Diversification at Work: Evidence from Employee Stock Options

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Abstract

Using a unique data set from Finland, this study examines how portfolio considerations influence the decisions of employee stock option (ESO) grantees. I find that employees who are less exposed to employer-specific risk due to their investments in other companies tend to hold their ESOs longer than other employees. This behavior is especially pronounced when employer-specific risk is harder to diversify. Employees' decisions are also affected by exogenous changes in stock market participation that make investments in other companies more salient. Overall, my findings support the long-standing hypothesis that diversification concerns play an important role in the exercise of ESOs.

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Diversification motives have long been thought to play a central role in shaping the exercise of employee stock options (ESOs). Intuitively, risk-averse employees who are less wealthy and more exposed to employer-specific risk would greatly benefit from diversifying early by disposing of their option position, whereas employees who are wealthier and hold more diversified portfolios would benefit less.[1] However, empirical evidence of these dynamics is scarce and the importance of diversification motives has been recently questioned.[2]

In this paper, I show that outside wealth shapes the decisions of ESO grantees. I use a unique data set from Finland, which covers over 40,000 individuals working in 85 publicly traded firms and participating in 628 executive and employee stock option plans between 1995 and 2014. I observe each grantee's option and directly held stock holdings and daily changes in these holdings. Throughout the paper, I measure outside wealth using the market value of direct stock holdings in non-employer firms (hereafter referred to as outside stock wealth). Directly held stocks represent an important component of wealth, measured both at a high frequency and at the individual level.[3] These granular data allow me to examine how portfolio considerations shape the behavior of ESO grantees.

Figure 1 illustrates my main result: it charts the fraction of available options that an employee disposes of in a given month, relative to coworkers who began the month with an identical number of ESOs. The data reveal a negative correlation between outside stock wealth and the probability of option disposal. The difference between the lowest and the highest groups exceeds one-eighth of the unconditional mean of my dependent variable (2.3%).

My results hold when including option series fixed effects, which eliminate all time-

[1] See, among others, Carpenter (1998), Detemple and Sundaresan (1999), Hall and Murphy (2002), Huddart (1994), Kulatilaka and Marcus (1994), and Lambert, Larcker, and Verrecchia (1991).

[2] For example, Fos and Jiang (2015) find "mixed" empirical support for diversification motives. The results in Heron and Lie (2017) are "inconsistent with diversification being a major reason for the exercises." Murphy and Vance (2019) argue that "exercise decisions are driven not by diversification motives but rather by liquidity."

[3] As of 2004, in the middle of my sample, directly held stocks were the largest risky asset class in Finland and accounted for over 40% of all risky assets held by households. Most investors who owned stocks did not invest in mutual funds. The average value of all (risky and risk-free) liquid financial assets was approximately €18,500 per Finnish resident (for additional details, see Keloharju, Knüpfer, and Rantapuska, 2012).

invariant characteristics of the firm (e.g., industry, company culture) and of the option series (e.g., strike price, vesting schedule, number and type of employees who receive options). Moreover, my results are robust to the inclusion of firm-month-grantee zip code fixed effects. This specification effectively restricts the analysis to coworkers who are exposed to similar firm-level shocks (e.g., stock performance, company news) and local shocks (e.g., change in house prices) in a given month.

Figure 1 hints that the behavior of ESO grantees is associated with whether or not they invest in other listed firms (extensive margin of outside stock wealth). To further explore the intensive margin, I repeat my analyses on the subset of observations in which employees own shares in other listed companies. As most Finnish investors with direct stock holdings refrain from investing in mutual funds during my sample period, this analysis helps isolate the effect of outside wealth by comparing employees who differ in the value of their direct stock holdings and are unlikely to hold other risky financial assets. I find that outside stock wealth is an important predictor of the decisions of ESO grantees also in this subsample. The estimated coefficients of interest are in line with or even larger than estimates in the full sample.

Next, I delve into the importance of *perceived* diversification. To unpack this underlying mechanism, I complement my main results with an instrumental variable (IV) analysis. Specifically, I exploit the conversion of customer-owned mutual companies into publicly listed firms as an exogenous shock to the probability of owning listed stocks in non-employer firms. These demutualizations represent a positive shock to stock market participation and in particular to the salience of owning outside stocks (Kaustia, Knüpfer, and Torstila, 2016), but they do not constitute a wealth shock. My results indicate that an exogenous increase in the salience of outside stock wealth leads employees to hold onto their options for longer, underscoring how salient components of outside wealth affect the decisions of ESO grantees.

In Finland, as opposed to the United States, ESOs can be sold to other investors and are frequently listed on an exchange. The majority of employees prefer selling their ESOs rather

than exercising them. In an efficient and frictionless market, risk-averse employees would find it optimal to sell their ESOs at the Black-Scholes value as soon as possible. However, most grantees in my sample retain their options for extended periods. This behavior could be explained by a combination of factors, such as procrastination, low liquidity, adverse selection, and the notable fact that listed ESOs in Finland often trade at a significant discount to their Black-Scholes value, especially when far from their maturity (Ikäheimo, Kuosa, and Puttonen, 2006).

How do these factors affect the decisions of employees? Do diversification motives matter in the case of transferable ESOs? To address these questions, I introduce a stylized model and discuss two illustrative scenarios in which selling the options early is not necessarily optimal, especially for wealthier employees. The model also shows that the transferability of ESOs mitigates the traditional trade-off between exercising early (to diversify employer-specific risk) and leaving the options alive (to benefit from the upside potential in stock prices). Thus, my estimates represent a credible *lower bound* to the effect of outside investments on the exercise of non-transferable ESOs. To corroborate this lower bound thesis, I exploit two distinctive features of the institutional setting.

First, approximately 5% of the ESOs in my sample are transferable but not listed on the exchange. Capitalizing on this unique source of variation, I show that the effect of outside stock wealth intensifies when the options are unlisted and thus harder to diversify. Panel A of Figure 2 provides some preliminary backing for this thesis, juxtaposing the probability of option disposal based on its listing status. In both subsamples, outside investors (i.e., grantees who hold outside stocks) exhibit a reduced inclination to dispose of their option positions compared to their counterparts without such investments. However, among wealthier outside investors, this effect is even more pronounced when the options are unlisted.

Second, a majority of the ESOs in my sample are listed on an exchange, and there is a high degree of heterogeneity in how often they are traded on the market. Options traded

less frequently tend to be more challenging and expensive to sell (i.e., they are more similar to traditional ESOs). Indeed, my results suggest that the effect of outside stock wealth is amplified for less liquid options. Panel B of Figure 2 shows some initial evidence in support of this hypothesis.

Next, I turn my attention to employee-rank effects. As highlighted by Carpenter, Stanton, and Wallace (2019), the decisions of higher-ranked employees could be fundamentally different from those of lower-ranked employees. Thus, it is important to test whether portfolio structure affects the decisions of both groups. My results indicate that outside stock wealth plays an important role for both higher-ranked and lower-ranked employees.

My large data set also allows me to control for unobserved heterogeneity by including employee fixed effects. This analysis effectively controls for all time-invariant individual characteristics, in addition to firm-level and local shocks. Notably, the effect of outside stock wealth remains negative and statistically significant at conventional levels. On the contrary, the effect of company stock wealth (i.e. investments in employer's shares) becomes positive and insignificant, further underscoring the importance of diversification motives. Finally, I show that alternative channels—such as liquidity needs and the dispersion of ESO discounts—are not driving the relationship between outside stock wealth and the decisions of ESO grantees.

This paper contributes to the literature studying the behavior of ESO grantees. In particular, a number of theoretical frameworks assume that exercise decisions are driven by the diversification motives of risk-averse employees.[4] However, data limitations have often prevented researchers from examining empirically the role of outside wealth. My empirical analysis complements this large body of theoretical work by showing that portfolio considerations help explain the decisions of ESO grantees.

Furthermore, as shown in Table 1, a number of recent papers examine the decisions of

[4]See, for example, Hall and Murphy (2003) for a review of this literature.

ESO grantees based on option, stock, and employee characteristics. The literature can be divided into two broad camps: studies that find evidence that is consistent with the existence of diversification motives (e.g., Carpenter et al., 2019; Hemmer, Matsunaga, and Shevlin, 1996) and those that do not (e.g., Fos and Jiang, 2015; Heron and Lie, 2017; Klein and Maug, 2020).[5] The article most closely related to mine is that of Murphy and Vance (2019), who leverage monthly fluctuations in median home values across different zip codes to argue that early exercise is primarily driven by liquidity motives. My paper differs from previous work in two important ways. First, rather than assessing the relative importance of various channels, I provide direct empirical evidence corroborating the existence of diversification motives. Second, I employ a unique data set to show how grantee behavior is shaped by an important and salient component of outside wealth measured at the *individual* level.

My work is also related to a stream of papers examining the causes and consequences of portfolio diversification. Lack of diversification is a common investment mistake and misconceptions about the benefits of diversification are quite common (Goetzmann and Kumar, 2008; Reinholtz, Fernbach, and De Langhe, 2021). Accordingly, households that diversify their exposure to financial markets tend to trade less and are more financially literate (Anderson, 2013; Von Gaudecker, 2015). In this paper, I show that reducing employer-specific risk by investing in other firms can benefit employees by removing some of the constraints that traditionally lead to early exercise, thus potentially allowing workers to extract more value from their compensation packages.

Finally, my paper contributes to a growing literature studying how salience affects the behavior of economic agents. Grounded in theoretical models of bounded rationality and costly information acquisition (Caplin and Dean, 2015), recent work shows that salience affects consumer behaviors and investment choices (see, among others, Frydman and Wang,

[5]While most previous papers control for one or more measures of employer-related wealth, it is difficult to test for the existence of diversification motives using these measures. In fact, as highlighted by Carpenter et al. (2019), employer-related wealth increases demand for hedging through early exercise, but higher wealth also decreases the relative importance of diversification motives. A separate stream of papers examines the relationships between CEO wealth, CEO compensation, and firm value (e.g., Becker, 2006; Colonnello, Curatola, and Xia, 2022).

2020; Taubinsky and Rees-Jones, 2018). In particular, the salience of one's participation in financial markets has been linked to changes in political attitudes (Jha and Shayo, 2019; Kaustia et al., 2016). My results show that the salience of employees' investments in other companies affects their financial decisions.

1 Institutional Setting and Data

1.1 Institutional Setting

The introduction of executive stock options in Finland dates back to 1988. Since then, ESOs have become an important component of corporate compensation. Already in 2001, over 80% of listed companies had issued one or more series of ESOs (Ikäheimo et al., 2006). Some option series are targeted exclusively at company executives, and some to both executives and rank-and-file employees.

A distinctive characteristic of the institutional setting is that ESOs are transferable and often listed on the stock exchange. The listing of ESOs is generally motivated by tax considerations, and is decided by the board of directors and announced with a public stock exchange release.[6]

1.2 Data

To the best of my knowledge, the data set used in this paper is the first to cover *both* the decisions of ESO grantees and information about an important component of outside wealth that is measured at the individual level. The data come from two distinct sources. First, daily holdings and changes in the holdings of both stocks and options listed in Finland from 1995 to 2014 are from Euroclear Finland.[7] Second, information on the characteristics of hundreds of employee and executive stock option plans issued in Finland between 1995 and

[6]See, for example, Ikäheimo et al. (2006) and Liljeblom, Pasternack, and Rosenberg (2011) for further discussions of the institutional setting.

[7]See Grinblatt and Keloharju (2000) for a more detailed review of these data.

