The (Self-)Funding of Intangibles

Robin Döttling[1], Tomislav Ladika[2] and Enrico Perotti[3]

[1]University of Amsterdam and Tinbergen Institute
[2]University of Amsterdam
[3]University of Amsterdam, CEPR and Tinbergen Institute

March 25, 2018

Abstract

We model how technological change leads to a shift in corporate investment towards intangible capital, and derive new implications for corporate financial policy. While tangible assets can be purchased and funded externally, most intangible capital is created by skilled workers investing their human capital, so it requires lower upfront outlays. Indeed, U.S. high-intangibles firms have larger free cashflows and lower total investment spending, and maintain lower net leverage. Our model shows how these firms optimally finance human capital investment using deferred equity grants to highly skilled employees. Firms support the value of these claims by retaining cash and favoring a payout policy of repurchases over dividends. The model thus predicts a retention motive for corporate resources that complements the traditional precautionary savings view. The data is consistent with the model's predictions, including among firms that do not appear more financially constrained.

Keywords. Technological change, intangible assets, cash holdings, human capital, corporate leverage, equity grants, deferred equity, share vesting.

JEL classifications. G32, G35, J24, J33

*We are grateful to Erasmo Giambona for providing us with data on lines of credit. We thank Fernando Anjos, Patrick Bolton, Lauren Cohen, Esther Eiling, Mariassunta Giannetti, Dirk Jenter, Paige Ouimet, Per Strömberg, Shusen Qi, Luke Taylor, Annette Vissing-Jørgensen, David Yermack, and seminar participants for helpful input.Send correspondence to Enrico Perotti, e.c.perotti@uva.nl.

The (Self-)Funding of Intangibles

March 25, 2018

Abstract

We model how technological change leads to a shift in corporate investment towards intangible capital, and derive new implications for corporate financial policy. While tangible assets can be purchased and funded externally, most intangible capital is created by skilled workers investing their human capital, so it requires lower upfront outlays. Indeed, U.S. high-intangibles firms have larger free cashflows and lower total investment spending, and maintain lower net leverage. Our model shows how these firms optimally finance human capital investment using deferred equity grants to highly skilled employees. Firms support the value of these claims by retaining cash and favoring a payout policy of repurchases over dividends. The model thus predicts a retention motive for corporate resources that complements the traditional precautionary savings view. The data is consistent with the model's predictions, including among firms that do not appear more financially constrained.

Keywords. Technological change, corporate leverage, cash holdings, human capital, intangible capital, equity grants, deferred equity, share vesting.

JEL classifications. G32, G35, J24, J33

1 Introduction

Progress in information technology since 1980 has transformed corporate investment. Firms' investment in intangible assets has risen progressively relative to physical plant and tangible assets (Corrado and Hulten, 2010; Falato et al., 2013). This major shift in capital asset composition concurred with an evolution in corporate practices, including a sharp decline in tangible investment and in its correlation with traditional measures of profitability (Philippon and Gutiérrez, 2016; Lee et al., 2016). Net corporate leverage has generally fallen, along with a rise in cash holdings especially but not exclusively among innovative firms (Bates et al., 2009; Pinkowitz et al., 2016; Graham and Leary, 2017), as shown in Figure 1.

It is long known that reliance on intangibles affects corporate financing and payout policies. Firms with a high ratio of intangible to total capital (henceforth HINT firms) are naturally concerned about becoming financially constrained because their assets are less pledgeable, reducing their debt capacity (Holmström and Tirole, 1998; Bates et al., 2009). Since innovative firms may also face higher costs of financial distress, they choose more cautious financial policies (Opler et al., 1999; Froot et al., 1993).

