

The Composition of Human Capital Within Firms

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Abstract

Human capital is crucial for the creation of intangible assets. Existing literature distinguishes between investments into knowledge and organizational capital, but little is known about how firms' skilled workers are distributed across these tasks. This project documents new facts, using a novel dataset on deferred compensation grants to five categories of skilled employees. The evidence shows that R&D scientists receive about half as much equity as marketers, lawyers, and administrators at most firms (including the information technology sector). This result cannot be explained by differences in employee numbers — marketers and administrative staff receive at least as much equity as a share of total compensation as R&D scientists. Since deferred equity conveys retention incentives, one interpretation is that firms face greater outside market competition for employees who create organizational capital than employees who create knowledge. Thus, firms' own compensation policies imply that organizational investments are significantly more important than previously thought.

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1 Introduction

Skilled employees create value for modern firms by contributing their human capital towards a wide range of activities. Scientists and engineers develop knowledge that leads to the creation of innovative products. Marketers design advertising campaigns and media outreach strategies, which inform potential customers about the firm's products and increase its brand appeal. Lawyers fine-tune the language of patent applications to ward off lawsuits, while administrative staff enforce workplace practices that foster the firm's culture. Such activities help to create intangible assets, which have grown rapidly since the 1980s and now comprise at least 1/3 of total corporate capital (Corrado and Hulten, 2010; Peters and Taylor, 2017; Falato et al., 2022).

Recent theoretical work has made significant progress in understanding the affirmative characteristics of intangible assets. One unique feature is that intangibles are partly embedded in employees' human capital. Because an employee cannot commit to remain at the firm throughout the process of creating an intangible asset, investment must be secured by deferring part of her compensation (Sun and Xiaolan, 2019; Eisfeldt et al., 2023; Doettling et al., 2025). Another unique feature of intangibles is that they are partially non-rival, allowing the firm to deploy them simultaneously across multiple divisions and to scale up their usage quickly (Crouzet et al., 2024). This has allowed innovative firms to capture significant rents over the past three decades (Crouzet and Eberly, 2023), but also makes the assets prone to duplication or expropriation by competitors.

Yet important gaps remain in researchers' understanding of intangible capital creation. Little is known about the distribution of skilled workers' tasks within the firm, and how much value firms derive from different applications of human capital. A standard empirical approach is to classify intangibles as either knowledge or organizational capital, and measure these assets by capitalizing annual R&D spending or a fraction of Selling, General, and Administrative (SG&A) expenses (Lev and Radhakrishnan, 2005; Eisfeldt and Papanikolaou, 2013; Peters and Taylor, 2017). This approach is useful for documenting the general growth of intangibles over time, but corporate cash spending may not correspond closely to employees' human capital contributions. Further, little progress has been made in determining the relative importance of different

activities for creating organizational capital.

This paper makes three contributions to this literature. First, it documents new facts on the composition of skilled employees' activities within publicly traded U.S. firms. It does this using a novel dataset of deferred equity grants that firms offer to five different categories of employees. Second, it interprets the evidence within a theoretical framework in which deferred equity conveys retention incentives. The framework shows that annual equity compensation is correlated with the outside market demand for a firm's non-replaceable human capital. Interpreting the evidence through this framework, firms' own pay policies indicate that there is greater demand for employees who create organizational capital than employees who create knowledge capital. Third, the paper empirically analyzes how the composition of equity grants to different employees varies over the life cycle of innovative firms.

The data on equity grants comes from footnotes to firms' annual financial statements. Since the mid-2000s, all U.S. firms have been required to expense total equity compensation (to all employees) in their income statements, and to disclose some basic information about grant parameters in a footnote. About 25% of firms further disclose a detailed breakdown of the equity grants, into several categories that correspond to individual line items in the income statement. For these firms, I can observe the distribution of equity grants to employees engaged in (1) R&D; (2) production; (3) marketing and sales; and (4) other general and administrative tasks. (Some firms, in particular Pharmaceuticals, combine the last two categories.) I further obtain data on equity grants to executives from Compustat ExecuComp.

I compile the detailed equity grant data for a sample of 1,649 firms covering the years 2010 through 2021.¹ Most sample firms operate in highly innovative sectors that rely heavily on equity to compensate employees: Pharmaceuticals (37% of sample firms), Software (22%), IT Hardware (15%), or Medical Devices (9%).

I document a variety of facts on equity grants to scientists, marketers, administrative staff, managers, and production workers. I measure each category's equity pay share as the annual value of equity grants to employees in the category, scaled by the annual value of equity grants

¹I use a Python script to extract information from all 10-K filings that are available on SEC EDGAR and use XBRL formatting. Firms also disclosed detailed equity grants in 2006 through 2009. I am in the process of compiling these data, which requires a more challenging procedure of directly parsing HTML code.

to all employees at the firm. For example, the equity pay share of a firm’s scientists is measured as the annual value of equity grants to R&D employees, divided by total annual equity pay. Thus, these equity pay shares capture the relative distribution of equity grants within the same firm and fiscal year.

The empirical methodology categorizes these detailed equity expenses into five different sets of skilled tasks: Knowledge, Marketing, Organizational, Managerial, and Production. Each detailed expense is measured as a ratio of total annual equity compensation expenses, to represent the composition of equity grants within each firm. For example, the equity grants to a firm’s employees working on Knowledge tasks in year t is measured using annual equity grants to R&D scientists, divided by total equity compensation granted by the firm in year t .

The key methodological assumption is that the correlation between equity expenses and outside market demand for human capital is the same across employee categories. Importantly, I do not need to assume that equity grants are precisely equal to a competitor firm’s valuation of the employees’ human capital. After all, existing work documents numerous non-retention reasons for granting equity to non-executive employees ([Gordon and Pound \(1990\)](#), [Graham et al. \(2004\)](#), [Babenko and Tserlukevich \(2009\)](#)). My methodology accounts for such determinants by comparing different categories of employees within the same firm and year (this is similar to using firm-year fixed effects). However, this approach would fail if there is greater demand for the human capital of R&D scientists than marketers, but a firm grants the same amount of equity to both types of employees.

The empirical analysis starts by presenting descriptive evidence on the composition of equity grants across different employee types. Across the entire sample, equity expenses are distributed remarkably equally across most categories of skilled employees. For the median firm-year observation, Knowledge employees receive 19.8% of the firm’s total equity grants in that year. Marketing employees receive 21.7%, Organizational employees receive 20.6%, and managers receive 24.2%. Production employees receive just 4.6%, consistent with the lower human capital intensity of goods production. Furthermore, at the median sample firm, the amount of equity granted to R&D scientists is equal to just 40.5% of the equity granted to marketers and administrative staff (“total organizational employees”) combined.

This composition is similar across almost all industries, including the information technology sector. At the median firm in the Software industry, for example, R&D scientists receive 45.2% as much equity as total organizational employees. The notable exception is Pharmaceuticals, where the median firm grants 4.9% more equity to R&D scientists than total organizational employees. This industry consists of numerous small firms that invest heavily into drug development, but engage in almost no marketing.

One interpretation of this evidence is that across most sectors of the U.S. economy, demand for the human capital of employees who acquire knowledge is significantly smaller than demand for the human capital of employees who build and maintain the firm's organizational value. This result is derived from firms' own compensation policies, combined with the assumption that the correlation between equity grants and human capital demand is similar across knowledge and organizational employees. It stands in stark contrast to academic research that has devoted significant attention to R&D investment and patenting outcomes, and relatively little to the importance of organizational investments.² The evidence is consistent with [Davydova et al. \(2023\)](#), who argue that intangible value arises primarily from network effects and economies of scale, and that such organizational capital is difficult to retain since it often cannot be patented.

One caveat is that the results have limited external validity for firms that choose not to disclose equity expenses across detailed categories of employees. The most important determinant of this choice is the amount of equity compensation paid out to employees (see [Figure 2](#)). The disclosure rate is generally high among information technology and medical firms. For example, 68% of Pharmaceuticals firms and 60% of Computers firms that grant equity compensation also disclose the expenses in detail. Notably, these sectors are among the fastest-growing in the U.S. economy, and comprise more than 25% of public market value.³

If R&D activities may scale up easily, then a firm may need fewer scientists overall than marketers or administrative staff. In this case, outside market demand aggregated over all of the firm's scientists may be lower for other employees. I test this by comparing the ratio of

²[Lerner and Seru \(2022\)](#) compile a list of finance studies that use patent data to understand innovative activity. Notable finance studies that measure organizational capital and its impact on firm value are [Eisfeldt and Papanikolaou \(2013\)](#), [Li et al. \(2018\)](#), [Dou et al. \(2021\)](#), [Cai and Prat \(2022\)](#), and [Desai et al. \(2022\)](#).

³In 2021, information technology firms constituted 18.7% of total U.S. market capitalization, while medical firms constituted 8.1%, based on Compustat data.

equity expenses over total operating costs for different categories of employees. Up to 83% of total R&D costs are compensation to scientists (Goolsbee, 1998), while total marketing or organizational costs contain a significant amount of non-compensation operating expenses, such as money spent to purchase advertisements. Therefore, if scientists receive the highest fraction of pay in equity, then the ratio of equity expenses over total operating costs should be highest for knowledge employees. Instead, the ratio is slightly higher for organizational employees (0.066) than knowledge employees (0.057).

I proceed to examine how the composition of equity expenses across employees varies with firm size and age. I focus on these determinants as a firm's reliance on particular types of human capital may change across the life cycle. Young or small firms may focus on knowledge acquisition and product development, and engage in little marketing until their products are ready to sell. Similarly, young or small firms may make limited organizational investments while their business models are specialized, but increase investment as they become larger and span a growing range of divisions or product groups. The analysis is also motivated by recent work showing that some firms build human capital while others acquire it (Ouimet and Zarutskie (2020), Beaumont et al. (2022)). Firms that focus on developing products with the intention of being acquired should invest more into knowledge than marketing. In contrast, firms that make frequently acquisitions should invest more into the organization, as they need to integrate different workplace cultures and pursue synergies.

However, initial results are somewhat puzzling. Using OLS regressions, I find a negative monotonic relationship between terciles of book assets and the share of equity grants to organizational employees. Conversely, there is a positive and monotonic relationship between size terciles and the share of equity grants to knowledge or marketing employees. This suggests that outside market demand is relatively greater for the organizational human capital employed at small firms, and for the knowledge and marketing human capital employed at large firms. The results are robust to controlling for a wide range of firm characteristics, and are not driven by any particular industry.

I conduct a similar regression analysis using terciles for the number of years since a firm's IPO. The composition of equity grants does not vary much across young and old firms. In par-

ticular, the share of equity grants to organizational employees is statistically indistinguishable across the age terciles.

The fact that large firms grant a large share of equity to knowledge and marketing employees could reflect that these firms are more successful, and invest more overall into R&D or branding. However, it is harder to explain why small firms grant relatively more equity to organizational staff, or why these employees do not receive a higher share of equity as the firm matures. The results could indicate that organizational tasks are fundamental to the operation of any public firm, and that firms diversify toward other tasks only as they grow larger. Alternatively, small firms may rely on organizational employees to attempt to establish network effects (Davydova et al. (2023)). Overall, the implication is that more academic research is needed to understand the importance of organizational capital.