2014 is from Alexander Incentives. Data from the two sources are primarily matched based on the year and on the names of the issuer and of the plan.[8]

I follow Keloharju and Lehtinen (2018) and exclude the following employee stock options plans: synthetic plans, plans by unlisted firms, plans that cannot be matched unambiguously, plans allocated abroad or to institutions, as well as unallocated plans. I also exclude some option series that are difficult to follow over time because of M&A events.[9] Moreover, as individuals are approximately risk neutral when stakes are relatively small (Arrow, 1971), I focus on economically meaningful ESOs by narrowing the sample to grants that have a Black-Scholes value of at least €100 at the time of vesting and, among direct stockholders, that are worth at least 0.1% of the employee's stock portfolio. Table 2 shows summary statistics on the 628 option series included in my sample.[10] The table highlights five characteristics of the data. First, there is important heterogeneity in the number of individuals in a given option series. This occurs because the sample includes both plans targeted at top managers and at employees at large. Second, most options can be exercised or sold for approximately two to five years. Third, the average grantee holds onto her vested ESOs for well over two years. Fourth, most grantees part from their options by selling rather than exercising them. Fifth, many grantees keep their options until they expire worthless.[11]

[8]See Keloharju and Lehtinen (2018) for a more complete review of the original data set, of the nomenclature, of the institutional setting, and for a number of descriptive statistics.

[9]The most prominent example is the 2002 merger between Telia and Sonera.

[10]Recent work examines the exercise decisions of employees across 5 (Murphy and Vance, 2019) to 88 firms (Carpenter et al., 2019). My sample covers 85 publicly traded firms.

[11]This is hardly surprising, as both Finnish households and US employees have been documented to leave some money on the table (Babenko and Sen, 2014; Rantapuska and Knüpfer, 2008). Moreover, some employees may struggle to understand that out-of-the-money options still have some value (Babenko and Sen, 2014).

2 Theoretical Framework

2.1 Stylized Model

Before describing my empirical strategy, I illustrate the theoretical importance of outside wealth with a simple stylized model inspired by the work of Huddart (1994), Kulatilaka and Marcus (1994), and Carpenter (1998). Extant models generally agree that as a risk-averse employee's outside wealth grows, her exercise policy will increasingly mirror that of a risk-neutral employee. I extend these models by also considering the case of transferable ESOs. Within this framework, I discuss two illustrative instances where selling the option early is not always optimal and diversification motives affect the decisions of the representative employee. The model also shows that the transferability of the ESOs attenuates the effect of outside wealth.

Consider a standard two-period binomial model (Cox, Ross, and Rubinstein, 1979). The initial stock price in $t = 0$ is \$100. At every node of the tree, the stock price moves up by $r\%$ with exogenous probability p or down by $r\%$ with probability $1 - p$. The representative employee has only two sources of wealth: a single ESO with a strike price equal to the initial stock price, and other financial wealth $W_0 > 0$ that is invested in assets that pay the risk-free rate. The ESO vests in $t = 1$ and expires in $t = 2$. The employee aims at maximizing her expected utility of wealth at the maturity of the option and exhibits constant relative risk aversion with $\gamma = 1$ and a logarithmic utility function for wealth W, i.e., $U(W) = ln(W)$.

Assume, for simplicity, that no taxes are imposed on the option, the risk-free rate is zero, $r = 30\%$ and $p = \frac{1}{2}$ (i.e., the stock has zero expected excess returns, so that the risk-free rate can be interpreted as the return on the market portfolio in an economy without systematic risk).[12] Then, Panel A of Figure A1 shows the evolution of the stock price over the two time periods. The nodes are uniquely identified by letters A–F.

[12] In the presence of systematic risk in the economy, a stock's expected return will be higher than that of a riskless asset. The general pattern of the employee's optimal exercise strategy remains consistent with the strategy documented here.

I now examine the employee's decision in the case of non-transferable and transferable ESOs. The examples described below are simply used to illustrate the mechanism through which outside investments affect the decisions of ESO grantees. Hall and Murphy (2002), among others, provide more detailed numerical estimates.

2.2 The Case of Non-transferable ESOs

Let us first consider the case of non-transferable employee stock options, which are a standard component of corporate compensation in the United States and in many other countries. In this setting, exercising early causes the employee to give up the time value of the option. Therefore, she benefits only from the intrinsic value of the ESO, which is reported in Panel B of Figure A1.

In my example, early exercise can only occur in node B. At this node, the employee can decide to exercise early and give up the time value of the options. She exercises early if $U(W_0+\$30) \geq \frac{1}{2}U(W_0)+\frac{1}{2}U(W_0+\$69)$. In general, diversification motives for early exercise arise because of the employee's risk aversion and of her exposure to company-specific risk. In my simple framework, the utility function is CRRA with $\gamma = 1$, so that the optimal decision of the employee is determined by her level of outside wealth W_0. Early exercise is the optimal choice when $W_0 \leq \$100 \stackrel{\text{def}}{=} W'$.

2.3 The Case of Transferable ESOs

Employee stock options in Finland are transferable and often listed on the exchange. This transferability alters the trade-off faced by the employee. In Panel C of Figure A1, I show the option value at different nodes, computed using a simple binomial option pricing model. Intuitively, in an efficient and frictionless market, the employee would find it optimal to sell her option early. In fact, in node B, the employee sells her option if $U(W_0 + \$34.5) > \frac{1}{2}U(W_0) + \frac{1}{2}U(W_0 + \$69)$, which holds for all positive wealth levels.

However, empirical evidence from Ikäheimo et al. (2006) shows that ESOs in Finland

trade well below their Black-Scholes values (average discount of 14.8%), especially when far away from maturity. As discussed below (in Section 4.3), various factors, such as illiquidity and adverse selection, may contribute to this underpricing. To model this underpricing, let $V_t(1-\delta)$ be the market value of the option at time t, where V is the option value from the binomial model and $\delta \in (0,1)$ represents the discount. For $\delta = 0.1$, the employee sells her option in node B if $U(W_0 + \$34.5(1-0.1)) \geq \frac{1}{2}U(W_0) + \frac{1}{2}U(W_0 + \$69)$. The inequality holds for $W_0 \leq \$140 \stackrel{\text{def}}{=} W''$.

Furthermore, even in the absence of underpricing, the employee could find it optimal not to sell her transferable ESO as soon as possible. For example, present-biased preferences often result in procrastination, especially when actions require some effort. In a seminal paper, O'Donoghue and Rabin (1999) show that agents delay doing unpleasant tasks that they themselves wish they would do sooner. More recently, Bisin and Hyndman (2020) show that delaying may represent an optimal strategy in an environment in which the cost of effort evolves over time.[13] For example, let us assume that acting early implies a random extra cost $c \sim \mathcal{U}(1,3)$ so that $E[c] = \$2$. Then, the employee acts early only if $U(W_0 + \$34.5 - \$2) \geq \frac{1}{2}U(W_0) + \frac{1}{2}U(W_0 + \$69)$, i.e., if $W_0 \leq \$264 \stackrel{\text{def}}{=} W'''$.

The examples described above highlight that outside wealth can be important also when grantees receive transferable options. Moreover, the transferability of ESOs removes part of the traditional trade-off between exercising early and leaving the options alive. In the case of transferable ESOs, outside wealth has to be relatively larger to induce the employee to hold onto her option (i.e., $W' < W'' < W'''$). The transferability of the option thus attenuates the effect of outside wealth.

[13] Empirical evidence suggests the present bias is widespread and has economically important consequences (Bai, Handel, Miguel, and Rao, 2021; Mahajan, Michel, and Tarozzi, 2020).

3 Methods

I build my data set at the investor-grant-month level. I have over 3.3 million observations which are associated with 124,354 option grants, 42,739 employees, 628 option series, and 85 firms. Below, I describe my empirical strategy.

3.1 OLS Framework

The main specification is:

$$Y_{i,j,t} = \alpha + \beta Ln(OutsideStockWealth)_{i,j,t-1} + \gamma Controls_{i,j,t-1} + \epsilon_{i,j,t}, \quad (1)$$

where the dependent variable $Y_{i,j,t}$ is the fraction of available (i.e., vested and/or listed) ESOs of series j that grantee i exercises or sells in month t. Generally, the dependent variable is multiplied by 100, so that the coefficients can be interpreted as percentage point changes. The choice of the dependent variable is consistent with previous papers (e.g., Carpenter et al., 2019; Izhakian and Yermack, 2017; Murphy and Vance, 2019), which generally use options exercised as a fraction of options available to exercise as the outcome of interest. Table 3 shows that, on average, 2.3% of available ESOs are exercised or sold in a given month by the grantees.[14]

The central aim of this paper is to examine how outside wealth shapes the behavior of ESO grantees. My proxy for outside wealth is the market value of direct stock holdings in non-employer firms. Specifically, my main independent variable of interest is the logarithm of outside stock wealth (plus one). Directly held stocks represent an important component of wealth: as of 2004, Finnish households owned stocks worth €18 billion, more than double their total investments in mutual funds (€8 billion). Table 3 shows that the average grantee holds 1.47 outside stocks worth €21,555. However, there is great heterogeneity in these outside investments, as grantees own outside stocks only in 41.7% of the observations.

[14]Table A1 reports the definitions of the main variables used in this paper.

Investments in own-company shares are also not common and display a fat right tail: this pattern is likely a result of implicit or explicit clauses in the employment contracts of certain executives (Core and Larcker, 2002).

My measure of outside stock wealth varies at a high frequency and at the individual level. To take advantage of this unique feature, my empirical strategy exploits linear regressions, enabling me to include a number of granular fixed effects to isolate the effect of changes in wealth levels and use an instrumental variable approach.[15] Throughout the paper, I exclude singleton observations (i.e., fixed effect groups with only one observation in the available sample) to avoid biased standard errors (Correia, 2015). Standard errors are two-way clustered at the employee-month and at the option series-month level. Two-way clustering helps me to take into account the correlation in monthly ESO exercises and sales at the individual level (across different grants) and at the option series level (across different individuals).[16]

3.2 Control Variables

Table 3 also shows summary statistics for several control variables. The choice of these variables generally follows Carpenter et al. (2019). In the paragraphs below, I discuss these covariates as well as the expected effects that have been predicted and/or observed in the traditional setting of non-transferable ESOs. The inclusion of control variables is important for two reasons. First, these variables allow me to control for a number of important firm, option, and grantee characteristics. Second, the inclusion of covariates from the literature allows me to assess the external validity of my empirical analysis. Examining whether the effects of these characteristics in my sample are in line with the standard case of non-transferable ESOs is especially important in light of the peculiarity of the Finnish institutional setting (discussed in Section 1).

[15] In a robustness test, I verify my results using fractional logit (Carpenter et al., 2019).

[16] Clustering by month, by investor, or by option series does not affect the significance of my main results, reported in Section 4.1.1.

3.2.1 Portfolio Characteristics

I control for portfolio characteristics other than outside stock wealth. I include both the value of holdings in the employer firm and the Black-Scholes value of the option grant.[17] Table 3 shows that both variables display a high degree of variability in my sample. The average company stock wealth (value of the option position) is €26,223 (€5,917), and the median is zero (€733).[18] Because of their skewed distributions, I control for the natural logarithm of both variables (plus one).

As highlighted by Carpenter et al. (2019), the effect of these two covariates on the overall behavior of grantees is uncertain. Exposure to employer-specific risk heightens the grantee's need for hedging. In contrast, greater wealth decreases the motivation for diversification, meaning risk-averse grantees are less inclined to exercise their options early (Carpenter, Stanton, and Wallace, 2010; Hall and Murphy, 2002).

3.2.2 Option Series Characteristics

I also control for various option series characteristics. I include the price-to-strike ratio, a measure of moneyness of the option. Two elements suggest that higher moneyness decreases the holding period of the ESOs. First, Carpenter et al. (2019) suggest this conclusion is supported by the critical stock price boundary approach (Cox and Rubinstein, 1985; Kim, 1990). Second, as moneyness is negatively related to the underpricing of listed options (Ikäheimo et al., 2006; ter Horst and Veld, 2008), I expect an increase in the ratio to be associated with an increase in the probability of disposing of the ESOs.