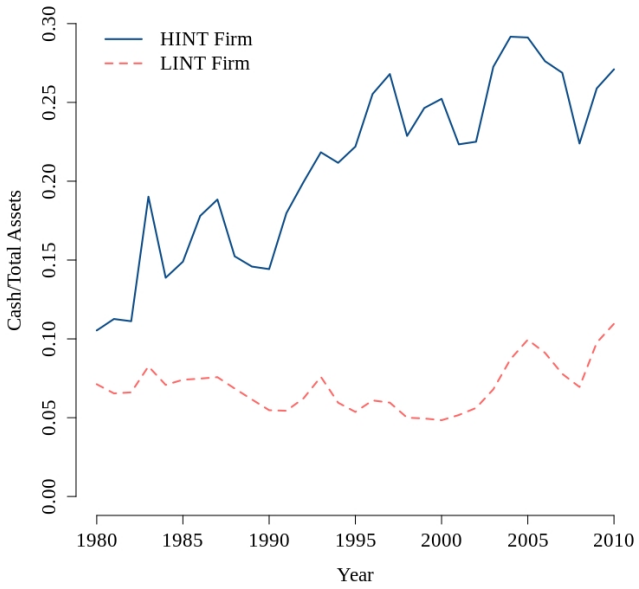
This paper offers a complementary view, based on fundamental differences in how intangible and tangible assets are produced. Our key insight is that intangible investment relies largely on the commitment of human capital over time. As a result, it requires lower upfront cash outlays than the acquisition of tangible assets. An increasing share of value created by successful companies today is derived from their software development, product design, innovative distribution, data analysis and brand marketing. These skill-intensive tasks require significantly lower cash spending and more human capital than traditional production processes.

This insight is consistent with the evolution of cashflows and financing over time and across firms. HINT firms generate similar operating (pre-investment) cashflows as low-intangibles (LINT) firms, yet over time they consistently spend a lower fraction of earnings on investment (see Figure 3). While LINT firms' outlays historically exceeded their cashflow and required external financing, HINT firms spend less than 80% of the cash they generate. In recent years, investment spending and leverage have fallen across the board, as reliance on information tech-

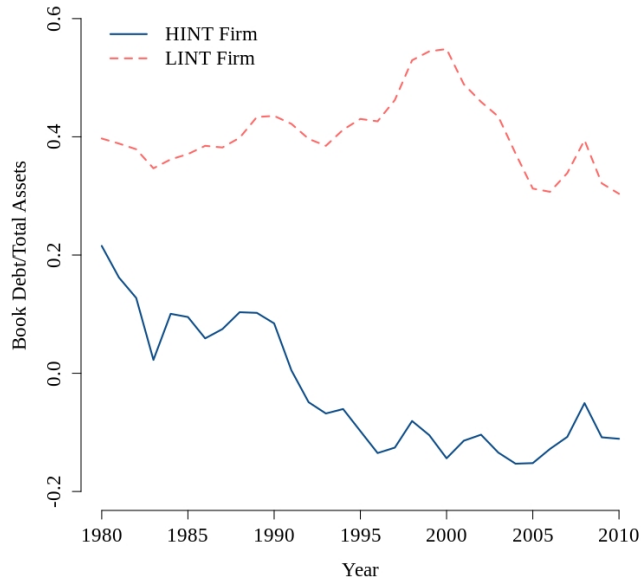
nology has grown for all firms and sectors.

Figure 1: Intangibles Usage, Cash Holdings and Net Leverage

Panel A. Cash Holdings



Panel B. Net Leverage



Our analysis suggests a second key difference between intangible and tangible assets. Firms cannot own the human capital of talented employees, who thus need to be rewarded over time

to ensure their commitment (Hart and Moore, 1994). Firms that use more intangible capital therefore must share the value created to ensure the retention of skilled employees and their embedded intangible capital.

Our setup focuses on describing the process of intangible investment, seeking insights into corporate financial and payout policies that are consistent with recent data patterns. In our model, firms differ in their technological profile and therefore in the composition of their investment. Traditional firms raise external capital to acquire tangible assets, while innovative firms create intangible capital primarily by engaging the human capital of highly skilled employees. Building on the insight that human capital cannot be purchased but must be co-invested, firms building intangible capital benefit from employee co-investment, thus require lower upfront cash outlays. This interpretation for HINT firms' higher free cashflows also has implications for firms' net leverage, vesting and payout policy choices. Figure **??** and Figure **??** report the differential profile of cash flows and their uses for HINT and LINT firms.