This paper is closely related to He et al. (2025), who show that firms derive significant value from “customer capital” and similar intangible assets created by marketing activities. Their paper examines total sales and marketing expenses, and thus creates a more accurate measure of organizational capital than existing measures based on total SG&A spending. He et al. (2025) complement this with data on marketers’ salaries, obtained by sources such as Revelio labs. My paper differs by comparing data on equity grants to marketers with other categories of employees. A key point of differentiation is that my paper can infer the relative outside market demand for the non-replaceable human capital of scientists, marketers, and other types of employees.

The paper also contributes to a broad and growing literature on the importance of different types of employees for firm innovation and value. Babina (2020), Babina and Howell (2022), and Babina et al. (2022b) examine how skilled employees use the knowledge acquired in firms to begin startups. Another strand of research examines how firms’ skill distributions change following mergers (Ma et al. (2022), Lagaras (2021), Lagaras (2023)) or investments into cutting-edge technology (Zhang (2019), Tuzel and Zhang (2021), Babina et al. (2022a)). I contribute to these studies by using new data on equity compensation to proxy for the market value of human capital possessed by different types of employees within each firm. I further show how firms’ *own compensation policies* indicate that marketing and organizational staff may possess more valuable human capital than scientists.

2 Theoretical Motivation

This section shows how a firm's total unvested equity compensation can be interpreted as a measure of the outside market value of its non-replaceable human capital. It presents a highly simplified framework in which deferred compensation helps the firm to convey retention incentives to critical employees. The framework abstracts away from several common features of corporate investment models, and focuses on the core problem of retaining human capital.

2.1 Basic setup

Agents. The framework covers three periods $t = 0, 1,$ and 2 . In $t = 0$ the economy contains a single firm f with a project that requires human capital investment, and a unit mass of potential employees who are ex-ante identical. Each person possesses the same amount of common human capital h_0^c , which can represent knowledge acquired through higher education prior to the start of the project cycle. Additionally, at the start of $t = 1$ a new firm e obtains an investment opportunity which also requires human capital to execute. This entrant can either hire from the pool of generic employees or attempt to poach human capital from firm f .

Production. At the start of $t = 0$, firm f hires a single employee i whose job is to develop new human capital throughout the project cycle. During $t = 0$ the employee exerts effort at a cost normalized to 0, and by the start of $t = 1$ she creates new sector-specific human capital h_1^s and proprietary human capital h_1^p . If the employee remains at firm f during $t = 1$, then by the start of $t = 2$ she creates additional sector-specific and firm-specific human capital of h_2^s and h_2^p , respectively. Thus, employee i 's total human capital is $h_0^c + h_1^s + h_1^p$ at the start of $t = 1$ and $h_0^c + h_1^s + h_1^p + h_2^s + h_2^p$ at the start of $t = 2$, conditional on remaining at firm f .

To understand the different types of human capital, consider an example from an electric car manufacturer. h_0^c can represent general knowledge of battery chemistry that an employee could acquire at a university. h_t^s can represent specialized knowledge of the most recent battery technology, such as knowledge of solid-state designs that could potentially replace traditional lithium ion batteries. Such knowledge can be applied at a wide range of firms that produce electric vehicles, which could all adopt batteries with a new solid-state architecture. h_t^p can rep-

resent expertise with the software that a manufacturer develops to regulate battery charging, which only works with the firm's propriety network of charging stations. Such expertise has little applicability at other manufacturers, whose vehicles each have unique operating systems. Both sector-specific knowledge and proprietary expertise accumulate over time as the employee works in the sector, while general knowledge remains constant.

Firm f 's project produces a single cashflow at the start of $t = 2$, based on the amount of human capital that employee i has created. If she remains at the firm throughout the project cycle, then the cashflow is:

$$\theta_2^{f,i} = \eta_f (h_0^c)^\alpha (h_1^s + h_1^p)^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} \quad (1)$$

Eq. (1) is similar to a Cobb-Douglas production function, in which the sole inputs are the employee's three different types of human capital, and output has constant returns to scale in total human capital. One difference is that $\theta_2^{f,i}$ is a cashflow instead of output, so η_f subsumes both the firm's factor productivity and its pricing schedule.⁴ Regardless, the setup assumes that innovative firms' value depends on the amount of intangible capital they have accumulated, which in turn depends on skilled employees' human capital.

This setup also abstracts away from investment into physical capital, since the focus is only firms' valuation of human capital. The setup also initially abstracts away from risk by assuming that cashflows are deterministic (conditional on retaining human capital), but this assumption is briefly relaxed in Section 2.4.

Employee Utility and Compensation. All potential employees are risk neutral and have a utility function that is additively separable in consumption across periods. Further, consumption in $t = 2$ is discounted by a common factor of $\zeta < 1$. Employee i 's utility function is:

$$U_i = u(c_1^{i,f}) + \zeta u(c_2^{i,f}) \quad (2)$$

⁴This section's implications only require that human capital has a heterogenous effect on the cashflows of firms f and e . It is outside the scope of this paper to analyze whether intangible assets increase innovative firms' productivity or instead allow them to accumulate market power.

where $c_t^{i,f}$ represents consumption by employee i in period t from compensation granted by firm f . In $t = 0$, each employee also has a common reservation utility \underline{U}_0 , which can represent the utility from being unemployed or working in a different sector.

Firm f offers employee i a compensation contract in $t = 0$ that covers the entire project cycle. It contains a fixed wage w^f that the employee can consume at the start of $t = 1$, and an equity grant b^f that vests at the start of $t = 2$. This structure is consistent with [Oyer and Schaefer \(2005\)](#) and [Eisfeldt et al. \(2023\)](#), who show that innovative firms' employees receive significant amounts of equity alongside fixed salaries. Equity provides the employee with a share of firm f 's total value, which initially depends only on $\theta_2^{f,i}$ (this assumption is relaxed in [Section 2.4](#)). Thus, the employee's consumption in $t = 1$ is $c_1^{i,f} = w^f$, and her additional consumption from staying until $t = 2$ would be $c_2^{i,f} = b^f \theta_2^{f,i}$.

Entry and Poaching. The new firm e enters the sector at the start of $t = 1$. It requires human capital during $t = 1$ to produce a cashflow in $t = 2$, but initially has no employees. Firm e can either poach employee i away from firm f , or alternatively hire an employee j from the general pool of labor. If employee i is poached, then she brings her existing human capital $h_0^c + h_1^s$ to firm e at the start of $t = 1$, and can further create new human capital $h_2^s + h_2^p$ during the period. However, the employee can not apply any of her proprietary human capital h_1^p developed at firm f . Firm e 's cashflow in this case would be:

$$\theta_2^{e,i} = \eta_e (h_0^c)^\alpha (h_1^s)^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} \quad (3)$$

Poaching only succeeds if firm e 's competing offer provides employee i with more utility than she would receive from remaining at firm f . By assumption, the competing offer consists of only an equity stake b^e that vests at the start of $t = 2$, and would provide the employee with consumption in $t = 2$ of $c_2^{i,e} = b^e \theta_2^{e,i}$.

Alternatively, if firm e hires employee j from the general pool, its cashflow would be:

$$\theta_2^{e,j} = \eta_e (h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \quad (4)$$

Because employee j was unemployed during $t = 0$, she possesses no sector-specific human capital h_1^s and the firm produces a lower cashflow $\theta_2^{e,j} < \theta_2^{e,i}$.

When employee i is poached, firm f can only retain a fraction $\gamma < 1$ of the human capital she created during $t = 0$, so that the firm's total human capital upon losing the employee is $\gamma(h_1^s + h_1^p)$. This can represent knowledge or ideas that a departing employee has shared with her co-workers or management, code that the employee has partially developed and which is stored on the firm's servers, or clients recruited by the employee who continue to do business with the firm after she leaves. However, a skilled employee also may have some ideas that have not been shared with the firm or recorded on accessible media. Further, she may possess innate talent, skills, or client relationships that her remaining colleagues do not have and cannot emulate.

While firm f cannot replace the human capital $(1 - \gamma)(h_1^s + h_1^p)$, it can hire an employee from the generic labor pool in $t = 1$, to produce human capital during the period that increases the firm's intangible assets in $t = 2$. In this case, firm f 's cashflow is:

$$\theta_2^{f,j} = \eta_f (h_0^c)^\alpha (\gamma[h_1^s + h_1^p])^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} \quad (5)$$

Note that firm f 's cashflow from hiring an employee j is higher than firm e 's cashflow, because some of employee i 's human capital can be used by the new employee. (Firm f also faces higher compensation costs than firm e , since it pays the wage w^f to employee i even when she departs.)

2.2 Statement of Problem

I apply backward induction to the setup to derive firm e 's competing offer and employee i 's participation constraints.

First, suppose that employee i 's compensation at firm f is sufficiently low such that firm e could credibly match it and poach the employee. In this case, the competing offer b^e must set employee i 's monetary payoff in $t = 2$ equal to the marginal impact of her human capital on firm e 's cashflow. If firm e were to instead offer a lower payoff, then the employee she could credibly renegotiate with firm f to receive a higher equity grant and stay at the incumbent

firm.⁵ Firm e also would not grant employee i a payoff that exceeds her marginal impact on cashflows, since otherwise the entrant's value (net of employee compensation) would be higher from hiring employee j . Put differently, employee i has more human capital than employee j , and firm e can only access this sector-specific human capital through poaching. As a result, employee i has full bargaining power in a compensation negotiation with firm e .

The marginal impact of employee i 's human capital on firm e 's cashflow is:

$$\begin{aligned}\theta_2^{e,i} - \theta_2^{e,j} &= \eta_e (h_0^c)^\alpha (h_1^s)^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} - \eta_e (h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \\ &= \eta_e (h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \left[(h_1^s)^\beta - 1 \right]\end{aligned}\quad (6)$$

Eq. (6) shows that the marginal impact is based on the sector-specific human capital that she developed during $t = 1$, which employees from the general pool do not possess.

Further, the competing offer b^e must satisfy:

$$\begin{aligned}b^e \theta_2^{e,i} &= \eta_e (h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \left[(h_1^s)^\beta - 1 \right] \\ \Rightarrow b^e &= 1 - \frac{1}{(h_1^s)^\beta}\end{aligned}\quad (7)$$

Next, I analyze how firm f sets its initial compensation choices (w^f, b^f) at the start of $t = 0$, anticipating the competing offer b^e . The firm faces two employee participation constraints, which determine each compensation component. First, at the start of $t = 1$, employee i 's utility from remaining at firm f must match her utility from moving to firm e :

$$\begin{aligned}u(c_1^{i,f}) + \zeta u(c_2^{i,f}) &\geq u(c_1^{i,e}) + \zeta u(c_2^{i,e}) \\ \Rightarrow u(w^f) + \zeta u(b^f \theta_2^{f,i}) &\geq u(w^f) + \zeta u(b^e \theta_2^{e,i}) \\ \Rightarrow b^f \theta_2^{f,i} &\geq \eta_e (h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \left[(h_1^s)^\beta - 1 \right]\end{aligned}\quad (\text{PC}_1)$$

⁵This statement is only true when firm f can match any offer that firm e would be willing to make. The employee creates more intangible capital by remaining at firm f than by joining firm e . However, when the entrant's total productivity η_e is sufficiently high relative to the incumbent's total productivity η_e , then firm e can always poach the employee in $t = 1$. I do not study this possibility further, since it implies an equilibrium in which firm f anticipates that it cannot retain employee i and hence does not offer any unvested equity grant.