Moreover, I control for one-year historical volatility. The effect of heightened volatility

[17] When valuing the ESOs, I estimate the implicit volatility as the standard deviation of daily log returns from the previous 252 trading days. I interpolate the risk-free rate from the Euribor rate (Helibor before the Euribor rate applied) for the time to maturity.

[18] It is hardly surprising that employees hold own-company shares. First, higher-ranked employees may be explicitly or implicitly encouraged not to sell all their own-company holdings (Core and Larcker, 2002). Second, various Finnish companies offer their stocks to employees at a discounted rate, which can be an incentive for employees to invest. Third, previous work shows that holding employer shares is a common source of portfolio underdiversification (Lee, Liu, and Zhu, 2008).

is unclear. Theoretically, the critical stock price above which exercise is the optimal policy for standard American stock options is increasing in stock return volatility. However, Bettis, Bizjak, and Lemmon (2005) find that ESOs are exercised earlier in high-volatility firms, and utility-maximizing models of option exercise that account for trading constraints on option holders show that exercise policy is not monotonic in stock return volatility (Carpenter et al., 2010; Leung and Sircar, 2009).[19]

I follow the standard theory of value-maximizing option exercise to take into account the effect of dividends and of time to maturity. First, I include the dividend yield times an indicator that is equal to one if there is a forthcoming dividend, and zero otherwise. Higher yields are generally associated with grantees exercising in order not to give up the dividend, even if dividend protection in Finland is more common than in the United States. Second, I include time to expiration, expecting exercise (or sale) to be more likely the closer the option expiration date.

Following Carpenter et al. (2019), my covariates also include an indicator to account for recent vesting events. These vesting events are typically associated with exogenous reminders from the firm or the plan administrator to all employees, possibly leading some individuals—who are already considering exercising their options—to close their position.[20]

Next, I include an indicator that is equal to one if the stock price at the end of the previous month is above the 90^{th} percentile of its past year's distribution, and zero otherwise. Positive recent returns may lead employees to exercise (or sell) their options for two reasons. First, extreme prices influence investors' trading decisions (Huddart, Lang, and Yetman, 2009), so that employees may decide to exercise their options out of fear of mean reversion of the share price. Second, realization utility may lead investors to close their position when prices are near historical highs (Barberis and Xiong, 2012).

[19]The empirical evidence on the effect of volatility is quite mixed. Table 1 of Izhakian and Yermack (2017) summarizes seven previous empirical studies on ESOs, with estimated impacts of volatility on early exercise ranging from positive to not significant and to negative.

[20]Contrary to Carpenter et al. (2019), I do not control for the time between vesting dates within a given option grant. This choice is motivated by the fact that option grants in my sample do not vest in stages.

3.2.3 Employee Characteristics

I also control for various additional employee characteristics. Inspired by Carpenter et al. (2019), I include an indicator to identify the ten largest grantees in an option series. Top-ranked employees could face decisions that are fundamentally different from lower-ranked employees, driven for example by their higher firm-specific human capital (Bias, 2021; Prendergast, 1993) or by policies mandating ownership of own-company shares. I expect these top-ranked employees to have slower exercise rates, in line with previous studies (Armstrong, Jagolinzer, and Larcker, 2007; Bettis et al., 2005; Carpenter et al., 2019). I also control for the gender of grantees, expecting male employees to manifest a significantly greater propensity to dispose of their options than female employees (Carpenter et al., 2019). Finally, I control for the age of the grantees, which can also affect investment decisions (Korniotis and Kumar, 2011).

4 Results

4.1 Outside Investments and the Behavior of ESO Grantees

This section presents the main results of my empirical analysis. I examine how portfolio structure affects the behavior of ESO grantees both in the whole sample and in the subsample of grantees who hold outside stocks.

4.1.1 OLS Estimation

Column (1) of Table 4 shows that employees who are better diversified due to their holdings in other listed companies are less likely to exercise or sell the ESOs in a given month, i.e., they tend to hold onto their options for longer.

Next, Column (2) of Table 4 shows that the coefficient on outside stock wealth is similar when including option series fixed effects. The inclusion of option series fixed effects allows

me to examine the effect of outside stock wealth within a given option series, controlling for any time-invariant characteristic of the firm and of the option series.

Column (3) of Table 4 shows that outside stock wealth still matters when including firm-month-grantee zip code fixed effects. This specification effectively removes all variations related to local shocks (such as the changes in median house prices examined by Murphy and Vance, 2019) and firm-level shocks (e.g., stock performance, company news) that occur in a given month. Moreover, if one assumes that employees in my sample are homeowners,[21] and that house prices within a zip code are relatively homogeneous (e.g., Kahn, 2021; McCartney, 2021; Paravisini, Rappoport, and Ravina, 2017), these fixed effects also control for substantial variation in unobserved housing wealth. The estimated effect of outside stock wealth changes from -0.055 in Column (1) to -0.027 in Column (3), likely because I am now comparing grantees who are more alike and face similar shocks in a given month. Nevertheless, the coefficient for outside stock wealth remains highly significant (t-statistic of -7.87). The standard errors decrease when I add firm-month-zip code fixed effects, indicating that there is still substantial identifying power among coworkers who are exposed to similar local shocks in a given month. In this specification, some control variables are subsumed by the fixed effects,[22] and the adjusted R-squared increases to 0.228.

Table 4 also shows the expected signs of my regressors. In each of the three specifications, the signs of the coefficients for the covariates are in line with those discussed in Section 3, providing important support for the external validity of my findings.[23,24]

[21] A similar assumption is present in Murphy and Vance (2019). In Finland, the homeownership rate is above 70%, and ESO grantees are generally managers and white-collar employees with ages typically associated with home ownership (the interquartile age range in my sample is 35 years to 47 years).

[22] In specifications that require grantees' zip codes, I exclude individuals whose residence is not available in the data and those who move to a different zip code during the sample period. Regressors that do not vary within the fixed effect (i.e., stock volatility, the product of dividend yield and of the dividend indicator, as well as the high stock price indicator) are also excluded.

[23] All estimated coefficients for these variables are also statistically significant at conventional levels, with the exception of *Male indicator* (which is significant when I include option series or firm-month-grantee zip code fixed effects) and *Recent vesting indicator* (which loses significance when I include firm-month-grantee zip code fixed effects).

[24] As for covariates that do not have clear theoretical predictions about the sign of their association, I find the following. First, the association of company stock wealth is generally negative (however, in Section 4.5, I find that this result is not robust to the inclusion of individual-level fixed effects). Second, higher option

Moreover, diversification motives should explain *early* exercise. Thus, to further investigate whether outside stock wealth explains the decision to exercise (or sell) early, I repeat the analysis from Equation 1 but also include an interaction term to capture how the effect of diversification motives varies as the time to maturity decreases. The results of this analysis are reported in Table A2. In all three columns, outside stock wealth is more important when the options are further away from maturity.

Taken together, the OLS results represent an important and novel piece of evidence showing that diversification motives shape the behavior of ESO grantees: an increase in outside stock wealth decreases the probability of exercising or selling the options.

4.1.2 Subsample Analysis

Next, I investigate whether the link between outside stock wealth and holding period is driven by the large group of option holders who do not own any outside stock. I show that this is not the case by repeating the OLS analyses on the subset of observations in which the employees own shares in other listed companies.

The subsample analysis is particularly interesting since, as of 2004, more than two-thirds of Finnish investors with direct stock holdings did *not* invest in mutual funds (Keloharju et al., 2012). Thus, assuming ESO grantees who hold outside stocks are a somewhat representative group of the broader population of Finnish stock investors, my data on outside wealth represent the majority of outside financial investments for most employees in my subsample. Moreover, both the value of the options and the investments in outside stocks in this subsample are economically meaningful.[25]

Table 5 reports the results of the subsample analysis. I find that point estimates for

values are associated with more exercises and sales. Third, my results confirm recent findings suggesting that volatility leads grantees to hold onto their ESOs to preserve option value (Heron and Lie, 2017; Izhakian and Yermack, 2017). However, consistent with utility maximizing models, I find that the relationship mutates (i.e., the effect becomes positive and insignificant) when examining changes in volatility within a given option series. Fourth, aging also seems to be associated with the choices of the grantees.

[25]Among outside investors, the average outside stock wealth (Black-Scholes option value) is €51,653 (€9,945).

the coefficient of interest in the subsample of stock market participants are in line with or even larger than estimates in the full sample of ESO grantees. As in the full sample, the estimated coefficient for outside stock wealth declines as I include more granular fixed effects. The results show that my findings are not driven by those grantees who do not invest in other listed companies. In particular, Column (3) of Table 5 allows me to isolate the effect of a change in outside wealth among employees who are unlikely to own mutual funds, holding constant median house prices, local shocks, and firm-level shocks.

4.2 Salience

Recent evidence suggests that, besides actual wealth, also *perceived* wealth affects financial decisions (Schnorpfeil, Weber, and Hackethal, 2023). Moreover, it is well known that behavioral channels are important determinants of exercise behavior (Carpenter et al., 2019; Heath, Huddart, and Lang, 1999). Therefore, in addition to rational economic considerations stemming from employees' diversification motives, one plausible reason for wealthier grantees holding onto their ESOs for longer is that investments in other listed companies make employees perceive that they are less exposed to employer-specific risk. To unpack this underlying mechanism, I now examine whether changes in the salience of outside stock wealth are contributing to my results.

My IV analysis exploits the conversion of customer-owned mutual companies into publicly listed firms as an exogenous shock to the salience of owning outside stocks. This approach has two advantages. First, it sheds light on the role of salience in the context of ESO exercises, complementing recent studies that examine other economic choices (Frydman and Wang, 2020; Taubinsky and Rees-Jones, 2018). Second, using an instrument helps take into account the endogeneity of individual portfolio choices and examine whether salient components of outside wealth causally affect an employee's decision to hold onto her ESOs.

Historically, to obtain a landline telephone in Finland, prospective customers would have to acquire a certificate of participation in the local mutual company. In the late 1990s,

three of these telecom companies decided to convert into publicly listed firms. Kaustia et al. (2016) show that these demutualizations affect the salience of owning outside stocks and have long-term effects on the portfolio compositions of affected investors. However, the demutualizations do not entail transfers of property rights and do not represent a wealth shock that would be of any economic significance.[26] Thus, my IV analysis identifies the local average treatment effect of an exogenous change in portfolio structure that increases the salience of outside wealth.

In my IV analysis, I use an indicator variable (equal to one if the employee has received shares as a result of the demutualizations, and zero otherwise) to instrument for the natural logarithm of outside stock wealth (plus one). The indicator is unlikely to be directly correlated with the choices of the grantees for at least three reasons. First, the vast majority of firms in my sample are not direct competitors of the three telecom companies. Second, I repeat the analysis including firm-month-grantee zip code fixed effects, which effectively remove any local and firm-specific effects. Third, many options in my sample are allocated well after the demutualizations take place.

These demutualizations influence affected employees in my sample in two ways. First, Kaustia et al. (2016) show that the demutualizations increase the salience of stock ownership, representing for many individuals the first experience of direct investment in a listed company unrelated to their employment status. Second, my first-stage regressions (reported in Table A3) show that the demutualizations also affect the structure of individual portfolios by increasing employees' investments in non-employer firms.[27]

Columns (1), (2), and (3) of Table 6 report the results of the second stage, both without and with fixed effects. In all the specifications, the effect of outside stock wealth is

[26]The direct effect of the demutualizations on firm value is unclear (Fama and Jensen, 1983; Lamm-Tennant and Starks, 1993; Mayers and Smith, 1986). The indirect wealth effect is of ambiguous sign and likely small: after the demutualizations, customers benefit from the higher liquidity of their shares but lose some untaxed benefits (i.e., customer discounts). Shares from the demutualizations had market values ranging from €262 to €3,088.

