.029***	0.025**
	(2.68)	(2.27)
Ln(1 + other stock portfolio value)	0.116***	0.095***
	(9.09)	(5.70)
Psychological factors		
Large losses	0.411***	0.358***
	(5.35)	(3.20)
Large gains	0.118	0.060
	(1.42)	(0.52)
Employee characteristics		
Employee rank	-0.000***	-0.000***
	(-5.57)	(-5.23)
Female	-1.567***	-1.545***
	(-5.59)	(-4.84)
Age	0.150***	0.128**
	(3.13)	(2.45)
Age squared	-0.002***	-0.002***
	(-3.78)	(-3.06)
Number of observations	1,211,725	639,301

Table B11: Individual characteristics and informed option trading

This table examines whether the informativeness of open-market own-company call option buys varies with a number of employee characteristics. The unit of analysis is an own-company call option buy. Information on gender is missing for some employees, who are excluded from the analyses in Columns (9) and (10). Differences between returns are multiplied by 100. *t*-statistics are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Dependent variable: Weekly market-adjusted stock returns										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
No. of own-company option buys in LTM	-0.009									-0.001
	(-0.58)									(-0.03)
No. of other option buys in LTM		-0.019								-0.025*
		(-1.43)								(-1.68)
No. of own-company stock buys in LTM			-0.009							-0.016
			(-0.79)							(-1.20)
No. of other stock buys in LTM				0.006						0.009*
				(1.42)						(1.84)
Ln(1 + own-company stock portfolio value)					-0.027					-0.016
					(-1.14)					(-0.56)
Ln(1 + other stock portfolio value)						0.004				-0.013
						(0.17)				(-0.42)
Large losses							-0.072			-0.177
							(-0.22)			(-0.49)
Large gains								-0.258		-0.208
								(-0.77)		(-0.57)
Female									-0.049	-0.143
									(-0.08)	(-0.22)
Number of observations	2,659	2,659	2,659	2,659	2,659	2,659	2,659	2,659	2,511	2,511
R-squared	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.002

Table B12: Market-adjusted weekly stock returns - Trades by ex-employees

Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option buys and sells by former and potential employees. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Own-company buys and other buys

	Average	N
After own-company call option buys	-0.14	5,654
After other call option buys	-0.18	9,526
Difference	0.04	
p-value	0.635	

Panel B: Own-company buys and other sells

	Average	N
After own-company call option buys	-0.14	5,654
After other call option sells	-0.10	8,069
Difference	-0.04	
p-value	0.659	

Panel C: Own-company buys and own-company sells

	Average	N
After own-company call option buys	-0.06	4,828
After own-company call option sells	-0.12	4,828
Difference	0.06	
p-value	0.467	

Table B13: Three-factor moddel

Excess returns are calculated for a horizon of 1 week (5 trading days) following open-market option buys and sells by employees. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Own-company buys and other buys

	Average	N
After own-company call option buys	0.70	2,646
After other call option buys	0.26	2,097
Difference	0.44**	
p-value	0.044	

Panel B: Own-company buys and other sells

	Average	N
After own-company call option buys	0.70	2,646
After other call option sells	0.13	1,660
Difference	0.56**	
p-value	0.014	

Panel C: Own-company buys and own-company sells

	Average	N
After own-company call option buys	0.78	2,202
After own-company call option sells	0.27	2,202
Difference	0.51**	
p-value	0.022	

Table B14: Market-adjusted monthly stock returns

Market-adjusted stock returns are calculated for a horizon of 1 month (21 trading days) following open-market option buys and sells by employees in my sample. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Own-company buys and other buys

	Average	N
After own-company call option buys	0.71	2,658
After other call option buys	-0.29	2,103
Difference	1.01***	
p-value	0.004	

Panel B: Own-company buys and other sells

	Average	N
After own-company call option buys	0.71	2,658
After other call option sells	0.14	1,663
Difference	0.58*	
p-value	0.096	

Panel C: Own-company buys and own-company sells

	Average	N
After own-company call option buys	0.99	2,213
After own-company call option sells	0.59	2,213
Difference	0.40	
p-value	0.195	

Table B15: Market-adjusted weekly stock returns - Excluding Nokia

Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option buys and sells by employees in my sample. Trades in Nokia options are excluded. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Own-company buys and other buys

	Average	N
After own-company call option buys	0.60	1,845
After other call option buys	0.05	1,787
Difference	0.56**	
p-value	0.023	

Panel B: Own-company buys and other sells

	Average	N
After own-company call option buys	0.60	1,845
After other call option sells	-0.09	1,434
Difference	0.70***	
p-value	0.006	

Panel C: Own-company buys and own-company sells

	Average	N
After own-company call option buys	0.69	1,500
After own-company call option sells	0.36	1,500
Difference	0.32	
p-value	0.224	

Table B16: Market-adjusted weekly stock returns - Excluding the most active own-company call option buyers

Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option buys and sells by employees in my sample. Trades made by the 100 most active own-company option buyers are excluded. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Own-company buys and other buys

	Average	N
After own-company call option buys	0.67	1,154
After other call option buys	0.05	1,509
Difference	0.61**	
p-value	0.027	

Panel B: Own-company buys and other sells

	Average	N
After own-company call option buys	0.67	1,154
After other call option sells	-0.09	1,111
Difference	0.76***	
p-value	0.009	

Panel C: Own-company buys and own-company sells

	Average	N
After own-company call option buys	0.86	857
After own-company call option sells	0.03	857
Difference	0.83**	
p-value	0.014	

Table B17: Market-adjusted weekly stock returns - Excluding small trades

Market-adjusted stock returns are calculated for a horizon of 1 week (5 trading days) following open-market option buys and sells by employees in my sample. Trades with a value below €1,000 are excluded. All returns and differences between returns are multiplied by 100. p-values are based on standard errors that are clustered at the stock-trade date level. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively (two-sided test).

Panel A: Own-company buys and other buys

	Average	N
After own-company call option buys	0.48	1,714
After other call option buys	-0.06	1,287
Difference	0.54**	
p-value	0.019	

Panel B: Own-company buys and other sells

	Average	N
After own-company call option buys	0.48	1,714
After other call option sells	0.07	1,090
Difference	0.41*	
p-value	0.082	

Panel C: Own-company buys and own-company sells

	Average	N
After own-company call option buys	0.50	1,494
After own-company call option sells	-0.20	1,494
Difference	0.70***	
p-value	0.002	