When firm f grants b^f such that (PC_1) is just satisfied, then the employee cannot be poached and will contribute her human capital to firm f throughout the project cycle. This occurs when the monetary value of her equity stake in firm f matches the highest competing offer that firm e would make. Note that the wage w^f does not convey any retention benefit: Because it vests at the start of $t = 1$, the employee can claim this wage and still join firm e . Thus, even though the employee prefers a unit of consumption in $t = 1$ to the same unit in $t = 2$, a significant portion of her compensation must be back-loaded. This arises because the employee cannot commit to stay at firm f throughout $t = 1$ if all of her pay is granted at the start of the period.

(PC_1) implies that firm e can guarantee employee i 's retention by making the equity grant:

$$b^f = \frac{\eta_e (h_1^s)^\beta - 1}{\eta_f h_1^s + h_1^p} \quad (8)$$

The employee's second participation constraint is that her total utility from working for firm f must exceed her reservation utility \underline{U}_0 :

$$\begin{aligned} & u(c_1^{i,f}) + \zeta u(c_2^{i,f}) \geq \underline{U}_0 \\ \Rightarrow & u(w^f) + \zeta u(b^f \theta_2^{f,i}) \geq \underline{U}_0 \\ \Rightarrow & w^f \geq u^{-1}(\underline{U}_0 - \zeta u(\eta_e (h_0^e)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} [(h_1^s)^\beta - 1])) \end{aligned} \quad (PC_0)$$

(PC_0) shows that the fixed wage payment's role is to ensure that employee i receives sufficiently high total utility from working, such that she is willing to join firm f at the start of $t = 0$. Note that if \underline{U}_0 is less than the (discounted) utility received from the equity grant $\zeta u(b^f \theta_2^{f,i})$, then employee i is willing to work for firm f in exchange for just unvested equity pay received in $t = 2$. In this case, part of the benefit to the employee of contributing her human capital during $t = 0$ is that it allows her to create human capital of h_1^s , which increases the value of a competing offer she could receive in $t = 1$ (and hence allows her to bargain for higher compensation at firm f).

2.3 Implications for Interpreting Equity Grants

In this simple theoretical framework, skilled employees are employed by innovative firms to create both sector-specific and proprietary human capital. A portion of this human capital is non-replaceable, in that the firm loses it when an employee leaves and also cannot hire another worker with the same human capital. A skilled employee's human capital also has an outside market value, in that the employee can bring some of her human capital to a new firm, helping it to generate a higher cashflow than it would receive from hiring a generic worker.

The first main implication is that the value of a firm's annual unvested equity compensation can be interpreted as the outside market value of its non-replaceable human capital, which I denote $V^e(H)$. This follows from (PC₁), which shows that the monetary value of employee i 's equity stake at firm f must equal the competing payoff from firm e . This expression also shows that $V^e(H)$ precisely equals the employee's marginal impact on the new firm's cashflows. Further, note that only sector-specific human capital has an outside market value.

The second implication is that the value of a firm's annual unvested equity compensation generally *cannot* be interpreted as the firm's internal value of non-replaceable human capital. This internal value, denoted $V^f(H)$, is the difference in firm f 's cashflow from retaining employee i in $t = 1$ versus losing her and hiring employee j instead:

$$\begin{aligned} \theta_2^{f,i} - \theta_2^{f,j} &= \eta_f (h_0^c)^\alpha (h_1^s + h_1^p)^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} - \eta_f (h_0^c)^\alpha (\gamma[h_1^s + h_1^p])^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} \\ \Rightarrow V^f(H) &= (1 - \gamma)\eta_f (h_0^c)^\alpha (h_1^s + h_1^p)^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} \end{aligned} \quad (9)$$

A third implication is that the difference between the internal value of non-replaceable human capital and outside market demand for it is driven by the ability to retain human capital as well as productivity differences across firms. Comparing Eq. (9) to (6) and re-arranging expressions yields:

$$\begin{aligned} V^f(H) - V^e(H) &= \eta_f (1 - \gamma) (h_0^c)^\alpha (h_1^s + h_1^p)^\beta (h_2^s + h_2^p)^{1-\alpha-\beta} - \eta_e (h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \left[(h_1^s)^\beta - 1 \right] \\ &= \eta_f (1 - \gamma^\beta) (h_1^s + h_1^p)^\beta - \eta_e [(h_2^s)^\beta - 1] \end{aligned} \quad (10)$$

Eq. (10) shows that $V^f(H)$ can differ from $V^e(H)$ because firm f retains fraction γ of both employee i 's sector-specific and proprietary human capital, while firm e can poach all of the employee's sector-specific human capital but none of her proprietary human capital. The expressions also differ since each firm's valuation of human capital depends on its own total productivity term. Yet Eq. (10) also indicates that $V^f(H)$ and $V^e(H)$ are similar when (i) the incumbent firm retains a similar amount of human capital as the entrant gains from poaching; and (ii) the two firms have similar total productivity. When these conditions both hold, the value of a firm's annual unvested equity compensation also approximates a firm's internal value of non-replaceable human capital.

2.4 Possible Extensions

Project Risk. Next I briefly analyze how risk affects the above implications. Suppose that all employees are risk-averse, and that the cashflows of both firms f and e are stochastic with volatilities of σ_f^2 and σ_e^2 , respectively. (This can be modelled by specifying η_f and η_e as random variables.) Each employee has mean-variance preferences over consumption, with risk-aversion parameter ρ . Further, each firm has an initial cash endowment C_0^f or C_0^e that remains on the balance sheet until the end of the project's completion. As shown in (PC'₁) below, cash holdings can reduce the employee's exposure to project risk, and thus increase her utility from equity compensation.

In this setup, the marginal impact of employee i 's human capital now depends on the expected value of firm e 's total productivity:

$$\theta_2^{e,i} - \theta_2^{e,j} = \mathbb{E}_1[\eta_e](h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \left[(h_1^s)^\beta - 1 \right]$$

Employee i 's participation constraint (PC₁) can be re-expressed as:

$$\begin{aligned} c_1^{i,f} + \zeta \mathbb{E}_1[c_2^{i,f}] - \rho(b^f)^2 \sigma_f^2 &\geq c_1^{i,e} + \zeta \mathbb{E}_1[c_2^{i,e}] - \rho(b^e)^2 \sigma_e^2 \\ \Rightarrow b^f(C_0^f + \mathbb{E}_1[\theta_2^{f,i}]) - \rho(b^f)^2 \sigma_f^2 &\geq b^e(C_0^e + (h_0^c)^\alpha (h_2^s + h_2^p)^{1-\alpha-\beta} \left[(h_1^s)^\beta - 1 \right]) - \rho(b^e)^2 \sigma_e^2 \end{aligned} \tag{PC'_1}$$

The revised constraint (PC'_1) shows that a firm's unvested equity compensation is no longer necessarily equal to the outside market value of its non-replaceable human capital. When an employee is risk averse, she requires a premium in exchange for receiving equity compensation at either firm f or e . The risk premium depends on the relative volatilities of the two firm's cash-flows, as well as the relative size of their cash endowments. Put differently, if an entrant has a highly risky project and the incumbent firm is relatively safe, then the incumbent can retain the employee even by offering deferred compensation that is smaller than the employee's marginal productivity at the new firm. This is because the employee's utility valuation of deferred compensation at the incumbent can differ from her utility valuation of the entrant's competing offer.

However, this extension shows that unvested equity compensation can be reasonably interpreted as the outside market value of human capital when firms competing over human capital are reasonably similar. If both firms f and e are established innovative firms with mature business models, then they may expose the employee to similar levels of project risk. For example, firm e could represent a large information technology company that is launching a new project to develop electric vehicles. The firm could benefit from poaching an existing electric vehicle company's human capital, but the overall risk of equity ownership in the two firms may be similar. The interpretation of unvested equity compensation is less accurate when young startup firms primarily compete for the human capital of established innovative firms.

Different Categories of Human Capital. The framework developed in this section only considers a single category of human capital. Yet modern innovative firms combine multiple categories of human capital into a single organizational structure.

One way to model multiple categories of human capital is to re-express firm f and e 's total productivity factors (η_f and η_e) as the products of marketing and organizational human capital, which enhance the knowledge human capital contributed by employee i . This would not change the implications from Section 2.3. The outside market value of a skilled employee's human capital would still equal that employee's marginal impact on firm e 's cashflow, which firm f would need to match with its unvested equity grant. However, extending the model in this way clarifies that the employee's marginal impact on firm e 's cashflow depends on the entrant's level of marketing and organizational human capital. Also, the difference between the internal and

outside value of human capital (from Eq. (10)) now depends on the relative level of marketing and organizational human capital between firms f and e .

looseness=-1

Equity Expenses. Finally, accounting rules require firms to expense only the value of equity that vests in each year. Suppose that a firm has overlapping project cycles, which require granting new equity compensation to an employee in each year. It is typical for firms to grant equity that vests proportionally over a three- to five-year period. Thus, equity expenses in any given year typically depend in part on equity compensation granted over the past few years. Analyzing overlapping project cycles is beyond the scope of this simple framework. However one implication is that if the outside market value of the employee's non-replaceable human capital rises over time, then the value of annual equity grants should as well. In this case, the annual equity expense will understate the outside market value of non-replaceable human capital, since it is based partly on the (lower) value of grants made in prior years.

3 Construction of Human Capital Measures

3.1 Disclosure of Equity Expenses

The main data used in this paper became available due to the adoption of accounting standard FAS 123-R (since re-codified as ASC 718) in the United States between 2005 and 2006. FAS 123-R required firms to begin expensing new stock option grants in their income statements, along with previous grants that had not yet vested. (Other equity grants already had to be expensed prior to 2005.) Firms now must expense the grant-date fair value of total equity compensation to all employees, pro-rated over each grant's vesting period.

All firms include these equity expenses in one or more income statement line items, but they do not report them as a separate line item. For example, the R&D line item combines expenses for all equity grants paid to scientists together with scientists' wages and the cost of supplies used during R&D activities. Firms also are required to disclose information on total annual equity expenses in a footnote to the financial statements (data available in Compustat), as well as to report equity expenses for the five highest-paid executives in a different filing (data

available in ExecuComp).

Some firms however choose to disclose the detailed equity expenses that they allocate to each line item in the income statement. These expense values are typically reported in a table, placed in the same footnote in which total annual expenses are disclosed. The SEC encourages (but does not require) these disclosures. The data used in this paper comes from these tables.

Figure 1 contains two examples of such disclosures, for Meta Platforms, Inc. (formerly Facebook) in 2017 and Becton, Dickinson, and Company in 2011. Meta discloses option expenses corresponding to four different line items: Cost of revenue (which is another name for Cost of Goods Sold or COGS), Research and development, Marketing and sales, and General and administrative. Firms often report the latter two line items separately, but Compustat combines them into a single SG&A item.⁶ Becton-Dickinson does not report marketing separately from other administrative expenses in the income statement, and its disclosure table instead contains a single entry that combines equity expenses for both categories of workers.

Importantly, the SEC requires firms to expense equity grants consistently with other forms of employee compensation. Specifically, SEC staff have clarified that “the [equity] expense should be reported in the same income statement line or lines as cash compensation paid to the same employees”.⁷ Thus firms are prohibited from manipulating the values disclosed in the footnote tables by, for example, including an employee’s equity expenses in the marketing line item while simultaneously expensing their wages in the R&D item. Indeed, Meta reports on page 39 of its 10-K that its Cost of Revenue entry in Figure 1 covers “share-based compensation for employees on our operations teams”; the R&D entry covers “employees on our engineering and technical teams who are responsible for building new products, as well as improving existing products”; the marketing and sales entry covers “employees engaged in sales, sales support, marketing, business development, and customer service functions”; and the general and administrative category covers “executives as well as our legal, finance, human resources, corporate communications and policy, and other administrative employees.”