[27]Kaustia et al. (2016) show that between 75% and 85% of the recipients of publicly listed shares still held the stock three years after the demutualizations.

negative and significant at the 1% level. The IV results are consistent with the existence of a causal relationship between the salience of outside stock wealth and ESO holding period, suggesting that the *perceived* level of diversification shapes the behavior of ESO grantees. The results also show that the local average treatment effect of an exogenous change in portfolio structure is larger than the OLS estimates (albeit comparable in magnitude), likely because the demutualizations represent a rather salient element of outside wealth and are often an employee's first direct investment in a listed stock.

4.3 Diversifying Employer-Specific Risk

As discussed in Section 1, a peculiarity of the institutional setting is that ESOs in Finland are transferable and are often listed on the exchange. Thus, in an efficient and frictionless market, risk-averse employees would find it optimal to sell their ESOs at the Black-Scholes value as soon as possible. However, most grantees in my sample tend to hold onto their ESOs for years. This behavior could be explained by a combination of factors, such as procrastination, selling pressure from the grantees, low liquidity, tax considerations,[28] and the fact that it may be difficult and/or costly for arbitrageurs to short the underlying stock.[29]

Ikäheimo et al. (2006) examine a number of ESOs listed on the Helsinki Stock Exchange and show that these options tend to trade at a large discount to the Black-Scholes value. The discount decreases as maturity approaches.[30] Even if the underpricing is economically important, it is highly likely that the transferability of ESOs removes part of the traditional trade-off between exercising early and leaving the options alive. For this reason, I argue that my estimates represent a lower bound of the effect of outside stock wealth in the case of non-

[28] ESOs in Finland are taxed as ordinary income (and not as capital income), and taxation is triggered when the grantee disposes of the options.

[29] An additional possible explanation is that the stakes are relatively low for many grantees. I address this concern in two ways. First, I exclude observations that are likely to be economically irrelevant (see Section 1). Second, additional analyses (discussed below) show that my results also hold among employees who hold large option positions.

[30] Adverse selection mechanisms could be contributing to this underpricing. In fact, ESOs are generally sold by employees and executives who are likely to have access to price-relevant non-public information (Brooks, Chance, and Cline, 2012; Green, Huang, Wen, and Zhou, 2019; Huddart and Lang, 2003; Ke, Huddart, and Petroni, 2003).

transferable ESOs. To corroborate this claim, I examine the effect of outside investments along two dimensions: the listing status of the options and their liquidity.

My empirical strategy is based on the following specification:

$$Y_{i,j,t} = \alpha + \beta_0 Ln(OutsideStockWealth)_{i,j,t-1} + \beta_1 X_{j,t-1} + \\ + \beta_2 Ln(OutsideStockWealth)_{i,j,t-1} * X_{j,t-1} + \gamma Controls_{i,j,t-1} + \epsilon_{i,j,t}, \quad (2)$$

where $X_{j,t-1}$ is a measure of listing status or of the liquidity of option series j, and everything else is defined as in Specification 1.

The objective of the analyses below is to examine how the effect of outside stock wealth is modulated by the listing status and liquidity of the option series. Thus, I use Specification 2 and focus especially on the interaction term, i.e., on $\hat{\beta}_2$.

4.3.1 Listing Status

As shown in Table 3, a small part of my sample consists of employees holding ESOs that are transferable but not listed on the exchange. Listing status represents a unique feature of the Finnish institutional setting and generates additional heterogeneity in how liquid and easy to sell the options from a given series are. Unlisted options are more similar to traditional ESOs in the sense that it is more difficult to diversify early without giving up the time value of the option. Thus, well-diversified employees may be more reluctant to diversify early, making portfolio considerations more (less) relevant for unlisted (listed) option series.

I use firm-month-grantee zip code fixed effects to compare employees who work for the same firm, live in the same area, are exposed to similar shocks in a given month, and hold either listed or unlisted ESOs. The fixed effects are important for two reasons. First, they control for firm-level and local shocks that can affect the choices of grantees in a given month. Second, the fixed effects account for the fact that the board of directors' decision to list the ESOs can be driven by firm characteristics and that these characteristics can also affect

grantees' diversification motives. For example, let us consider the case of human capital. Core and Guay (2001) show that large option series are more likely to be issued by firms in which human capital is more important. To the extent that this human capital includes a firm-specific component, diversification motives will be stronger in firms issuing large option series (which are often listed). Focusing on decisions made by grantees within a firm allows me to automatically control for firm characteristics and to properly identify the effect of listing status.

The results reported in Column (1) of Table 7 suggest that outside stock wealth is indeed more important in unlisted option series. The sign of the coefficient of the interaction term is positive and statistically significant at the 5% level.

4.3.2 Liquid and Illiquid Options

Table 3 shows that there is large heterogeneity in how often listed options are actually traded on the market.[31] I take advantage of this variation to examine how the role of outside stock wealth varies with option liquidity. There is evidence that liquidity plays an important role in derivatives markets (Brenner, Eldor, and Hauser, 2001; Deuskar, Gupta, and Subrahmanyam, 2011; Li and Zhang, 2011). In particular, Christoffersen, Goyenko, Jacobs, and Karoui (2018) show that illiquid equity options have lower prices and higher expected returns. As option illiquidity makes it costlier for the grantee to diversify away the employer-specific risk, I expect the effect of outside stock wealth to be weaker (stronger) when the options are traded more (less) frequently.

I compare grantees who work at the same company, live in the same area, are exposed to similar shocks, but hold more or less liquid ESOs. Firm-month-grantee zip code fixed effects allow me to isolate the effect of liquidity by taking into account that the trading frequency of an option series in a given month is driven by firm-specific factors and by the decisions of other grantees. On the one hand, the fixed effects remove any firm-level shocks related to the

[31] *Trading frequency* is defined as the fraction of days at least one option from a given listed option series was traded in the previous month.

liquidity and to the recent performance of the underlying stock. On the other hand, the fixed effects also remove local shocks that may lead similar grantees to dispose of their options. The results, reported in Column (2) of Table 7, show that the effect of outside stock wealth is larger when the ESOs are less liquid. The estimated coefficient for the interaction term is positive and significant (p-value of 0.07), suggesting that outside stock wealth matters relatively more when the options are traded less frequently.

Taken together, the results on listing status and liquidity are consistent with diversification motives playing a more important role when employer-specific risk is harder to diversify.

4.4 Outside Stock Wealth and Employee Rank

I also examine whether portfolio structure affects the decision of *both* top-ranked and lower-ranked employees. The analysis is motivated by Carpenter et al. (2019), who highlight that the decisions of highly-ranked employees could be fundamentally different from those of lower-ranked employees. This observation motivates me to examine whether portfolio structure affects the decisions of both top-ranked and lower-ranked employees.

In Table A4, I analyze how the importance of various regressors varies with employee rank. My specification includes both the regressors used in the baseline specification and a number of interaction terms. The first column shows the coefficients for lower-ranked employees, whereas the second column shows the differences in the coefficients between lower-ranked and higher-ranked employees. The regression model includes firm-month-grantee zip code fixed effects, so that I am effectively comparing top-ranked and lower-ranked employees within the same firm, area, and month. The regression output shows that outside stock wealth has a negative and significant coefficient for lower-ranked employees. The interaction of outside stock wealth with *Top-10 grantee indicator* is economically small and not statistically significant, suggesting the effect of outside stock wealth is similar for top-ranked and lower-ranked employees. The regression output shows that outside stock wealth has a negative

and significant coefficient for lower-ranked employees. The implied coefficient for top-ranked employees is -0.023 (-0.027+0.04), associated with a t-statistic of -2.76.[32]

At first sight, these results may seem surprising. Higher-ranked employees are likely to have higher levels of firm-specific human capital (Prendergast, 1993), so that they may be more exposed to firm-specific risk and could benefit more from diversification. However, my regressions control for the value of the option position, which is significant at the 1% level and likely to be highly correlated with the unobservable firm-specific human capital of the employee.[33] Thus, the results presented in Table A4 show that portfolio structure matters to both top-ranked and lower-ranked employees similarly, holding constant all other regressors that are likely to shape the employees' choices.

4.5 Evaluating Alternative Explanations

The results presented so far are consistent with theoretical models in which an employee's decision of holding onto her ESOs is determined by her risk aversion and exposure to employer-specific risk. However, there exist various alternative explanations, such as individual characteristics and liquidity needs. Below, I discuss evidence that speaks against these other channels.

4.5.1 Employee Characteristics

Employee characteristics could affect the decision to hold onto the ESOs. For example, less risk-averse employees may invest more in stocks and also exercise their options later. Stock holdings could also be a proxy for financial literacy (i.e., employees who better understand option valuations may hold their options for longer).[34] To the extent that these and other

[32]Table A5 shows that I obtain similar results when including only the interaction between outside stock wealth and the *Top-10 grantee indicator*.

[33]Similar to Carpenter et al. (2019), fractional exercise (or sale) is not the usual choice for employees in my sample. Conditional on exercising or selling at least one option in a given month, the average employee in my sample parts from 78% of her option position in that month.

[34]E.g., some employees believe that out-of-the-money options with several years to maturity have no value (Babenko and Sen, 2014).

individual characteristics omitted from the model are persistent and moderately stable over time,[35] the inclusion of employee fixed effects effectively controls for these dimensions.

In Column (1) of Table 8, I use employee fixed effects to control for omitted time-constant employee characteristics. Reassuringly, the coefficient for outside stock wealth is significant also in this specification, showing that outside stock wealth matters within the same individual over time. In Column (2), I obtain similar results including both employee and option series fixed effects. In Column (3), I confirm the importance of outside stock wealth using a very demanding specification that accounts for individual characteristics while comparing coworkers who are exposed to similar firm and local shocks. It is also important to underline that the inclusion of granular geographic fixed effects (see, e.g., Table 4) effectively removes a lot of the variation in unobserved housing wealth. Taken together, these results show that time-invariant differences in individual characteristics are unlikely to be driving my results.

4.5.2 Liquidity Constraints

Employees might dispose of their options because they have liquidity needs. Various arguments show that liquidity constraints are unlikely to be driving my results. First, Aguiar, Bils, and Boar (2020) show having a low liquidity-to-income ratio is a persistent characteristic of households. Thus, specifications including employee fixed effects (see Table 8) effectively remove a lot of the variation stemming from individuals' potential liquidity needs.

Second, an explanation which is based solely on liquidity constraints and disregards employer-specific risk would suggest that grantees with other liquid wealth tend to dispose of their ESOs later, regardless of the source of such wealth. However, Table 8 shows that changes in company stock wealth and in outside stock wealth have different effects. On the one hand, the coefficient for outside stock wealth is negative and statistically significant

[35] See Schildberg-Hörisch (2018) and Angrisani, Burke, Lusardi, and Mottola (2020) for discussions on the individual-level persistence of risk aversion and financial literacy, respectively.

at conventional levels. On the other hand, the within-employee effect of company stock wealth is positive and not statistically significant in all three specifications. While these results are difficult to reconcile solely through liquidity constraints, they are consistent with the existence of diversification motives: investments in outside stocks, unlike those in own-company stocks, attenuate the demand for hedging.[36]

Third, building on the above results, one cannot wholly dismiss the possibility that ESO grantees might systematically decide to fund their consumption by liquidating their outside stock holdings, rather than drawing from their own-company stocks or options. While it might be an uncommon strategy, such a choice—if adopted en masse—would mechanically generate a negative correlation between outside stock wealth and the likelihood of option disposal. To address this concern, I examine a subset of grantees that stand apart from this potential confounding behavior: those who consistently hold onto their outside stocks. I turn my attention to this distinct subsample of employees who, despite owning outside stocks (worth on average over €6,500), have not liquidated any of these assets from 1995 to 2014. This analysis also attenuates concerns related to the fact that employees may respond to ESO grants by reducing their outside stock holdings. Table A6 shows that the effect of outside stock wealth remains negative and statistically significant at conventional levels.