Figure 2: Intangibles Usage, Composition and Use of Cash Flows

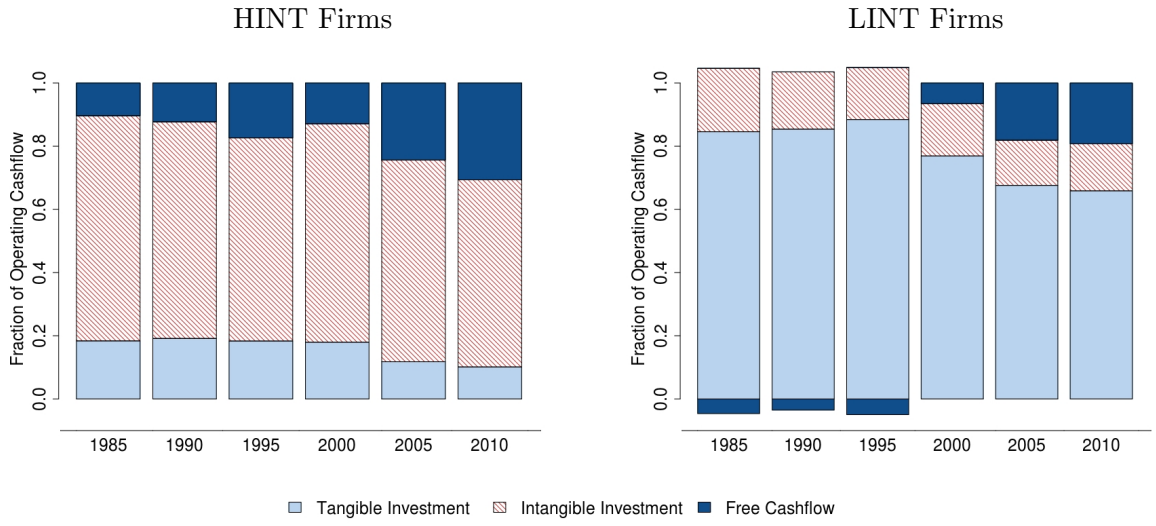
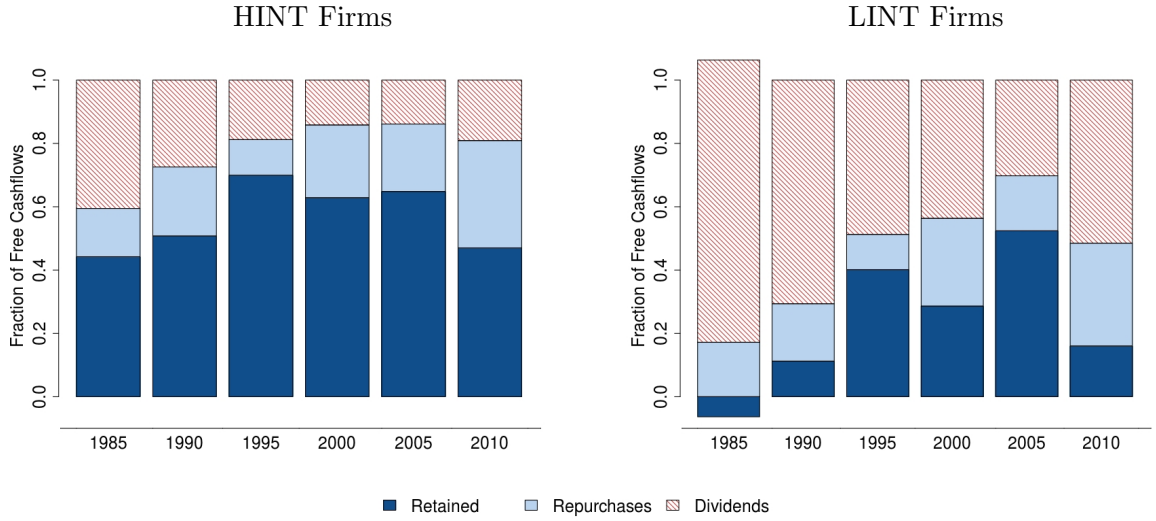


Figure 3: Intangibles Usage and Composition of Free Cashflows



We recognize that HINT firms should choose a cautious financial policy (the classic *precautionary motive*) to avoid funding constraints. In the model all firms may face an interim shock that requires additional investment. While more tangible firms can pledge assets to raise financing, firms with more intangibles need to self-finance any spending using resources on hand due to their assets' reduced debt capacity (e.g., Almeida and Campello, 2007). Thus HINT firms have a greater need for precautionary savings.

Our model complements this view by focusing on the need to ensure the commitment of developed intangible capital, embedded in human capital. The optimal reward scheme involves deferred compensation that vests once output is realized. Promised compensation must also match a skilled employee's future outside option, namely the gain from moving to (or starting) another firm (Oyer and Schaefer, 2005; Eisfeldt and Papanikolaou, 2013).[1] We show that optimal compensation is provided in the form of unvested equity grants (as in (Oyer and Schaefer, 2005)), or implicitly via career prospects that are also correlated with future company performance.