⁶A Compustat service representative confirmed that the database does not include a separate item for marketing and sales expenses. Compustat collects data on advertising expenses, but this is a different income statement line item that is only reported by about half of firms in the database.

⁷See the newsletter “Share-based payments: Navigating the guidance in ASC 718” published by Grant Thornton on April 22, 2021.

3.2 Sample Construction

I start by identifying 6187 firms that grant any equity compensation during the years 2010 through 2021. I start in 2010 as it is the first year for which data is available in XBRL format for most U.S. firms.⁸ I downloaded from SEC EDGAR all XBRL 10-K filings that these firms submitted during the sample period. Next, I retained the filings of 1649 firms that disclosed equity expenses for detailed categories, such as those in Figure 1. Thus 27% of firms that grant equity compensation choose to disclose the associated expenses in detail.

The benefit of XBRL formatting is that each financial fact in a 10-K is “marked up” with tags placed immediately before and after each number. The SEC has developed a taxonomy of tags, so that financial facts are labelled consistently across filings. For example, when a firm discloses equity expenses allocated to the R&D account in a footnote table, it typically labels the value with the tag “ResearchAndDevelopmentExpenseMember”. Because labelling is consistent across filings, a programming script can be used to extract all equity expense values disclosed in the 10-K. Essentially, footnote tables such as those in Figure 1 can be exported into a database. I use Python’s Beautiful Soup module to create this database, which has individual observations at the firm-fiscal year-expense category level for the 1649 firms that disclose detailed expenses.

Firms also disclosed equity expense data in tabular form during 2006 through 2011, but 10-K filings in these years are typically written in HTML or Javascript. I am currently working to extend the database to cover these years. Extracting these footnote tables is significantly more challenging, because the structure of the 10-K source code is typically inconsistent across firms.

Most of the 1649 sample firms disclose expenses for either four categories of employees (as does Meta) or for three categories (as does Becton-Dickinson). The only major difference is that 641 firms disclose expenses separately for a “Marketing and Sales” line item and an “Other SG&A” line item, while 1008 firms combine these expenses into a single line item (typically SG&A). A small number of firms disclose expenses for more than four categories, usually by further breaking down the COGS line item. These additional categories tend to contain small value and are in-

⁸In 2009 the SEC adopted a rule that required firms to begin reporting financial statements in XBRL format (see SEC Release No. 33-9002). Firms appeared to gradually adjust their 10-K formats, and the number of XBRL filings rose significantly from 2010 through 2012. However, in each filing firms typically report equity expenses for each of the past three years. Therefore, I was able to extract data for 2010 for most firms.

consistently reported across firms, so I combine them into the main categories of human capital.

Note that the footnote tables typically do not separately disclose expenses for executive equity grants. Top executives apply their human capital to significantly different tasks than do lower-level employees, so it makes sense to categorize them separately. For firms in ExecuComp, I collect data on annual expenses from equity grants made to all of their top executives. (Most ExecuComp firms report data for the five to seven highest-paid executives.) I sum up these managerial equity expenses for each firm-year. For sample firms that are not in ExecuComp, I extrapolate managerial expenses. I first calculate the value of managerial/total expenses for the median ExecuComp firm in each of the 48 Fama-French industries. Then, I multiply this median ratio by the value of total annual expenses for each non-ExecuComp firm. Further, for all firms I subtract managerial expenses from organizational employee expenses, since executive compensation is most often included in the SG&A line item.

3.3 Categories of Human Capital

As Section 2 explains, the motivating theory of this paper is that annual equity expenses are associated with the outside market demand for non-replaceable human capital possessed by the firm's employees (but not necessarily equal to it). Under this framework, detailed expense disclosures can be used to measure the composition of the market value of a firm's human capital across different categories of employees. Five categories are used throughout the paper:

- **Knowledge HC** is measured using equity expenses included in the R&D line item. This category represents human capital possessed by scientists and engineers.
- **Marketing HC** is measured using equity expenses included in the "Marketing and Sales" line item. This category represents human capital possessed by marketers, and also salespeople whose role is to develop and service client relationships.
- **Organizational HC** is measured using equity expenses included in the "Other SG&A" line item. This category represents human capital possessed by human resources staff, lawyers, data analysts, and any administrative staff whose role is to maintain workplace practices and organizational culture.

- **Managerial HC** is measured using equity expenses for grants to top executives. This category represents human capital possessed by the CEO, C-Suite executives, and a few other top managers.
- **Production HC** is measured using equity expenses included in the COGS line item. This category represents human capital possessed by factory managers, logistics specialists, and other employees involved directly in the production process.

Note that these five categories apply to the 641 firms that disclose detailed expenses for marketing and organizational employees separately. For the 1008 firms that combine these expenses, I use four categories including a single “Marketing and Organizational HC” category.

Most of the empirical analysis expresses each measure as a fraction of total annual expenses for equity granted by the firm to all of its employees. These ratios are measured as the annual equity expense from grants to each category of employees at the firm, divided by the firm’s total equity expenses (summed across all categories) in that year. One advantage of using ratios is that they account for all firm-level determinants of equity grants that are unrelated to human capital retention, as long as those equity grants are made proportionally across the above categories.⁹

3.4 Comparison to Capitalization Approach for Measuring Intangibles

Existing literature widely recognizes that the application of skilled human capital is an important part of intangible capital creation (Bolton et al. (2019), Sun and Xiaolan (2019), Doettling et al. (2025), Crouzet et al. (2024)), alongside firm investments such as spending on laboratory supplies, advertising purchases, and acquisition of big data. The literature typically classifies the resulting assets as either Knowledge capital or Organizational capital.

The most common approach for measuring intangible capital is to separately capitalize total R&D spending and 30-40% of total SG&A expenses, with assumptions made about depreciation

⁹For example, suppose that the true value of a firm’s non-replaceable human capital is \$100 for knowledge category, \$80 for marketing, and \$50 for organizational. The firm grants deferred equity to each category of employees that is equal in value to the employees’ non-replaceable human capital. Yet the firm also grants an extra 10% equity to all employees for non-retention purposes, so equity expenses are \$110 for knowledge employees, \$88 for marketing, and \$55 for organizational. In this case, the within-firm distribution of equity expenses is equal to the distribution of non-replaceable human capital.

rates for each expense. These capitalized values equal the stock of Knowledge and Organizational capital. [Peters and Taylor \(2017\)](#) provide a detailed discussion of this capitalization approach.¹⁰ This approach provides useful insights about the time-series evolution of intangible asset values. However, several measurement issues limit the approach’s applicability to estimating the composition of human capital within firms.

First, the capitalization approach uses information from income statement line items. While these items include equity expenses from grants to skilled employees, they also contain a wide range of cash expenditures that are not directly related to human capital. For example, the R&D line item includes expenditures on lab supplies, while SG&A includes spending to place advertisements that marketers have already developed. Both categories also include significant expenses for wages paid to employees, some of whom likely possess little non-replaceable human capital. Put simply, the capitalization approach measures intangible assets created by both human capital and firm spending, and does not attempt to isolate the human capital embedded in them.

Second, a firm’s accounting expenses decrease as it learns to use cash more efficiently, but under the capitalization approach this would lead to a reduction in intangible capital (all else equal). For example, firms can reduce SG&A expenditures by using analytics to re-structure supply chains. This investment would likely increase the amount of non-replaceable human capital possessed by organizational or production employees, but it would also lead to a reduction in the capitalized amount of Organizational capital.

Third, the capitalization approach relies heavily on the SG&A line item. This is a broad category of expenditures, many of which do not reflect intangible investment. The literature recognizes this by only capitalizing a fraction of SG&A, but applying the same fraction to all firms leads to noisy measures of Organizational capital. Moreover, the majority of Compustat firms report no R&D spending, meaning that the value of intangible assets at these firms is based solely on SG&A.

Fourth, individual income statement line items likely display higher time-series volatility

¹⁰Another approach is to measure intangibles using information on firms that are acquired or undergo a bankruptcy ([Ewens et al. \(2020\)](#)). This approach provides more detailed measures, but only for a subset of publicly traded firms.

than the human capital corresponding to each item. Annual cash spending on R&D or SG&A is partly driven by shocks that are unrelated to human capital. The SG&A measure in particular changes over time as firms adjust their operating efficiency. As such, some of the annual variation in capitalized intangible assets is uncorrelated with changes to the amount of human capital possessed by the firm. This measurement issue likely varies across industries and with other firm-level characteristics.

This paper attempts to overcome these challenges by following a revealed preference approach. Rather than using broad accounting measures that vary significantly across firms, it measures human capital using the value of deferred equity that firms grant directly to employees. While one can argue about the extent to which equity grants convey retention incentives, the expenses themselves are measured accurately in each year and for each category. This makes it easy to study how equity expenses change over time for different types of employees.

3.5 Potential Selection Issues

As explained above, firms choose whether or not to disclose detailed categories of equity expenses in 10-K footnote tables. Naturally, this means that the baseline sample contains a selected subset of all U.S. publicly traded firms. Thus all evidence presented in the paper may have limited external relevance to firms that choose not to disclose detailed expenses.

One of the key determinants of a firm's disclosure choice is its overall reliance on equity grants to compensate employees. Figure 2 shows the correlation between total annual equity expenses (as a share of total operating expenses) and the fraction of firms in an industry that disclose detailed equity expenses. Each point in the figure represents one of the 48 Fama-French industries. The correlation is positive overall.¹¹ The figure also shows that firms in the Information Technology or Medical industries are far more likely to disclose detailed expenses than firms in other industries. These firms also grant large amounts of equity to employees. For example, 68% of Pharmaceuticals firms and 63% of Medical Equipment firms, and 60% of Computers firms disclose detailed expenses.

¹¹The main outlier is the Precious Metals industry. In this industry equity expenses amount to 11.6% of total operating expenses, but only 7% of firms disclose detailed expenses. However, the industry represents only 0.4% of the sample in Figure 2.

Importantly, this choice has no direct impact on firms' earnings or valuations. FAS 123-R required firms to expense all equity compensation, and the income statement values do not depend on how firms further choose to disclose this information in their 10-K footnotes. The choice also has no direct impact on commonly used valuation metrics such as the P/E or EV/EBITDA ratios, since these are based on broad measures of earnings.

One remaining concern is that some firms choose not to disclose detailed equity expenses for strategic reasons. For example, a firm that faces fierce competition for its scientists may not want to disclose equity expenses for the R&D account, as this could provide information about the scientists' retention incentives. However, such strategic considerations are likely to be small for most firms. All firms must report total R&D expenses as well as total expenses from equity compensation. Alongside this information, detailed equity expense disclosures might not have much marginal value for a firm's peers.

4 Descriptive Analysis of Human Capital Composition

The empirical analysis begins by documenting descriptive statistics on the value of equity grants to employees, as well as the composition of equity grants across different categories of skilled employees within the firm.

4.1 Total Value of Equity Grants

I first briefly compare the magnitude of equity grants to physical investment in Figure 3. This comparison provides some indication of how investment into non-replaceable human capital has evolved over time, under the motivating assumption that equity expenses are associated with this capital stock. The sample is all 1649 firms that disclose detailed equity expenses, including those that combine marketing and organizational expenses into a single category.