Fourth, following the reasoning of Hemmer et al. (1996), I restrict the sample to individuals whose transactions are less likely to be liquidity motivated.[37] Specifically, in Table A7 I only include grantees who hold an option position worth at least €10,000. I select this threshold because Fagereng, Holm, and Natvik (2021) use data from Norway to show that windfall income above a similar threshold (i.e., $8,300) is less likely to be consumed. Columns (1), (2), and (3) of Table A7 show that my results also hold in this low-liquidity needs subsample, further reassuring that liquidity concerns are not the sole driver of the relationship between outside stock wealth and holding period. Moreover, in

[36]Carpenter et al. (2019) note that the theoretical effect of own-company stock holdings on grantee behavior is unclear: employer-specific risk (greater wealth) increases (decreases) hedging needs.

[37]In their work, Hemmer et al. (1996) restrict their analyses *"to transactions that involve a material number of options, i.e., reducing the likelihood of liquidity-motivated transactions."*

Table A8, I use a higher threshold (i.e., €50,000) to account for the fact that grantees in my sample may be wealthier than the general population and could therefore have different liquidity needs. Reassuringly, my results also hold using this higher threshold.

Finally, it is also important to underline that the analyses in Table A7 and Table A8 alleviate concerns about the fact that many ESOs in my sample have relatively small euro values. Limited economic stakes, if anything, should introduce bias against finding results. Nevertheless, it is reassuring to show that outside stock wealth remains an important determinant of employee behavior also when I restrict my sample to grants with large euro values.

4.5.3 Dispersion of ESO Discounts

Ikäheimo et al. (2006) show that ESO discounts in Finland vary across firms and over time. This may raise some concerns. For example, when the stock market experiences high volatility, both the value of direct stock holdings and the discounts for ESOs could be affected. Thus, one could argue that employees sell their options not because their outside wealth has changed, but because the movements in the market changed the observed discount. To control for the dispersion of ESO discounts, I include option series-month fixed effects, which allow me to identify variation within an option series in a given month.

Table A9 reports the results of my analysis including option series-month fixed effects. The fixed effects subsume all regressors that do not vary within a given option series-month (i.e., price-to-strike ratio, volatility, dividend yield $*$ dividend indicator, years to expiration, recent vesting indicator, and high stock price indicator). The results reported in Column (1) of Table A9 show that, among coworkers who experience similar ESO discounts in a given month, the employees with more outside stock wealth are more likely to hold onto their options. In Column (2) of Table A9, I include both option series-month and employee fixed effects. The coefficient for outside stock wealth remains negative and significant. On the contrary, the coefficient for company stock wealth changes sign, further highlighting the

difference between outside wealth and company wealth.

4.6 Robustness

I discuss additional robustness tests below.

4.6.1 Alternative Measures of Outside Stock Wealth

I verify the robustness of my results using two alternative measures of outside stock wealth. First, I use an indicator that is equal to one if the grantee owns outside stocks, and zero otherwise. This robustness test allows me to verify that my main result is not simply driven by very large investments in outside stocks. Using an indicator variable effectively allows me to compare the behavior of outside investors with the choices of similar grantees who do not own stocks in other listed companies. Table A10 shows that outside investors in general are less likely to exercise or sell their option positions. This simple indicator highlights the economic significance of my main effect. The coefficient of interest corresponds to 17.1% ($-0.396/2.321$) of the average fraction of options disposed of in a given month. This is roughly comparable to the effect of gender or of a grantee being among the key decision makers at the firm.

Second, I take into account the number of outside stocks held by the employee. This simple and intuitive measure of diversification (Statman, 1987) allows me to further confirm the robustness of my findings. To de-emphasize outliers, I employ the standard logarithmic transformation. The results are reported in Table A11 and show that owning a larger number of outside stocks is associated with a lower tendency to dispose of the ESOs.

4.6.2 Alternative Empirical Strategies

Some papers examine the decisions of ESO grantees using hazard models (e.g., Armstrong et al., 2007). While Carpenter et al. (2019) argue that hazard models may be inappropriate because employees do not consistently exercise outstanding option grants in full, this

approach allows researchers to incorporate censoring, arising—for example—from data limitations (e.g., ESOs being alive at the end of the sample period). Reassuringly, my sample period includes the expiry dates of the vast majority of option series examined in this paper. Moreover, Table A12 shows the relationship between outside stock wealth and ESO holding period remains negative and statistically significant also using a Cox hazard model.

Finally, I verify the robustness of my findings using the fractional logistic approach employed by Carpenter et al. (2019). Table A13 shows that the main results still hold when I employ this methodology. Moreover, the signs of estimated coefficients for other covariates are unchanged from the OLS specification without fixed effects reported in Table 4. The results of the fractional logistic approach also show that my findings are not driven by potential biases associated with the linear probability model (Horrace and Oaxaca, 2006).

5 Conclusion

Leveraging unique data from Finland, I examine how portfolio structure shapes the behavior of executives and employees who receive stock options as part of their compensation packages. To the best of my knowledge, this is the first paper that studies this research question by observing an important and time-varying component of outside wealth that is measured at the individual level.

I find that employees who are less exposed to employer-specific risk due to their holdings in other listed companies tend to hold onto their options for longer. My large data set allows me to control for unobserved heterogeneity by verifying that my results hold among coworkers who are exposed to the same local and firm-level shocks, among employees who are unlikely to invest in mutual funds, and also within employee. Moreover, unique features of the institutional setting suggest that my estimates represent a credible lower bound to the

effect of outside investments on the exercise of ESOs in other countries. Specifically, the effect of outside stock wealth is more pronounced when the options are less liquid and employer-specific risk is harder to diversify. An IV analysis exploiting the conversion of customer-owned mutual companies into publicly listed firms shows that the salience of outside wealth is also an important underlying mechanism.

Taken together, my results support the long-standing hypothesis that portfolio considerations play an important role in shaping the behavior of ESO grantees.

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Figure 1: Outside Investments and Grantee Behavior

This figure shows the inverse relationship between an employee's outside stock wealth and her propensity to dispose of her ESOs in a given month. Effect sizes are calculated relative to coworkers who hold the same amount of ESOs of the same stock at the start of the month, but do not own any outside stocks.

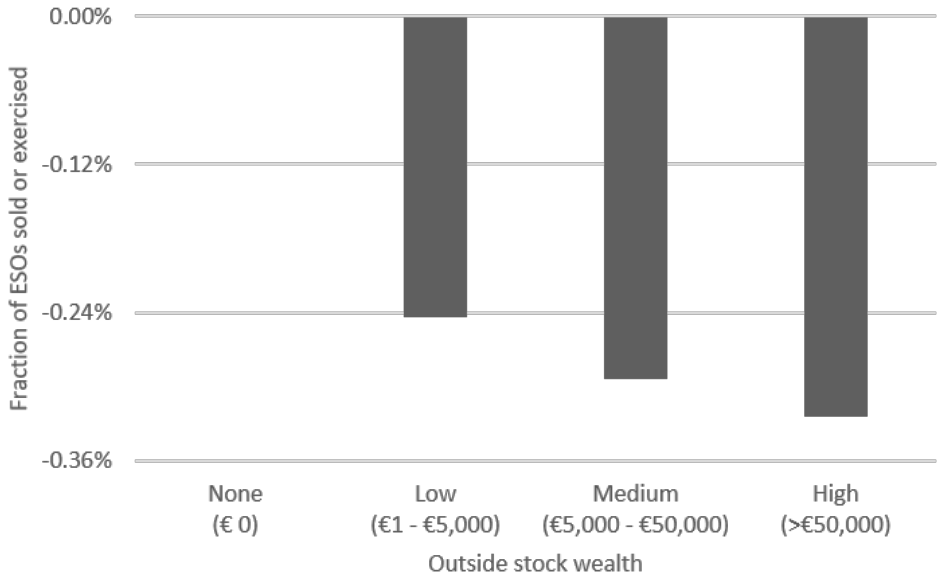
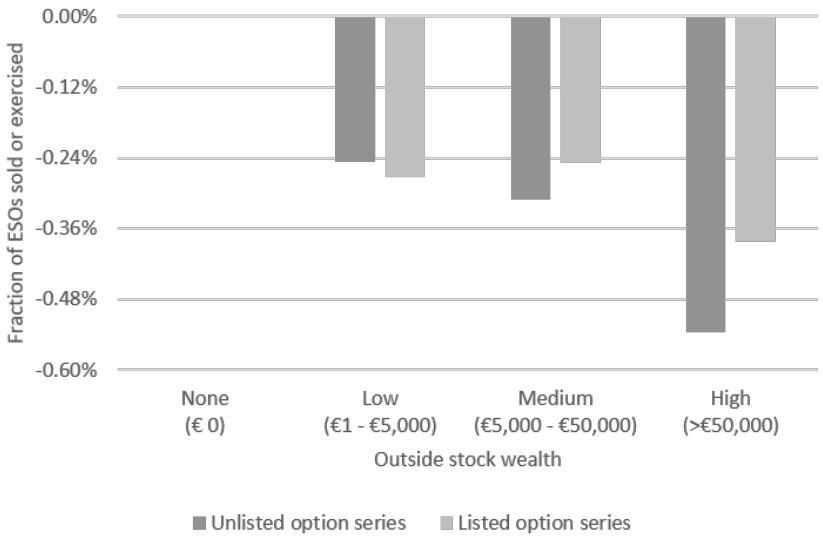


Figure 2: Outside Investments and Grantee Behavior - The Role of Listing Status and Liquidity

These figures examine whether liquidity and ESO listing status affect the inverse relationship between an employee's outside stock wealth and her propensity to dispose of her ESOs in a given month. Effect sizes are calculated relative to coworkers who hold the same amount of ESOs of the same stock at the start of the month, but do not own any outside stocks.

Panel A: Unlisted vs. Listed ESOs

Unlisted (dark grey) and listed (light grey) option series are displayed separately.



Panel B: Illiquid vs. Liquid ESOs

Grants from listed option series that were (not) traded every day on the exchange in the previous month are shown in light grey (dark grey).

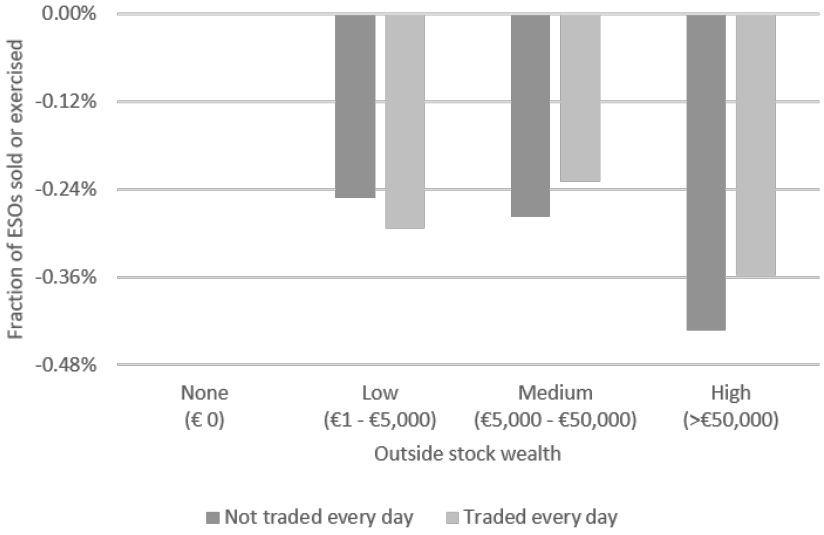


Table 1: Recent Studies on Wealth and Employee Stock Options

The table shows various recent studies on employee stock options, with information about the the measures of wealth used as independent variables. A positive (negative) effect suggests that a higher value for the variable is associated with disposing of the options earlier (later). Murphy and Vance (2019) scale their measure of company wealth by the sum of median house price plus the value of unvested restricted holdings and unexercised stock options.

Study	**Measures of company wealth**	**Effect**	**Measures of outside wealth**	**Effect**
Carpenter, Stanton, and Wallace (2019)	Company option holdings	Negative	None	n/a
Heron and Lie (2017)	Company stock holdings Company option holdings	Mixed	None	n/a
Izhakian and Yermack (2017)	Company stock holdings	Negative	None	n/a
Murphy and Vance (2019)	Unvested restricted holdings + unexercised stock options	Positive	Change in median house price	Positive
Present study (2024)	Company stock holdings Company option holdings	Mixed	Outside stock wealth	Negative

Table 2: Summary Statistics on the Option Series

This table presents summary statistics on the 628 option series included in the sample. *Number of grantees* is the number of employees who received options within the series. *Days listed* is the number of days options in that series were listed on the exchange. *Days vested* is the number of days options in that series were vested. *Holding period* is the number of days from first allocation to the final action (exercise, sale, or expiry). *Fraction exercised* indicates the percentage of grantees who exercise their last available options before expiry. *Fraction sold* indicates the percentage of grantees who sell their last available options before expiry.

	N	Mean	SD	P25	P50	P75
Number of grantees	628	291	1,272	18	49	127
Days listed	628	895	522	597	756	1,118
Days vested	628	1,095	642	730	944	1,452
Holding period, days	628	900	471	555	880	1,230
Fraction exercised	628	0.09	0.17	0.00	0.00	0.13
Fraction sold	628	0.40	0.39	0.00	0.30	0.82

Table 3: Summary Statistics on Observed Characteristics

This table presents summary statistics on the main variables used in the empirical analysis. The sample includes 3,338,639 monthly observations associated with 124,354 option grants received by 42,739 employees in 85 firms. The variables reported in this table are defined in Table A1. *Trading frequency* is defined only for listed option series.

Variable	N	Mean	SD	P25	P50	P75
Dependent variable						
100 * Fraction of available ESOs that are exercised or sold	3,338,639	2.321	14.421	0.000	0.000	0.000
Portfolio characteristics						
Outside stock wealth (€)	3,338,639	21,555	196,733	0	0	4,176
Outside investor indicator	3,338,639	0.417	0.493	0.000	0.000	1.000
Number of outside stocks	3,338,639	1.472	3.090	0.000	0.000	2.000
Company stock wealth (€)	3,338,639	26,223	1,150,576	0	0	600
Black-Scholes option value (€)	3,338,639	5,917	37,571	154	733	2,114
Option series characteristics						
Price-to-strike ratio	3,338,639	1.099	2.735	0.416	0.650	0.955
Volatility	3,338,639	0.427	0.618	0.275	0.402	0.549
Dividend yield * Dividend indicator	3,338,639	0.245	1.055	0.000	0.000	0.000
Years to expiration	3,338,639	2.255	1.163	1.334	2.164	3.085
Recent vesting indicator	3,338,639	0.033	0.178	0.000	0.000	0.000
High stock price indicator	3,338,639	0.209	0.407	0.000	0.000	0.000
Trading frequency	3,147,289	0.650	0.389	0.286	0.850	1.000
Listed series indicator	3,338,639	0.943	0.232	1.000	1.000	1.000
Grantee characteristics						
Top-10 grantee indicator	3,338,639	0.067	0.250	0.000	0.000	0.000
Male indicator	3,338,639	0.740	0.439	0.000	1.000	1.000
Age	3,338,639	41.376	8.722	35.000	40.000	47.000

Table 4: OLS Results

This table examines the relationship between outside stock wealth and employees' decision to exercise or sell their ESOs. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)	–	-0.055***	-0.042***	-0.027***
		(-6.34)	(-5.39)	(-7.87)
Other control variables				
Ln(Company stock wealth)	+/-	-0.037***	-0.026***	-0.015***
		(-3.48)	(-3.57)	(-2.91)
Ln(Black-Scholes option value)	+/-	0.917***	0.820***	0.369***
		(13.28)	(6.00)	(9.40)
Price-to-strike ratio	+	0.329***	0.227***	0.278***
		(11.27)	(5.07)	(9.16)
Volatility	+/-	-0.227***	0.124	
		(-6.12)	(1.46)	
Dividend yield * Dividend indicator	+	0.231**	0.188*	
		(1.99)	(1.74)	
Years to expiration	–	-2.074***	-2.351***	-1.119***
		(-12.14)	(-7.41)	(-8.81)
Recent vesting indicator	+	2.987***	3.738***	0.297
		(3.57)	(4.54)	(0.70)
High stock price indicator	+	1.823***	1.403***	
		(4.72)	(3.96)	
Top-10 grantee indicator	–	-1.743***	-0.556***	-0.432***
		(-6.97)	(-2.78)	(-3.91)
Male indicator	+	0.050	0.250***	0.341***
		(0.62)	(4.17)	(6.31)
Age		-0.175***	-0.123***	-0.032**
		(-6.90)	(-5.54)	(-2.21)
Age squared		0.002***	0.001***	0.000
		(5.62)	(4.59)	(1.08)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		3,338,639	3,338,636	3,121,058
Adjusted R-squared		0.046	0.064	0.228

Table 5: Subsample Analysis

This table shows the results of OLS regressions, restricting the sample to months in which the grantee holds stocks of non-employer firms. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)	–	-0.149***	-0.117***	-0.022**
		(-5.87)	(-3.31)	(-2.26)
Other control variables				
Ln(Company stock wealth)	+/-	-0.023***	-0.023***	-0.017***
		(-2.81)	(-3.63)	(-4.35)
Ln(Black-Scholes option value)	+/-	0.922***	0.838***	0.395***
		(14.56)	(5.85)	(6.92)
Price-to-strike ratio	+	0.371***	0.213***	0.487***
		(7.62)	(3.99)	(6.91)
Volatility	+/-	-0.216***	0.254**	
		(-5.77)	(2.30)	
Dividend yield * Dividend indicator	+	0.215*	0.181*	
		(1.94)	(1.72)	
Years to expiration	–	-2.152***	-2.595***	-1.367***
		(-12.84)	(-8.33)	(-8.13)
Recent vesting indicator	+	2.001***	3.046***	-0.028
		(2.70)	(4.06)	(-0.06)
High stock price indicator	+	1.829***	1.348***	
		(4.51)	(3.61)	
Top-10 grantee indicator	–	-1.706***	-0.634***	-0.510***
		(-6.86)	(-2.87)	(-3.42)
Male indicator	+	0.125	0.267***	0.281***
		(1.37)	(4.66)	(5.17)
Age		-0.196***	-0.167***	-0.098***
		(-6.64)	(-6.92)	(-4.71)
Age squared		0.002***	0.002***	0.001***
		(5.63)	(6.28)	(4.13)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		1,393,217	1,393,217	1,259,860
Adjusted R-squared		0.052	0.071	0.264

Table 6: IV Results

This table shows the results of my IV analysis. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)	–	-0.090***	–0.064***	-0.059***
		(6.02)	(-6.13)	(-7.76)
Other control variables				
Ln(Company stock wealth)	+/-	-0.024**	-0.019**	-0.003
		(-2.15)	(-2.44)	(-0.60)
Ln(Black-Scholes option value)	+/-	0.929***	0.830***	0.383***
		(13.41)	(6.10)	(9.68)
Price-to-strike ratio	+	0.327***	0.227***	0.276***
		(11.22)	(5.05)	(9.11)
Volatility	+/-	-0.226***	0.123	
		(-6.14)	(1.44)	
Dividend yield * Dividend indicator	+	0.231**	0.188*	
		(1.99)	(1.74)	
Years to expiration	–	-2.073***	-2.352***	-1.133***
		(-12.15)	(-7.41)	(-8.93)
Recent vesting indicator	+	2.978***	3.730***	0.297
		(3.56)	(4.54)	(0.70)
High stock price indicator	+	1.814***	1.399***	
		(4.71)	(3.95)	
Top-10 grantee indicator	–	-1.726***	-0.551***	-0.438***
		(-6.94)	(-2.75)	(-3.97)
Male indicator	+	0.074	0.264***	0.366***
		(0.92)	(4.29)	(6.63)
Age		-0.172***	-0.123***	-0.031**
		(-6.76)	(-5.54)	(-2.15)
Age squared		0.002***	0.001***	0.000
		(5.57)	(4.64)	(1.11)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		3,338,639	3,338,636	3,121,058

Table 7: Outside Stock Wealth When the ESOs Are Not Listed or Less Liquid

This table shows the results of OLS regressions. In Column (2), only listed option series are included. Some control variables are not included because they are subsumed by the fixed effects. t-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold			
	Expected sign	(1)	(2)
Independent variable(s)			
Ln(Outside stock wealth)	–	-0.062***	-0.043***
		(-4.24)	(-4.53)
Listed series indicator		-0.452	
		(-0.54)	
Ln(Outside stock wealth) * Listed series indicator	+	0.036**	
		(2.38)	
Trading frequency			0.850**
			(2.13)
Ln(Outside stock wealth) * Trading frequency	+		0.023*
			(1.80)
Other control variables			
Ln(Company stock wealth)	+/-	-0.015***	-0.011**
		(-2.92)	(-2.02)
Ln(Black-Scholes option value)	+/-	0.369***	0.232***
		(9.39)	(6.09)
Price-to-strike ratio	+	0.286***	1.112***
		(6.77)	(6.09)
Years to expiration	–	-1.120***	-0.916***
		(-8.76)	(-8.02)
Recent vesting indicator	+	0.295	0.826**
		(0.70)	(1.97)
Top-10 grantee indicator	–	-0.431***	-0.289**
		(-3.81)	(-2.47)
Male indicator	+	0.341***	0.379***
		(6.30)	(6.93)
Age		-0.031**	-0.007
		(-2.20)	(-0.50)
Age squared		0.000	-0.000
		(1.06)	(-0.53)
Firm-month-grantee zip code FE		Yes	Yes
N		3,121,058	2,963,638
Adjusted R-squared		0.228	0.218

Table 8: Employee Fixed Effects

This table shows the results of OLS regressions which include employee fixed effects. *Male indicator* is not included because it is subsumed by the fixed effects. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

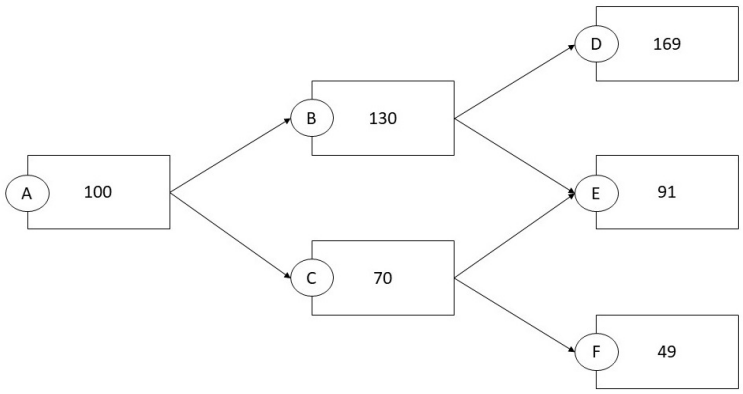
Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)	–	-0.080***	-0.052**	-0.032***
		(-3.07)	(-2.12)	(-3.01)
Other control variables				
Ln(Company stock wealth)	+/-	0.031	0.046	0.016
		(0.85)	(1.52)	(1.12)
Ln(Black-Scholes option value)	+/-	1.121***	1.151***	0.542***
		(8.46)	(6.85)	(11.16)
Price-to-strike ratio	+	0.363***	0.231***	0.371***
		(8.22)	(4.96)	(9.83)
Volatility	+/-	-0.197***	0.092	
		(-3.52)	(1.08)	
Dividend yield * Dividend indicator	+	0.185*	0.147	
		(1.67)	(1.33)	
Years to expiration	–	-2.624***	-2.658***	-1.489***
		(-9.79)	(-3.67)	(-9.99)
Recent vesting indicator	+	1.689**	2.651***	-0.253
		(2.30)	(3.77)	(-0.45)
High stock price indicator	+	1.460***	1.231***	
		(4.08)	(3.37)	
Top-10 grantee indicator	–	-1.652***	-0.307*	-0.827***
		(-5.43)	(-1.75)	(-5.36)
Age		-0.708***	-1.012**	
		(-3.29)	(-2.31)	
Age squared		0.008***	0.015***	0.004***
		(3.68)	(6.73)	(3.54)
Employee FE		Yes	Yes	Yes
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		3,338,248	3,338,245	3,120,708
Adjusted R-squared		0.085	0.096	0.256