Panel A plots total annual equity expenses and capital expenditures, for the median sample firm. Total equity expenses declined slightly from 2010 through 2013, but since then they have increased in each year, from \$4.6M in 2013 to \$11.1M in 2020. In the final sample year, equity expenses jumped by a further 64% to \$18.2M. Over the same time period, capital expenditures

declined from \$7.2M to \$5.1M. The plots further show that total equity expenses have exceeded capital expenditures in all years since 2014. This indicates that the outside market value of human capital has grown significantly relative to physical investment, which is consistent with evidence on the rising importance of intangible assets (Falato et al. (2022)).

Firms pay substantial amounts of equity compensation to top executives, and some of these grants may reflect the need for incentive alignment rather than human capital retention. Therefore Panel A also plots expenses for equity grants to all non-executive employees. These grants constitute about 2/3 of total equity expenses for the median firm, and they have also risen consistently since 2013. Moreover, these expenses have been larger than capital expenditures for the median firm since 2016.

As discussed in Section 3.5, only a select subset of publicly traded firms disclose detailed equity expenses, and disclosure rates are highest among Information Technology and Medical firms. These firms' capital expenditures are also lower than those of the median publicly traded firm, and thus Panel A may overstate the importance of human capital across the entire economy. Panels B and C document the same plots, but separately for Information Technology/Medical firms and Traditional firms. Panel B shows that capital expenditures are small and declining for Information Technology and Medical firms, while the value of equity grants in recent years is about twice as large as capital expenditures, even after excluding top executives. Unsurprisingly, Panel C documents a different result for Traditional firms. Their capital expenditures are growing over time, and exceed equity expenses in all years. However human capital investment is non-trivial even among these firms—in 2020, total equity expenses were about half as large as capital expenditures (one-third when excluding executives).

Overall, Figure 3 indicates that compensation for human capital investment is growing over time, and now constitutes a significant portion of total firm investment. Notably, these plots may understate firms' total investment into human capital, since equity grants are not the only mechanism that firms use to retain skilled employees.

4.2 Composition of Human Capital within Firms

Next I report summary statistics on equity expenses for different categories of skilled employees. Table 1 reports statistics on annual expenses to employees in each category as a ratio of a firm's total annual equity expenses, across all firm-year observations in the sample. Under the paper's motivating assumption, these ratios represent the composition of market demand for non-replaceable human capital possessed by different types of employees within the firm.

Panel A reports statistics for the 641 firms that disclose expenses for five categories, including separate expenses for marketing and organizational employees. For these firms, total equity expenses are broken down into five categories of skilled employment. The composition of equity grants is remarkably evenly distributed across four of the five categories. For the median firm-year observation, Knowledge employees receive 19.8% of total equity granted by the firm in that year. Marketing employees receive 21.7%, Organizational employees receive 20.6%, and managers receive 24.2%. Production employees receive far less equity (only 4.6% of the total), which reflects the fact that production of goods requires significantly more manual labor than research, marketing, or organizational management.

Existing work on intangibles focuses mostly on knowledge and organizational capital, measured by capitalizing R&D expenses and a fraction of SG&A (e.g., [Peters and Taylor \(2017\)](#)). Thus Panel A also reports statistics on equity expenses to R&D scientists, divided by equity expenses to total organizational employees at the same firm. The median value of Knowledge / Total Organizational HC indicates that R&D scientists receive just 40.5% as much equity as the firm's total organizational employees. There is ample variation in this ratio across the sample, but even at the 75th percentile R&D scientists receive significantly less equity than total organizational employees.

Next, Panel B reports statistics for the 1008 firms that combine marketing and organizational expenses into one category. The distribution of equity grants is similar to that of Panel A. For the median firm-year observation in this sample, Knowledge employees receive 24.3% of total equity grants, Marketing and Organizational employees combined receive 37.7%, and managers receive 27.9%. The median of Knowledge / Total Organizational HC is 57.5%, though the 75th

percentile is 130%. Thus this subset of firms grants somewhat more equity to knowledge employees and managers than to other employees. Differences between panels A and B are largely driven by firms in the Pharmaceuticals sector, which grant relatively large amounts of equity to R&D scientists and are mostly in the sample for Panel B.

The key implication of this descriptive analysis is that the market value of non-replaceable human capital possessed by employees who acquire knowledge (mostly R&D scientists) is significantly smaller than market value for non-replaceable human capital possessed by employees who build up the firm’s brand or organizational capital (marketers and administrative staff). This result is consistent with the theoretical motivation of [Davydova et al. \(2023\)](#). They argue that as usage of intangible assets grows, it becomes increasingly important for firms to establish network effects and economies of scale. Thus high-intangible firms rely heavily on organizational employees who develop business processes.

Yet, one possible explanation for relatively small share of Knowledge human capital is that R&D activities may scale up more effectively than marketing or organizational investments. In this case a firm may need fewer scientists overall than marketers and administrative staff, and thus may expense less equity under the R&D item of the income statement than under the SG&A item.

Table 2 examines this possibility by reporting summary statistics for the detailed categories of equity expenses as a fraction of the total value of the associated line item. In this table, Knowledge HC is measured as equity expenses to knowledge employees, divided by total R&D spending reported in the income statement. Marketing HC is measured as the ratio of equity expenses to marketing employees, divided by total spending in the “Marketing and Sales” line item.¹² Organizational and Production HC are similarly defined. The table excludes Managerial HC, because top executives receive a much higher ratio of equity to total compensation than other employees.

Total spending in each line item includes wages and other forms of employee compensation, and thus it should be larger for categories that have more employees. Essentially, these ratios are a proxy measure for non-replaceable human capital per employee, which cannot be measured

¹²Firms in Panel A of Table 2 include a “Marketing and Sales” line item in their income statement. Compustat does not collect data on this line item. I extract the operating expense directly from 10-K filings using Python’s Beautiful Soup module.

directly since most firms do not report the number of employees working in different roles.

Table 2 reports statistics separately for the same two subsets of firms as in Table 1. In Panel A, marketing employees receive less equity as a fraction of total expenses (0.041 at the median) than do knowledge or organizational employees. However, organizational employees receive a higher ratio of equity pay over total operating expenses (0.066) than do knowledge employees (0.057). Panel B reports a similar pattern. Thus even after accounting for differences in the number of employees across categories, the value of non-replaceable human capital devoted to organizational tasks within a firm appears to be larger than the value of human capital devoted to creating knowledge.

4.3 Industry and Time-Series Trends

The value that the outside market assigns to different types of human capital may vary across industries. For example marketing human capital may be more critical to firms that primarily provide services, or that generate a large share of sales through long-term relationships with large clients. Conversely, knowledge and production human capital may be more important to firms that develop or manufacture products which rely on rapidly changing technology.

Table 3 examines the composition of equity grants varies across different industries. The values reported in the table are annual expenses from equity grants made to each category of employees, as a fraction of the firm's total annual equity expenses. The table reports the median value for each ratio across different industries. Note that for the Pharmaceuticals industry, the table does not report separate values for Marketing HC and Organizational HC categories. This is because the vast majority of Pharmaceuticals firms disclose only combined expenses for marketing and organizational employees. The table combines all firms outside of information technology or medicine into a single category, since these firms generally grant less equity compensation overall.

The statistics reveal some variation in the composition of equity grants, which is consistent with the nature of value creation in the different industries. The share of equity grants to R&D scientists is relatively large in the Computers & Electronic Equipment and Pharmaceuticals industries. Equity grants to employees involved in production is also highest in the Computers &

Electronic Equipment industry. In contrast, the share of equity grants to marketing employees is relatively large in the Software and Medical Devices industries. It may seem surprising that medical device manufacturers grant relatively little equity to R&D employees compared to marketing staff. However these products are typically sold directly to hospitals and other medical organizations, and thus establishing and servicing client relationships is crucial. Interestingly, the table shows that managers receive a significantly larger share of equity in medical industries than among information technology firms.

Importantly, in almost all industries the share of equity grants is far higher for marketing and organizational employees than for knowledge employees. For example, although Computers & Electronic Equipment firms produce cutting-edge products such as graphics cards or processing chips, the equity expenses for knowledge employees are only 59% as large as equity expenses to total organizational employees. The median value of Knowledge / Total Organizational HC is even lower in most other industries. The one exception is the Pharmaceuticals industry, where equity expenses for the median firm's knowledge employees are 1.05 times as large as equity expenses to total organizational employees. This industry consists of numerous small firms that invest heavily into R&D, but engage in almost no marketing.

Next, Figure 4 documents how the share of equity expenses for different categories of employees has evolved over time. In Panel A the equity expenses for each category are scaled by total annual equity expenses, and this ratio is plotted for the median firm in each year. The most notable trend is that the share of equity expenses going to knowledge employees has risen gradually over time. These employees received 17.4% of all equity grants in 2012, compared to 23.3% in 2021. This suggests that the outside market value of the median firm's human capital has shifted toward knowledge employees, who received the highest share of equity grants within the median firm for the first time in 2021. Meanwhile, market demand shifted away from marketing employees over the 2010 through 2017 period, and more recently away from managers.

Panel B of Figure 4 scales equity expenses by total operating expenses for each category, and plots the median ratio in each year. Consistent with Figure 1, the amount of equity paid to each category of skilled employees has risen significantly since 2012. The rise has been steepest for knowledge employees. Equity expenses were just 5.1% of total R&D in 2012, but tripled to

15.4% in 2021.

Interestingly, the 15.4% value indicates that the typical R&D scientist now receives about one-fifth (or perhaps more) of their total compensation as equity.¹³ Additionally, marketing and organizational employees receive more than 10% of their total compensation as equity. This is new evidence showing how the share of equity compensation is changing for non-executive employees, and it cannot be estimated using other standard databases. (Eisfeldt et al. (2023) use Compustat data to document a rising ownership share among all of a firm's employees, but cannot break this down by type of employee.)

5 Empirical Analysis of Determinants of Human Capital Composition

This section proceeds to examine some firm-level determinants of the composition of equity grants to skilled employees. In particular, the focus is on how the composition varies with firm size and age.

The motivation for this analysis is that firms rely on particular types of human capital at different stages of the life cycle. Young or small firms may invest more into knowledge acquisition and product development, as they attempt to create an exceptional product that can provide a dominant market position. Such firms may avoid investment into marketing and branding until their products are ready to sell, and then later ramp up those investments as the firm's customer base grows. Similarly, a young or small firm may make limited organizational investments while its business model is highly specialized. It should increase this type of investment as the company becomes larger and must coordinate across a growing range of divisions or product groups.

The analysis is also motivated by recent research documenting how some firms build human capital while other firms acquire it (Ouimet and Zarutskie (2020), Cortes et al. (2021), Beaumont et al. (2022)). Firms that focus on building a hit product, with the intention to be acquired afterward, should invest heavily into knowledge acquisition and little into marketing. In contrast,

¹³Employee compensation constitutes the majority of R&D expenses reported in the income statement, but firms also must expense laboratory supplies and other R&D inputs that are used up within a year. Thus the 15.4% value is lower than the ratio of equity/total compensation for R&D employees.

firms that frequently acquire promising entrants should make large organizational investments, as they need to integrate different workplace cultures and pursue synergies (Li et al. (2018)).