Internet Appendix for: "Diversification at Work: Evidence from Employee Stock Options"

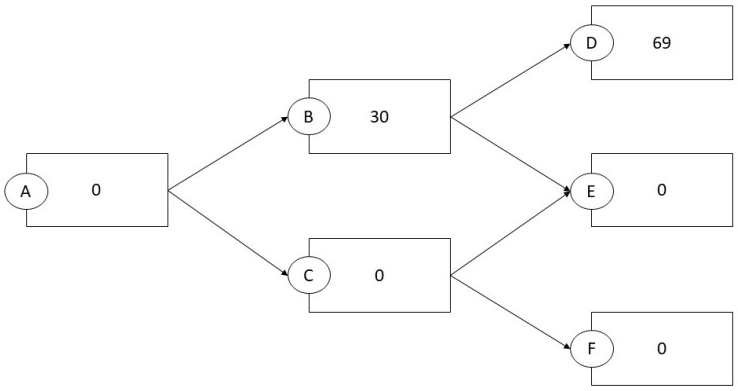
Figure A1: Stock Price, Intrinsic Value, and Option Value in the Stylized Model

These figures show the stock price, intrinsic value and option value in the example described in my stylized model.

Panel A: Stock Price



Panel B: Intrinsic Value



Panel C: Option Value

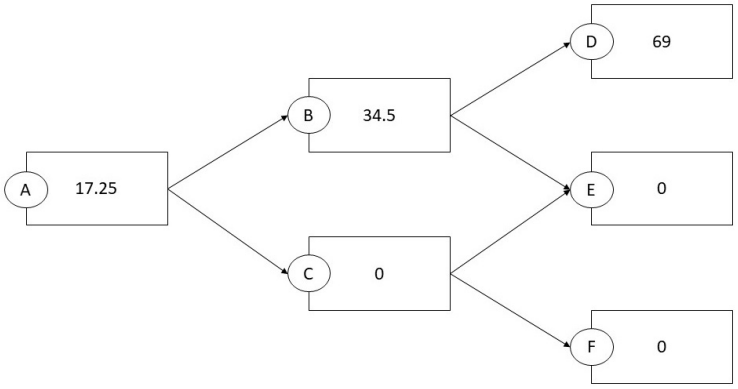


Table A1: Variable Definitions

This table reports the definitions of the main variables used in this paper.

Dependent variable	
Fraction of available ESOs that are exercised or sold	The fraction of available (vested and/or listed) ESOs of series j that grantee i exercises or sells in month t.
Portfolio characteristics	
Outside stock wealth	The market value of direct stock holdings in non-employer firms.
Outside investor indicator	An indicator equal to one if the grantee directly holds stocks of non-employer firms, and zero otherwise.
Number of outside stocks	The number of stocks directly held by the grantee, excluding the employer stock.
Company stock wealth	The market value of direct stock holdings in the employer.
Black-Scholes option value	The estimated Black-Scholes value of the holdings of grantee i in series j. I estimate the implicit volatility as the standard deviation of daily log returns from the previous 252 trading days. I interpolate the risk-free rate from the Euribor rate (Helibor before the Euribor rate applied) for the time to maturity.
Option series characteristics	
Price-to-strike ratio	The ratio of the split-adjusted stock price to the option strike price.
Volatility	The annualized volatility of the daily stock return, estimated over the previous 252 trading days.
Dividend yield * Dividend indicator	100 times the product of a dummy indicating whether a dividend will be paid within the next 30 days and the ratio of the dividend payment to the current stock price.
Years to expiration	The number of years remaining until the expiration date of the options.
Recent vesting indicator	An indicator equal to one if the option grant has just become exercisable by the grantee, and zero otherwise.
High stock price indicator	An indicator that is equal to one if the stock price is above the 90^{th} percentile of its past year's distribution, and zero otherwise.
Trading frequency	The fraction of days that at least one option from option series j was traded in the previous month. The variable is defined only for listed options.
High trading frequency	An indicator equal to one if Trading frequency is above the median, and zero otherwise.
Listed series indicator	An indicator equal to one if the ESOs are traded on the exchange before expiration, and zero otherwise.
Grantee characteristics	
Top-10 grantee indicator	An indicator that identifies the ten largest grantees in option series j.
Male indicator	An indicator equal to one if grantee i is a male, and zero otherwise.
Age	The age of grantee i.

Table A2: Diversification Motives and Time to Maturity

This table examines the relationship between outside stock wealth and employees' decision to exercise or sell their ESOs early. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)		0.002	0.022	0.049***
		(0.09)	(1.07)	(3.79)
Ln(Outside stock wealth) * Years to expiration	–	-0.024***	-0.027***	-0.032***
		(-3.51)	(-4.27)	(-6.34)
Other control variables				
Ln(Company stock wealth)	+/-	-0.036***	-0.026***	-0.014***
		(-3.43)	(-3.46)	(-2.63)
Ln(Black-Scholes option value)	+/-	0.907***	0.807***	0.350***
		(12.98)	(5.85)	(9.24)
Price-to-strike ratio	+	0.326***	0.228***	0.269***
		(11.26)	(5.09)	(9.00)
Volatility	+/-	-0.227***	0.123	
		(-6.11)	(1.45)	
Dividend yield * Dividend indicator	+	0.231**	0.188*	
		(1.99)	(1.74)	
Years to expiration	–	-1.982***	-2.247***	-0.976***
		(-11.08)	(-6.88)	(-8.32)
Recent vesting indicator	+	2.994***	3.747***	0.289
		(3.57)	(4.55)	(0.69)
High stock price indicator	+	1.833***	1.412***	
		(4.75)	(3.99)	
Top-10 grantee indicator	–	-1.758***	-0.557***	-0.420***
		(-7.04)	(-2.78)	(-3.81)
Male indicator	+	0.056	0.255***	0.348***
		(0.70)	(4.23)	(6.43)
Age		-0.168***	-0.114***	-0.021
		(-6.63)	(-5.04)	(-1.49)
Age squared		0.002***	0.001***	0.000
		(5.42)	(4.10)	(0.35)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		3,338,639	3,338,636	3,121,058
Adjusted R-squared		0.046	0.064	0.228

Table A3: First-Stage Regressions

This table shows the first-stage regressions of the IV analysis reported in Table 4. The demutualization indicator takes the value of one if the grantee has received stocks from one of the demutualized companies, and zero otherwise. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: Ln(Outside stock wealth)			
	(1)	(2)	(3)
Instrument			
Demutualization indicator	3.263***	3.281***	3.196***
	(79.87)	(104.93)	(86.88)
Other control variables			
Ln(Company stock wealth)	0.311***	0.318***	0.328***
	(59.71)	(66.36)	(62.90)
Ln(Black-Scholes option value)	0.346***	0.378***	0.397***
	(36.50)	(30.96)	(49.54)
Price-to-strike ratio	-0.058***	-0.020	-0.046
	(-11.83)	(-4.79)	(-16.83)
Volatility	-0.010	-0.066***	
	(-1.06)	(-5.51)	
Dividend yield * Dividend indicator	0.013	0.002	
	(0.89)	(0.22)	
Years to expiration	-0.000	-0.034	-0.408***
	(-0.01)	(-1.17)	(-30.74)
Recent vesting indicator	-0.260**	-0.299***	0.014
	(-2.49)	(-4.04)	(0.29)
High stock price indicator	-0.282***	-0.138***	
	(-4.28)	(-3.05)	
Top-10 grantee indicator	0.359***	0.202***	-0.171***
	(6.21)	(6.67)	(8.60)
Male indicator	0.643***	0.597***	0.673***
	(47.04)	(47.80)	(46.05)
Age	-0.012**	-0.065***	-0.050
	(-2.18)	(-11.40)	(-9.27)
Age squared	0.000	0.001***	0.001***
	(0.45)	(14.08)	(11.29)
Option series FE	No	Yes	No
Firm-month-grantee zip code FE	No	No	Yes
N	3,338,639	3,338,636	3,121,058

Table A4: The Effect of Outside Stock Wealth for Top-Ranked and Lower-Ranked Employees

This table shows the result of one regression. The first column reports the coefficients for the set of regressors used in Table 4. The second column reports the coefficients for the product of the regressor with an indicator that is equal to one for the ten largest grantees in a given option series. t-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold		
	Main effect (lower ranked employees)	Top-10 grantee interaction term
Ln(Outside stock wealth)	-0.027***	0.004
	(-7.61)	(0.41)
Ln(Company stock wealth)	-0.014***	-0.019
	(-2.67)	(-1.52)
Ln(Black-Scholes option value)	0.362***	0.093***
	(9.20)	(2.64)
Price-to-strike ratio	0.297***	-0.036
	(8.44)	(-1.35)
Volatility		0.020
		(1.05)
Dividend yield * Dividend indicator		0.068
		(0.81)
Years to expiration	-1.096***	-0.332***
	(-8.56)	(-4.08)
Recent vesting indicator	0.339	-0.915
	(0.79)	(-1.25)
High stock price indicator		-0.243
		(-0.93)
Top-10 grantee indicator	0.383	
	(0.43)	
Male indicator	0.341***	0.036
	(6.04)	(0.42)
Age	-0.024*	-0.044
	(-1.66)	(-1.11)
Age squared	0.000	0.001
	(0.52)	(1.35)
Firm-month-grantee zip code FE	Yes	
N	3,121,058	
Adjusted R-squared	0.228	

Table A5: Top-Ranked and Lower-Ranked Employees - Additional Evidence

This table reports the output of an OLS regression. Some control variables are not included because they are subsumed by the fixed effects. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent Variable: 100 * fraction of available ESOs that are exercised or sold		
	Expected Sign	(1)
Independent variable(s)		
Ln(Outside stock wealth)	–	-0.028***
		(-7.75)
Top-10 grantee indicator	–	-0.495***
		(-4.19)
Ln(Outside stock wealth) * Top-10 grantee indicator		0.011
		(1.30)
Other control variables		
Ln(Company stock wealth)	+/-	-0.015***
		(-2.92)
Ln(Black-Scholes option value)	+/-	0.369***
		(9.40)
Price-to-strike ratio	+	0.278***
		(9.16)
Years to expiration	–	-1.119***
		(-8.81)
Recent vesting indicator	+	0.297
		(0.70)
Male indicator	+	0.341***
		(6.31)
Age		-0.032**
		(-2.20)
Age squared		0.000
		(1.06)
Firm-month-grantee zip code FE		Yes
N		3,121,058
Adjusted R-squared		0.228

Table A6: Employees Who Never Sell Outside Stocks

This table examines the relationship between outside stock wealth and employees' decision to exercise or sell their ESOs. Only observations where the employee owns outside stocks but systematically refrains from selling them are included. t-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)	–	-0.068***	-0.075***	-0.039**
		(-4.16)	(-3.64)	(-2.15)
Other control variables				
Ln(Company stock wealth)	+/-	-0.000	-0.005	0.004
		(-0.02)	(-0.39)	(0.32)
Ln(Black-Scholes option value)	+/-	0.844***	0.920***	0.312***
		(8.78)	(5.11)	(5.65)
Price-to-strike ratio	+	0.445***	0.183	0.926***
		(4.80)	(1.60)	(4.40)
Volatility	+/-	0.005	8.083***	
		(0.01)	(3.80)	
Dividend yield * Dividend indicator	+	17.767	13.834	
		(1.35)	(1.12)	
Years to expiration	–	-2.038***	-3.142***	-1.186***
		(-8.51)	(-6.42)	(-8.16)
Recent vesting indicator	+	1.662***	2.352***	-0.182
		(3.57)	(4.46)	(-0.35)
High stock price indicator	+	1.255***	1.157***	
		(2.83)	(2.86)	
Top-10 grantee indicator	–	-1.673***	0.157	-0.664***
		(-5.33)	(0.49)	(-4.08)
Male indicator	+	-0.089	-0.085	0.040
		(-0.88)	(-1.13)	(0.47)
Age		-0.209***	-0.156***	-0.109***
		(-5.76)	(-4.83)	(-2.90)
Age squared		0.002***	0.002***	0.001***
		(4.85)	(4.39)	(2.71)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		246,077	246,072	199856
Adjusted R-squared		0.052	0.069	0.329

Table A7: Subsample With Low Likelihood of Liquidity-Motivated Transactions

This table shows the results of OLS regressions in the subsample of grantees whose option position is worth at least €10,000. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)	–	-0.063***	-0.106***	-0.065***
		(-2.81)	(-4.77)	(-3.37)
Other control variables				
Ln(Company stock wealth)	+/-	-0.066**	-0.122***	-0.118***
		(-2.13)	(-7.91)	(-5.30)
Ln(Black-Scholes option value)	+/-	0.574**	-0.082	-0.363
		(2.23)	(-0.36)	(-1.33)
Price-to-strike ratio	+	0.201***	0.304***	0.194**
		(4.31)	(3.84)	(2.12)
Volatility	+/-	-0.174***	-3.128	
		(-8.89)	(-1.09)	
Dividend yield * Dividend indicator	+	0.466***	0.567***	
		(2.68)	(3.50)	
Years to expiration	–	-3.876***	-4.769***	-3.867***
		(-9.07)	(-7.70)	(-9.74)
Recent vesting indicator	+	6.896**	10.148***	0.220
		(2.55)	(4.48)	(0.16)
High stock price indicator	+	4.328***	3.246***	
		(5.25)	(5.42)	
Top-10 grantee indicator	–	-1.290***	1.221***	1.422***
		(-3.16)	(4.91)	(3.72)
Male indicator	+	0.682***	0.553***	0.653***
		(4.10)	(3.43)	(3.38)
Age		-0.288***	-0.544***	-0.107
		(-2.69)	(-5.92)	(-1.04)
Age squared		0.002**	0.005***	0.001
		(2.10)	(5.77)	(0.83)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		295,727	295,714	209,831
Adjusted R-squared		0.055	0.085	0.258

Table A8: Higher Threshold

This table shows the results of OLS regressions in the subsample of grantees whose option position is worth at least €50,000. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(Outside stock wealth)	–	-0.104***	-0.163***	-0.138***
		(-4.02)	(-7.18)	(-3.49)
Other control variables				
Ln(Company stock wealth)	+/-	-0.113***	-0.171***	-0.160***
		(-3.82)	(-6.33)	(-3.22)
Ln(Black-Scholes option value)	+/-	1.793***	-0.433	-1.757***
		(4.73)	(-1.42)	(-3.83)
Price-to-strike ratio	+	0.143***	0.286**	0.052
		(3.27)	(2.54)	(0.55)
Volatility	+/-	-0.189***	-3.946	
		(-6.47)	(-1.43)	
Dividend yield * Dividend indicator	+	1.074***	1.188***	
		(3.39)	(4.19)	
Years to expiration	–	-3.770***	-3.931***	-5.342***
		(-8.93)	(-9.05)	(-9.97)
Recent vesting indicator	+	9.679***	11.183***	-0.395
		(3.23)	(4.81)	(-0.21)
High stock price indicator	+	3.880***	3.048***	
		(5.11)	(4.55)	
Top-10 grantee indicator	–	-2.096***	1.758***	4.000***
		(-4.09)	(3.90)	(5.24)
Male indicator	+	1.135***	1.106***	0.601
		(3.47)	(3.58)	(0.85)
Age		-0.407*	-0.740***	-0.423
		(-1.81)	(-4.29)	(-1.60)
Age squared		0.004*	0.007***	0.004
		(1.72)	(4.19)	(1.52)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		69,275	69,262	39,621
Adjusted R-squared		0.052	0.090	0.240

Table A9: Option Series - Month Fixed Effects

In this table, I include option series-month fixed effects. Various regressors are excluded because they are subsumed by the fixed effects. t-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold			
	Expected sign	(1)	(2)
Independent variable(s)			
Ln(Outside stock wealth)	–	-0.018***	-0.025***
		(-5.59)	(-2.88)
Other control variables			
Ln(Company stock wealth)	+/-	-0.022***	0.033***
		(-4.80)	(2.78)
Ln(Black-Scholes option value)	+/-	-0.077*	0.163**
		(-1.73)	(2.05)
Top-10 grantee indicator	–	0.717***	0.242*
		(7.15)	(1.75)
Male indicator	+	0.441***	
		(9.51)	
Age		0.068***	
		(5.54)	
Age squared		-0.001***	0.000
		(-6.82)	(0.58)
Option series-month FE		Yes	Yes
Employee FE		No	Yes
N		3,337,769	3,337,378
Adjusted R-squared		0.206	0.242

Table A10: Alternative Measures of Outside Stock Wealth - Outside Investor Indicator

This table examines the relationship between an outside investor indicator (equal to one if the grantee owns stocks of other listed companies, and zero otherwise) and the behavior of ESO grantees. *t*-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Outside investor indicator	–	-0.396***	-0.297***	-0.238***
		(-6.33)	(-6.06)	(-7.89)
Other control variables				
Ln(Company stock wealth)	+/-	-0.043***	-0.031***	-0.016***
		(-4.30)	(-4.51)	(-3.25)
Ln(Black-Scholes option value)	+/-	0.910***	0.814***	0.366***
		(13.36)	(6.01)	(9.33)
Price-to-strike ratio	+	0.329***	0.227***	0.278***
		(11.29)	(5.07)	(9.16)
Volatility	+/-	-0.227***	0.125	
		(-6.11)	(1.47)	
Dividend yield * Dividend indicator	+	0.231**	0.188*	
		(1.99)	(1.74)	
Years to expiration	-	-2.074***	-2.350***	-1.115***
		(-12.13)	(-7.40)	(-8.78)
Recent vesting indicator	+	2.993***	3.743***	0.296
		(3.57)	(4.55)	(0.70)
High stock price indicator	+	1.826***	1.403***	
		(4.71)	(3.96)	
Top-10 grantee indicator	–	-1.749***	-0.571***	-0.435***
		(-6.96)	(-2.82)	(-3.95)
Male indicator	+	0.037	0.241***	0.339***
		(0.45)	(3.97)	(6.28)
Age		-0.178***	-0.125***	-0.033**
		(-7.02)	(-5.58)	(-2.30)
Age squared		0.002***	0.001***	0.000
		(5.70)	(4.61)	(1.13)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		3,338,639	3,338,636	3,121,058
Adjusted R-squared		0.046	0.064	0.228

Table A11: Alternative Measures of Outside Stock Wealth - Outside Stocks

This table examines the relationship between the number of outside stocks and the behavior of ESO grantees. t-statistics, reported in parentheses, are based on standard errors that are two-way clustered at the employee-month and at the option series-month level.

Dependent variable: 100 * fraction of available ESOs that are exercised or sold				
	Expected sign	(1)	(2)	(3)
Independent variable(s)				
Ln(1+Number of outside stocks)	–	-0.206***	-0.160***	-0.087***
		(-4.07)	(-4.07)	(-4.17)
Other control variables				
Ln(Company stock wealth)	+/-	-0.043***	-0.031***	-0.019***
		(-4.07)	(-4.36)	(-3.83)
Ln(Black-Scholes option value)	+/-	0.909***	0.812***	0.362***
		(13.18)	(5.97)	(9.27)
Price-to-strike ratio	+	0.330***	0.228***	0.278***
		(11.29)	(5.07)	(9.17)
Volatility	+/-	-0.228***	0.126	
		(-6.10)	(1.48)	
Dividend yield * Dividend indicator	+	0.231**	0.188*	
		(1.99)	(1.74)	
Years to expiration	-	-2.076***	-2.351***	-1.111***
		(-12.12)	(-7.40)	(-8.76)
Recent vesting indicator	+	2.997***	3.746***	0.297
		(3.57)	(4.55)	(0.70)
High stock price indicator	+	1.828***	1.405***	
		(4.72)	(3.96)	
Top-10 grantee indicator	–	-1.752***	-0.557***	-0.427***
		(-6.99)	(-2.78)	(-3.87)
Male indicator	+	0.043	0.245***	0.334***
		(0.53)	(4.14)	(6.26)
Age		-0.179***	-0.124***	-0.033**
		(-7.03)	(-5.57)	(-2.27)
Age squared		0.002***	0.001***	0.000
		(5.68)	(4.57)	(1.07)
Option series FE		No	Yes	No
Firm-month-grantee zip code FE		No	No	Yes
N		3,338,639	3,338,636	3,121,058
Adjusted R-squared		0.046	0.064	0.228

Table A12: Hazard Model

This table presents hazard ratios and t-statistics for the Cox hazard model. Observations following the first disposal of ESOs (at the employee-month-grant level) are excluded. Standard errors are clustered at the option series-month level.

Dependent variable: fraction of available ESOs that are exercised or sold		
	Expected sign	(1)
Independent variable(s)		
Ln(Outside stock wealth)	–	0.999***
		(-5.89)
Other control variables		
Ln(Company stock wealth)	+/-	0.999***
		(-5.90)
Ln(Black-Scholes option value)	+/-	1.001***
		(13.65)
Price-to-strike ratio	+	1.000**
		(2.05)
Volatility	+/-	0.994*
		(-1.93)
Dividend yield * Dividend indicator	+	1.000
		(0.15)
Years to expiration	-	0.997***
		(-7.71)
Recent vesting indicator	+	0.991***
		(-9.27)
High stock price indicator	+	1.001
		(1.61)
Top-10 grantee indicator	–	0.997***
		(-7.34)
Male indicator	+	1.010
		(0.25)
Age		1.000***
		(-5.83)
Age squared		1.000***
		(5.36)
N		3,026,237

Table A13: Fractional Logistic Estimator

This table presents coefficient estimates and t-statistics (in parentheses, standard errors are two-way clustered at the employee-month and at the option series-month level) for the fractional logistic estimator.

Dependent variable: fraction of available ESOs that are exercised or sold		
	Expected sign	(1)
Independent variable(s)		
Ln(Outside stock wealth)	–	-0.020***
		(-8.25)
Other control variables		
Ln(Company stock wealth)	+/-	-0.022***
		(-6.86)
Ln(Black-Scholes option value)	+/-	0.299***
		(22.37)
Price-to-strike ratio	+	0.069***
		(9.47)
Volatility	+/-	-1.505***
		(-6.02)
Dividend yield * Dividend indicator	+	0.061***
		(3.68)
Years to expiration	-	-0.874***
		(-14.10)
Recent vesting indicator	+	1.355***
		(5.93)
High stock price indicator	+	0.483***
		(5.65)
Top-10 grantee indicator	–	-0.573***
		(-9.10)
Male indicator	+	0.036
		(0.97)
Age		-0.039***
		(-4.59)
Age squared		0.000***
		(4.33)
N		3,338,639