5.1 Firm Size and Human Capital Composition

Table 4 examines how the composition of equity grants varies between larger, more complex firms versus smaller, more focused firms. I first calculate terciles of book assets, using all observations for the 641 firms that disclose detailed expenses for five categories. I then construct *Middle Firm Size* and *Large Firm Size* indicators, which equal 1 if the firm’s book assets are in the second or third tercile of the distribution, and 0 otherwise. (The excluded group is firm-year observations with assets in the first tercile.) I then regress the annual equity expenses to each category of employees (scaled by total equity expenses) on these indicators, a set of control variables, and year and industry fixed effects. The analysis excludes Production HC since the value is tiny at most firms. All standard errors are clustered at the firm level.

Columns (1) and (2) show that as firm size increases, equity expenses for knowledge employees make up a higher share of total expenses at the firm. For example, the 0.095 coefficient on *Large Firm Size* in Column (2) indicates that knowledge/total expenses are 0.095 higher among firm-years in the top tercile of the size distribution than firm-years in the bottom tercile. The results are similar for expenses to marketing employees in columns (3) and (4), although the difference between firm-years in the top and bottom tercile is somewhat smaller. In contrast, columns (5) through (8) show that the share of organizational and managerial expenses is substantially lower among firm-years in the top tercile of the size distribution than firm-years in the bottom tercile. Notably, most coefficients on the firm size indicators are statistically significant at the 1% level.

Under the paper’s motivating assumption that equity expenses are associated with the outside market value of human capital, the results indicate that large firms’ knowledge employees and marketers possess a relatively high share of non-replaceable human capital that is valuable to competing firms, while organizational employees and managers possess a relatively low share. Conversely, at small firms organizational employees and managers possess a relatively high share of human capital that is valuable to the labor market. In other words, market demand for human capital is shifted more toward Knowledge and Marketing HC at large firms,

and more toward Organizational and Managerial HC at small firms.

Some regressions in Table 4 include *Firm Age* to control for life cycle dynamics; *Market-Book Ratio* to control for growth opportunities; and *Net Leverage* to control for capital structure. I further control for *Cash/Assets* and *Cashflow Volatility*, because more financially constrained firms may compensate certain employees largely with equity instead of cash wages. *EBIT/Sales* is a measure of profitability, which may affect firms' willingness to incur accounting expenses for granting equity. Coefficients on these control variables show that firms with higher market-to-book ratios possess relatively more knowledge and marketing human capital, as do firms that hold more cash. Other control variables are not significantly associated with the human capital composition.

Importantly, the coefficient estimates on the *Middle Firm Size* and *Large Firm Size* indicators do not change substantially when control variables are included in the regressions. Further the results are not driven by differences across industries, since all regressions control for fixed effects using the Fama-French 48 industry classification. In untabulated results, I confirm that the coefficients on *Middle Firm Size* and *Large Firm Size* are positive and statistically significant among a subset of just Information Technology or Medical firms.

Figure 5 graphically depicts the composition of equity grants across firm size terciles. Each bar represents the distribution for the average firm-year observation in the corresponding size group. The figure shows that 57% of equity at small firms is granted to organizational employees and managers. This share shrinks to 41% at large firms, whose equity grant composition is overall more evenly distributed across the five categories.

Overall, the results in this subsection are somewhat puzzling. The fact that large firms grant relatively more equity to knowledge and marketing employees could reflect that these firms are more successful, and that successful firms invest more into R&D or branding. However, it is harder to explain why small firms grant relatively more equity to organizational staff. These firms should need fewer lawyers, data analysts, or administrators to maintain workplace culture. One possible explanation is that organizational tasks are fundamental to the operation of any public firm, and that firms diversify toward other tasks by hiring more scientists and marketers as they grow large. If so, then this reinforces the key takeaway of Section 4 that more academic

research is needed on the importance of organizational investments.

5.2 Firm Age and Human Capital Composition

Table 5 conducts a similar regression analysis as Table 4, using terciles of the firm age distribution instead of firm size. Specifically, I construct *Middle Firm Age* and *Highest Firm Age* indicators which equal 1 if the number of years since the firm's IPO are in the second or third tercile of the distribution, and 0 otherwise. The excluded group is firm-year observations with years since IPO in the first tercile. As in Table 4, I regress the annual equity expenses to each category of employees (scaled by total equity expenses) on these indicators, using the same sample, control variables, and fixed effects.

The results in columns (1) through (4) show that older firms grant a relatively smaller share of equity expenses to knowledge and marketing employees. However there is no difference between firm-years in the lowest and middle tercile of the age distribution after control variables are included, indicating that the composition of human capital shifts only for the oldest firms (at least 12 years out from their IPO in this sample). Moreover, the differences in composition are quite small—the average share of equity expenses to knowledge employees is 3.1% lower among the oldest firms than among younger firms, while the share for marketing employees is 2.6% lower. The results also show that the share of equity expenses for organizational employees and managers does not vary significantly with firm age after controls are included.

Overall, Table 5 indicates that market demand for various types of replaceable human capital does not vary much across young and old firms. This result is also somewhat puzzling, since the type of human capital that firms rely on should change as they mature. In particular, it is not clear why the weight of Organizational HC in the human capital composition does not change as firms mature.

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Figure 1: Examples of Detailed Equity Expense Disclosures

The equity expense disclosure table for Meta is obtained from page 42 of the 10-K filing corresponding to fiscal year 2017. The table for Becton Dickinson is obtained from page 56 of the 10-K filing corresponding to fiscal year 2011. Both filings are obtained via SEC EDGAR.

Panel A. Meta Disclosure for 2017

Share-based compensation expense included in costs and expenses:

	Year Ended December 31,		
	2017	2016	2015
	(in millions)		
Cost of revenue	\$ 178	\$ 113	\$ 81
Research and development	2,820	2,494	2,350
Marketing and sales	436	368	320
General and administrative	289	243	218
Total share-based compensation expense	<u>\$ 3,723</u>	<u>\$ 3,218</u>	<u>\$ 2,969</u>

Panel B. Becton Dickinson Disclosure for 2011

Note 7 — Share-Based Compensation

The Company grants share-based awards under the 2004 Employee and Director Equity-Based Compensation Plan ("2004 Plan"), which provides long-term incentive compensation to employees and directors consisting of: stock appreciation rights ("SARs"), stock options, performance-based restricted stock units, time-vested restricted stock units and other stock awards.

The amounts and location of compensation cost relating to share-based payments included in consolidated statements of income is as follows:

	2011	2010	2009
Cost of products sold	\$14,440	\$15,128	\$16,846
Selling and administrative expense	49,536	54,423	58,920
Research and development expense	9,387	9,823	10,808
	<u>\$73,363</u>	<u>\$79,374</u>	<u>\$86,574</u>

Figure 2: Correlation between Equity Grants and Disclosure of Detailed Expenses

Each point represents one of the 48 Fama-French industries. The y-axis is the average ratio of total annual equity expenses paid by the firm to all employees over total annual operating expenses. This average is calculated over all firm-year observations for each industry. The sample is all firms that grant equity, and covers the years 2010 through 2021. Information Technology firms are those in the Fama-French 48 industries of Computers, Electronic Equipment, Measuring and Control Equipment, or Business Services (only SIC codes between 7370 and 7379). Medical firms are those in the Fama-French 48 industries of Pharmaceutical Products, Medical Equipment, or Healthcare. Traditional firms are all sample firms other than Information Technology or Medical firms.

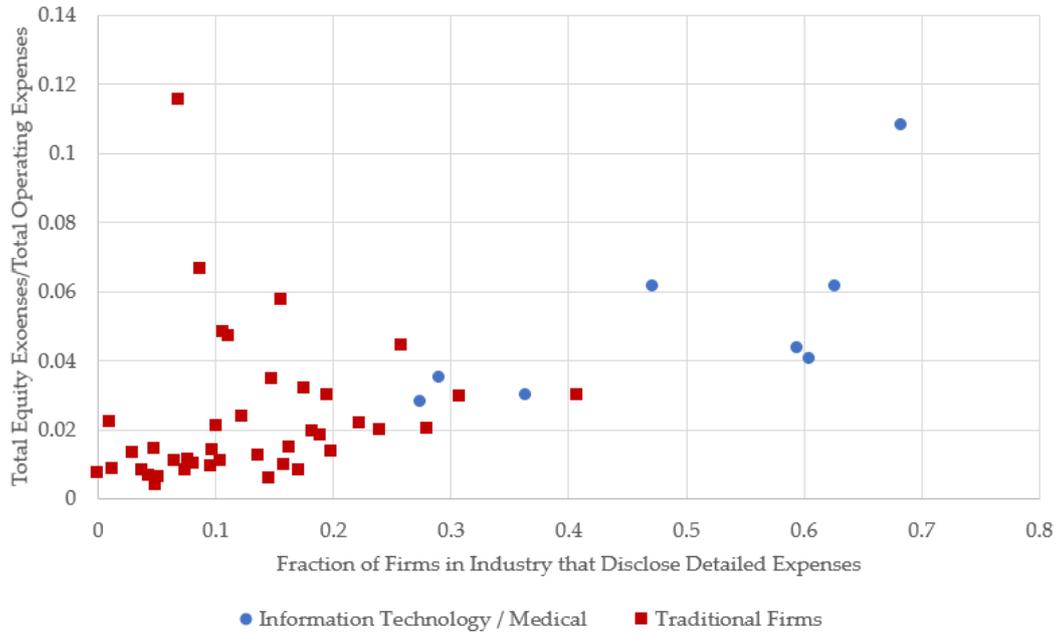
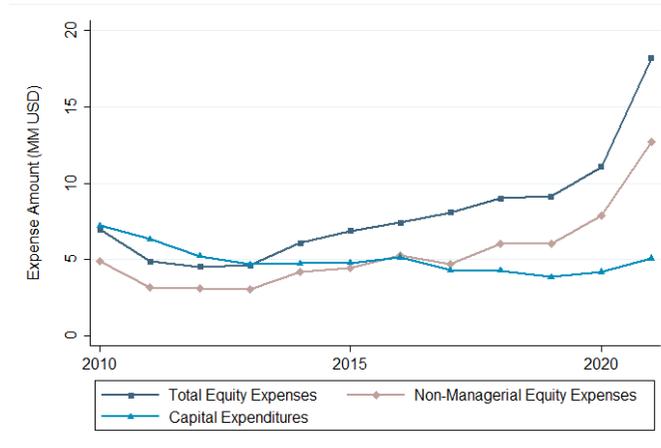


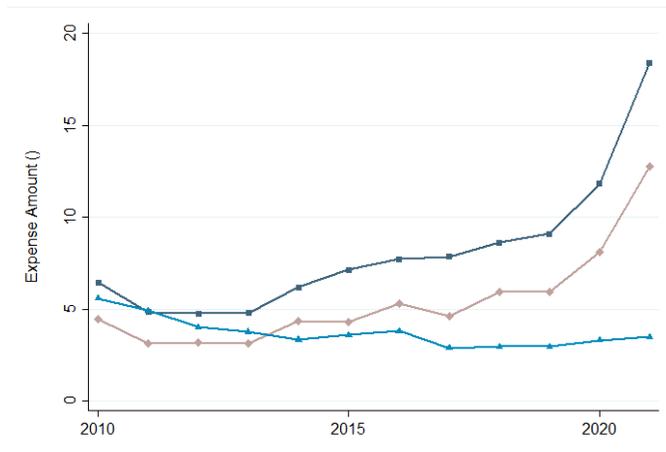
Figure 3: Total Value of Equity Grants versus Physical Investment

Plots show the median value of total annual equity expenses paid by a firm to all employees, the median value of total annual equity expenses excluding those for equity grants to managers, and median capital expenditures. Managerial equity expenses are measured using grants to top executives listed in ExecuComp. For non-ExecuComp firms, managerial expenses are estimated by multiplying the firm's total equity expenses by the median ratio of managerial/total equity expenses for ExecuComp firms in the same Fama-French 48 industry. The sample in Panel A is all 1649 firms that report detailed equity expenses between the years 2010 and 2021. In Panel B, Information Technology firms are those in the Fama-French 48 industries of Computers, Electronic Equipment, Measuring and Control Equipment, or Business Services (only SIC codes between 7370 and 7379). Medical firms are those in the Fama-French 48 industries of Pharmaceutical Products, Medical Equipment, or Healthcare. In Panel C, Traditional firms are all sample firms other than Information Technology or Medical firms.

Panel A. All Firms



Panel B. Information Technology and Medical Firms



Panel C. Traditional Firms

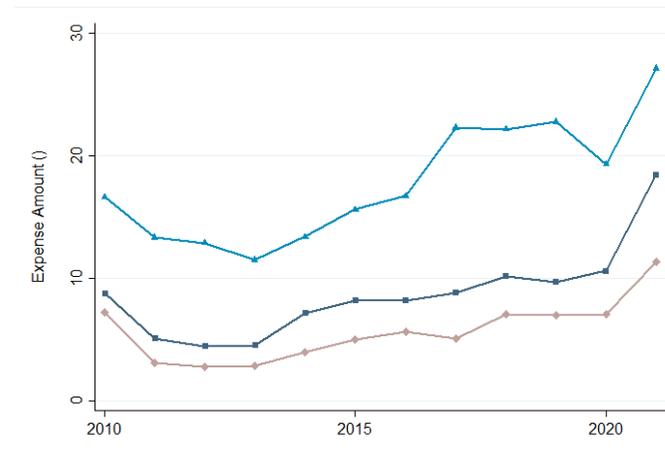
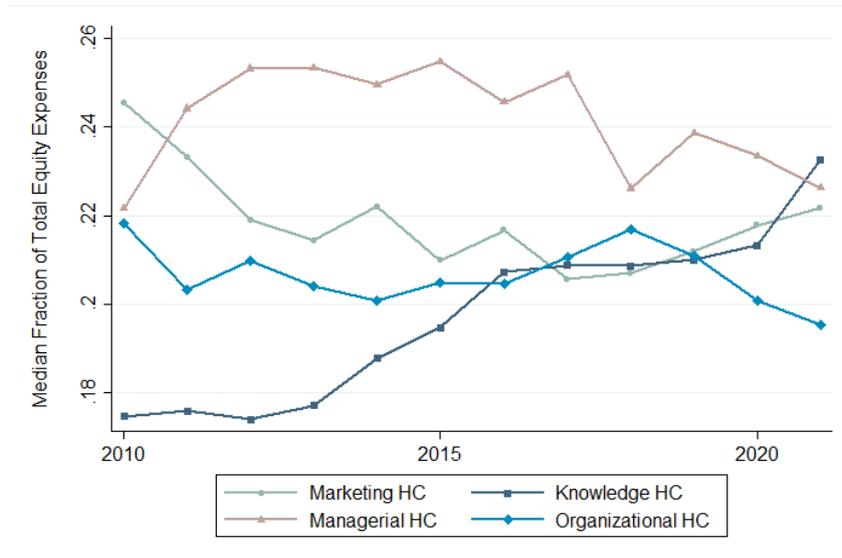


Figure 4: Time-Series Evolution of Human Capital Composition

In Panel A, each plot shows the median value of annual equity expenses for each category of employees, as a fraction of total annual equity expenses paid by the firm to all employees. In Panel B, each plot shows the median value of annual equity grants for each category of employees, as a fraction of the total operating expense from the associated income statement line item. Knowledge HC is measured using equity expenses included in the R&D line item of the income statement. Marketing HC is measured using equity expenses included “Marketing and Sales” item, Organizational HC is measured using equity expenses included in the “Other SG&A” item, Managerial HC is measured using equity expenses for grants to top executives listed in ExecuComp, and Production HC is equity expenses included in the COGS item. For non-ExecuComp firms, managerial expenses are estimated by multiplying the firm’s total equity expenses by the median ratio of managerial/total equity expenses for ExecuComp firms in the same Fama-French 48 industry. The sample in both panels is 641 firms that disclose equity expenses for at least five different categories, including separate expenses for the marketing and organizational employees.

Panel A. Detailed Equity Expenses as Fraction of Total Equity Expenses



Panel B. Detailed Equity Expenses as Fraction of Total Operating Expenses

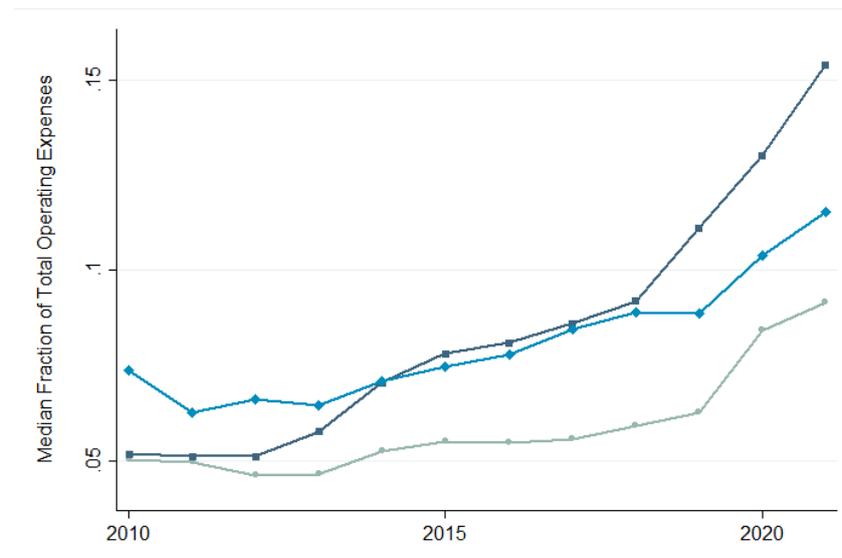


Figure 5: How Human Capital Composition Varies with Firm Size

The sample is 641 firms that disclose equity expenses for at least five different categories, including separate expenses for the marketing and organizational employees. Observations are at the firm-year level, for the years 2010 through 2021. For all firm-year observations in the sample, terciles of the distribution of *Firm Size* are calculated. *Small Firm Size* equals 1 for all observations with a *Firm Size* value in the first tercile, and 0 otherwise. *Middle Firm Size* equals 1 for all observations with a *Firm Size* value in the second tercile, and 0 otherwise. *Highest Firm Size* equals 1 for all observations with a *Firm Size* value in the third tercile, and 0 otherwise. *Firm size* is measured as the natural logarithm of book assets at the start of the year. For each firm-year in the sample, the annual equity expenses to employees in a given category are divided by the total annual equity expenses for all employees of the firm. Each bar represents the average of these values across all observations in the firm size tercile. Knowledge HC is measured using equity expenses included in the R&D line item of the income statement. Marketing HC is measured using equity expenses included “Marketing and Sales” item, Organizational HC is measured using equity expenses included in the “Other SG&A” item, Managerial HC is measured using equity expenses for grants to top executives listed in ExecuComp, and Production HC is equity expenses included in the COGS item. For non-ExecuComp firms, managerial expenses are estimated by multiplying the firm’s total equity expenses by the median ratio of managerial/total equity expenses for ExecuComp firms in the same Fama-French 48 industry.

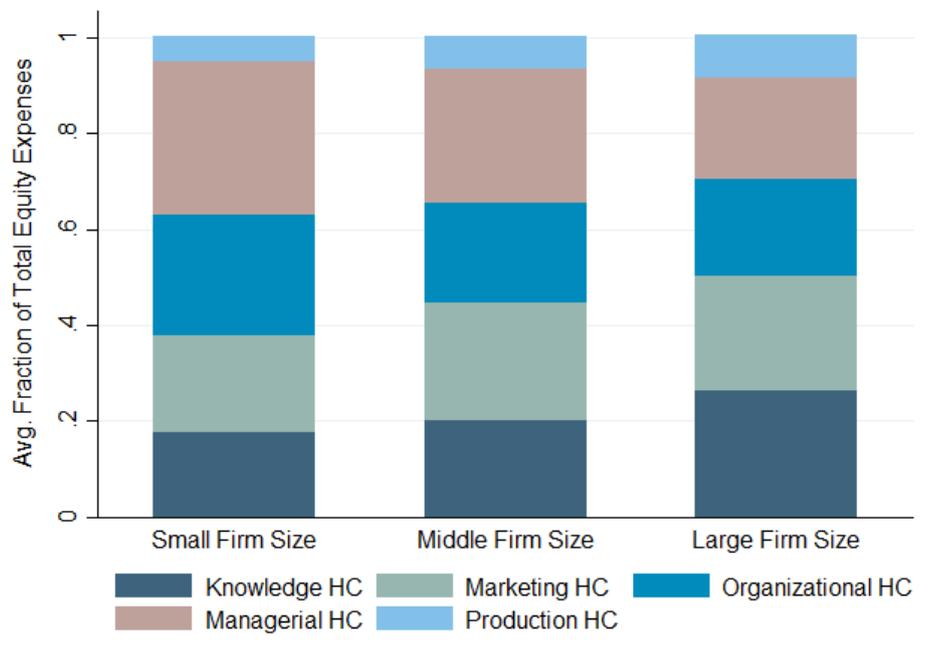


Table 1: Composition of Non-Replaceable Human Capital (Scaled by Total Equity Expenses)

The reported summary statistics are for equity grants to different categories of employees, as a fraction of total annual equity expenses paid by the firm to all employees. Knowledge HC is measured using equity expenses included in the R&D line item of the income statement. Marketing HC is measured using equity expenses included “Marketing and Sales” item, Organizational HC is measured using equity expenses included in the “Other SG&A” item, Managerial HC is measured using equity expenses for grants to top executives listed in ExecuComp, and Production HC is measured using equity expenses included in the COGS item. Managerial equity expenses are estimated for non-ExecuComp firms by multiplying the firm’s total equity expenses by the median ratio of managerial/total equity expenses among ExecuComp firms in the same Fama-French 48 industry. Knowledge / Total Organizational HC is measured as a firm’s Knowledge HC in a given year, divided by the sum of the firm’s Marketing and Organizational HC in the same year. The sample for Panel A is 641 firms that disclose equity expenses for at least five different categories, including separate expenses for marketing and organizational employees. The sample for Panel B is 1008 firms that disclose equity expenses for four categories, combining expenses for marketing and organizational employees into the SG&A item. Both samples contain firm-year observations from 2010 through 2021.

Panel A. Firms that separate marketing and organizational expenses					
	No. of Obs.	25 th Perc.	Median	75 th Perc.	St. Dev.
Knowledge HC	3886	0.095	0.198	0.310	0.162
Marketing HC	3886	0.129	0.217	0.317	0.134
Organizational HC	3886	0.122	0.206	0.293	0.151
Managerial HC	3816	0.142	0.242	0.351	0.176
Production HC	3886	0.002	0.046	0.098	0.085

Knowledge / Total Organizational HC	3821	0.192	0.405	0.718	0.643
Panel B. Firms that combine marketing and organizational expenses					
	No. of Obs.	25 th Perc.	Median	75 th Perc.	St. Dev.
Knowledge HC	6536	0.070	0.243	0.413	0.205
Marketing and Organizational HC	6536	0.280	0.377	0.524	0.188
Managerial HC	6366	0.205	0.279	0.351	0.154
Production HC	6536	0.000	0.000	0.075	0.099

Knowledge / Total Organizational HC	6368	0.142	0.575	1.30	1.092

Table 2: Composition of Non-Replaceable Human Capital (Scaled By Operating Expenses)

The reported summary statistics are for equity grants to different categories of employees, as a fraction of total operating expense from the associated income statement line item. Knowledge HC is measured using equity expenses included in the R&D line item of the income statement. Marketing HC is measured using equity expenses included “Marketing and Sales” item, Organizational HC is measured using equity expenses included in the “Other SG&A” item, and Production HC is measured using equity expenses included in the COGS item. This table excludes Managerial HC. The reason is equity expenses to top executives typically constitute the majority of their total compensation. Therefore the ratio of managerial equity expenses to total operating expenses is not comparable to the ratio for other employee categories. The sample in Panel A is 641 firms that disclose equity expenses for at least five different categories, including separate expenses for marketing and organizational employees. The sample for Panel B is 1008 firms that disclose equity expenses for four categories, combining expenses for marketing and organizational employees into the SG&A item. Both samples contain firm-year observations from 2010 through 2021.

Panel A. Firms that separate marketing and organizational expenses					
	No. of Obs.	25 th Perc.	Median	75 th Perc.	St. Dev.
Knowledge HC	3650	0.025	0.057	0.111	0.486
Marketing HC	3736	0.019	0.041	0.081	0.143
Organizational HC	3883	0.032	0.066	0.113	0.540
Production HC	3802	0.000	0.005	0.018	0.056

Panel B. Firms that combine marketing and organizational expenses					
	No. of Obs.	25 th Perc.	Median	75 th Perc.	St. Dev.
Knowledge HC	9291	0.022	0.050	0.093	1.400
Marketing and Organizational HC	10354	0.031	0.060	0.105	0.830
Production HC	9087	0.000	0.002	0.009	0.158

Table 3: Composition of Human Capital across Industries

For each industry and detailed category, the table reports the median ratio of equity expenses for employees in the category over total annual equity expenses for all employees. Knowledge HC is measured using equity expenses included in the R&D line item of the income statement. For all industries except Pharmaceuticals, Marketing HC is measured using equity expenses included “Marketing and Sales” item and Organizational HC is measured using equity expenses included in the “Other SG&A” item. Only for Pharmaceuticals, Organizational HC is measured using equity expenses included in the SG&A item, which combines expenses for marketing and organizational employees. The reason is that Pharmaceuticals firms rarely disclose detailed expenses separately for marketing and organizational employees. Managerial HC is measured using equity expenses for grants to top executives listed in ExecuComp, and Production HC is measured using equity expenses included in the COGS item. Managerial equity expenses are estimated for non-ExecuComp firms by multiplying the firm’s total equity expenses by the median ratio of managerial/total equity expenses among ExecuComp firms in the same Fama-French 48 industry. Knowledge / Total Organizational HC is measured as a firm’s Knowledge HC in a given year, divided by the sum of that firm’s Marketing and Organizational HC in the same year. For all industries except Pharmaceuticals, the sample is 641 firms that disclose equity expenses for at least five different categories, including separate expenses for marketing and organizational employees. For Pharmaceuticals the sample is 1008 firms that disclose equity expenses for four categories, combining expenses for marketing and organizational employees. For all industries, the sample contains firm-year observations from 2010 through 2021. Industries are based on the Fama-French 48 classification. The second column combines the Computer and Electronic Equipment industries. Traditional firms are those that are not in Software, Computers, Electronic Equipment, Medical Devices, or Pharmaceuticals.

	Software	Computers & Electronic Equipment	Medical Devices	Pharmaceuticals	Traditional
Knowledge HC	0.216	0.261	0.123	0.351	0.118
Marketing HC	0.244	0.237	0.216	—	0.171
Organizational HC	0.193	0.164	0.234	0.321 ⁺	0.256
Managerial HC	0.215	0.187	0.330	0.313	0.250
Production HC	0.044	0.066	0.042	0.000	0.046
Knowledge / Total Organizational HC	0.452	0.590	0.258	1.049	0.241

⁺ Pharmaceuticals firms typically disclose combined equity grants for marketing and organizational employees

Table 4: Determinants of Human Capital Composition: Firm Size

The sample is 641 firms that disclose equity expenses for at least five different categories, including separate expenses for the marketing and organizational employees. Observations are at the firm-year level, for the years 2010 through 2021. Each column reports coefficient estimates from an OLS regression. The dependent variable in each column is the ratio of annual equity expenses for firm employees in the given category, over total annual equity expenses for all employees of the firm. *Knowledge HC* is measured using equity expenses included in the R&D line item of the income statement. *Marketing HC* is measured using equity expenses included “Marketing and Sales” item, *Organizational HC* is measured using equity expenses included in the “Other SG&A” item, and *Managerial HC* is measured using equity expenses for grants to top executives listed in ExecuComp. Managerial equity expenses are estimated for non-ExecuComp firms by multiplying the firm’s total equity expenses by the median ratio of managerial/total equity expenses among ExecuComp firms in the same Fama-French 48 industry. For all firm-year observations in the sample, terciles of the distribution of *Firm Size* are calculated. *Middle Firm Size* equals 1 for all observations with a *Firm Size* value in the second tercile, and 0 otherwise. *Large Firm Size* equals 1 for all observations with a *Firm Size* value in the third tercile, and 0 otherwise. The excluded group is observations with a *Firm Size* value in the first tercile. *Firm size* is measured as the natural logarithm of book assets at the start of the year. *Firm Age* is the number of years since the firm’s initial public offering. *Market-Book Ratio* is market capitalization plus the book value of debt, divided by book assets. *Net Leverage* is total debt minus cash and cash equivalents, divided by book assets. *Cash/Assets* is cash and cash equivalents, divided by book assets. *Cashflow Volatility* is the standard deviation over the past 10 years of annual operating cashflows divided by total assets. *EBIT/Sales* is annual EBIT divided by total annual sales. Industry fixed effects are based on the Fama-French 48 classification. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

Dependent Variable	<i>Knowledge HC</i>		<i>Marketing HC</i>		<i>Organizational HC</i>		<i>Managerial HC</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Middle Firm Size</i>	0.017*	0.030**	0.041***	0.043***	-0.046***	-0.049***	-0.026***	-0.036**
	(1.66)	(2.02)	(4.72)	(3.49)	(-5.08)	(-3.89)	(-2.71)	(-2.50)
<i>Large Firm Size</i>	0.069***	0.095***	0.033***	0.059***	-0.059***	-0.074***	-0.076***	-0.107***
	(4.21)	(5.27)	(2.88)	(4.18)	(-4.66)	(-4.80)	(-6.08)	(-6.89)
		-0.001		-0.001		0.001		0.001
		(-1.27)		(-1.50)		(1.00)		(1.01)
		0.007***		0.006***		-0.007***		-0.004*
		(2.93)		(3.27)		(-4.19)		(-1.82)
		-0.057**		0.014		0.038*		-0.003
		(-2.08)		(0.69)		(1.91)		(-0.14)
		0.067*		0.070**		-0.016		-0.109***
		(1.69)		(2.13)		(-0.49)		(-2.71)
		-0.006		-0.006		0.017		0.003
		(-0.73)		(-0.77)		(1.39)		(0.38)
		0.001		0.002		-0.003		-0.003
		(0.21)		(0.86)		(-1.54)		(-1.01)
No. Observations	3658	2407	3658	2407	3658	2407	3617	2385
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.155	0.225	0.099	0.147	0.204	0.269	0.174	0.210

Table 5: Determinants of Human Capital Composition: Firm Age

The sample is 641 firms that disclose equity expenses for at least five different categories, including separate expenses for the marketing and organizational employees. Observations are at the firm-year level, for the years 2010 through 2021. Each column reports coefficient estimates from an OLS regression. The dependent variable in each column is the ratio of annual equity expenses for firm employees in the given category, over total annual equity expenses for all employees of the firm. *Knowledge HC* is measured using equity expenses included in the R&D line item of the income statement. *Marketing HC* is measured using equity expenses included “Marketing and Sales” item, *Organizational HC* is measured using equity expenses included in the “Other SG&A” item, and *Managerial HC* is measured using equity expenses for grants to top executives listed in ExecuComp. Managerial equity expenses are estimated for non-ExecuComp firms by multiplying the firm’s total equity expenses by the median ratio of managerial/total equity expenses among ExecuComp firms in the same Fama-French 48 industry. For all firm-year observations in the sample, terciles of the distribution of *Firm Age* are calculated. *Middle Firm Age* equals 1 for all observations with a *Firm Age* value in the second tercile, and 0 otherwise. *Highest Firm Age* equals 1 for all observations with a *Firm Age* value in the third tercile, and 0 otherwise. The excluded group is observations with a *Firm Age* value in the first tercile. *Firm Age* is measured as the number of years since the firm’s initial public offering. *Firm size* is the natural logarithm of book assets at the start of the year. *Market-Book Ratio* is market capitalization plus the book value of debt, divided by book assets. *Net Leverage* is total debt minus cash and cash equivalents, divided by book assets. *Cash/Assets* is cash and cash equivalents, divided by book assets. *Cashflow Volatility* is the standard deviation over the past 10 years of operating cashflows divided by total assets. *EBIT/Sales* is EBIT divided by total sales. Industry fixed effects are based on the Fama-French 48 classification. *t*-statistics are based on standard errors that are clustered at the firm level. ***, **, * indicate significance levels of 1%, 5%, and 10%, respectively.

Dependent Variable	<i>Knowledge HC</i>		<i>Marketing HC</i>		<i>Organizational HC</i>		<i>Managerial HC</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Middle Firm Age</i>	-0.022** (-2.16)	-0.002 (-0.15)	-0.015* (-1.83)	-0.011 (-1.07)	0.002 (0.32)	0.003 (0.35)	0.010 (1.31)	-0.002 (-0.15)
<i>Highest Firm Age</i>	-0.058*** (-4.65)	-0.031** (-2.03)	-0.028*** (-2.63)	-0.026** (-2.04)	0.020* (1.84)	0.020 (1.47)	0.032*** (2.77)	0.018 (1.16)
		0.030*** (5.94)		0.013*** (4.02)		-0.017*** (-4.75)		-0.031*** (-10.09)
		0.007*** (3.41)		0.007*** (3.70)		-0.008*** (-4.91)		-0.005** (-2.23)
		-0.064** (-2.24)		0.012 (0.60)		0.041** (1.99)		0.002 (0.10)
		0.058 (1.46)		0.066** (2.05)		-0.009 (-0.28)		-0.101*** (-2.62)
		-0.004 (-0.52)		-0.006 (-0.73)		0.017 (1.30)		0.001 (0.12)
		-0.003 (-1.22)		0.001 (0.59)		-0.002 (-0.95)		0.001 (0.38)
No. Observations	3794	2407	3794	2407	3794	2407	3752	2385
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.145	0.272	0.095	0.146	0.183	0.272	0.158	0.243