However, the volatility of this future value is costly for risk-averse individuals, and very hard to hedge. Firms may thus offer some form of insurance in order to reduce compensation costs (Berk et al., 2010). We show that HINT firms optimally choose to maintain lower leverage

[1] Zábojnik (2018) describes a firm's optimal deferred compensation, showing that firms develop a reputation to reward innovative employees.

and higher cash holdings to decrease the volatility of deferred compensation, thus reducing its cost for risk-neutral investors. Holding cash involves some managerial agency cost, but it also increases skilled employees' utility value of compensation. For firms aiming at retaining human talent, this benefit may outweigh any costs associated with managerial discretion.

The model shows that HINT firms should also adjust their payout policy to avoid diluting unvested claims, as this undermines the compensation for skilled human capital and damages its ability to attract talent (Zábojnik, 2018). An implication is that firms with more intangibles should prefer share repurchases over dividends.

Here the optimal capital structure addresses a conflict distinct from the agency problem associated with external financing. Critical employees can depart with the knowledge they have created before the investment project generates revenues, depriving the firm of value creation. Promoting retention thus requires the firm to promise skilled employees adequate and reliable compensation that discourages any departure until the project's completion. A policy of retaining resources to safeguard unvested or uncontracted future compensation is essential for employee motivation (Acharya et al., 2011), as financial distress may prompt innovative employees to exit (Babina, 2017).

This retention motive provides a refinement of the classical precautionary motive for HINT firms' prudent financial policies. Both motives encourage firms to provide insurance, yet our theory is based on a careful description of how intangibles are created. It offers distinct implications that HINT firms earn higher free cashflows and hold more cash relative to investment needs. It also shows that a prudential motive may exist regardless of the presence of future financial constraints, as the retention motive should lead to a positive association between intangibles usage and cash holdings even among unconstrained firms.

Overall, our model makes clear predictions on HINT firms' free cashflow levels and their financing, compensation and payout policies. For illustration, we provide some empirical support for these predictions by studying a large sample of Compustat firms over the period 1970 through 2010. Our long panel analysis establishes correlation rather than causation, for which more precise identification is required.

We measure intangible asset values by capitalizing annual investment into the production of

knowledge, brand quality, and organizational culture (Peters and Taylor, 2016). Interestingly, most of these expenditures reflect salaries, illustrating how intangible assets are created and maintained by the human capital investment of highly skilled employees.

We use two empirical approaches to study how intangibles affect firms' financial policies. First, we estimate pooled OLS regressions using all of the sample's cross-sectional and time-series variation in intangibles usage. Second, we examine how policies change following large, sectoral shifts from tangible to intangible investment. These technological transitions are staggered across time, reflecting how IT and the Internet have transformed corporate strategies at different speeds across industries.[2] To further highlight the broad adoption of intangibles across sectors and firms' life cycle stages, we report all results separately after excluding young or high-tech firms.

The data show that firms use different sources of financing to produce tangible and intangible assets. HINT firms have significantly lower net leverage, and raise larger amounts of internal funding by granting employees more unvested stock options and restricted stock. (Our measures exclude equity grants to top executives.) The value of these grants rises by 40% following technological transitions, and amounts to an annual transfer of 0.7% of firms' market capitalizations to employees. Thus, the data suggest that firms that rely on more human capital-intensive production also tend to defer more compensation, as our model predicts.

The evidence suggests that HINT firms adopt various corporate policies to support the value of unvested equity claims to skilled employees. First, HINT firms retain a higher fraction of their free cashflows, which keeps more resources in the firm until equity grants vest. Yet because HINT firms earn higher operating cashflows, their overall payments to external shareholders are similar to those of LINT firms. Second, HINT firms' cash holdings are larger when their employees are more exposed to firm risk. The positive association between intangibles usage and cash holdings is stronger among firms that have higher stock price volatility, and that grant more equity to employees. These effects are robust to controlling for commonly used measures of financial constraints, which are also positively associated with HINT firms' cash holdings.

[2]We use Andrews (1993)'s procedure to identify major structural breaks in each industries' time-series of investment composition. These breaks range from 1974 to 2002, and are consistent with anecdotal evidence on the staggered impact of technology across industries.

Thus, the evidence suggests both a precautionary and retention motive for holding cash, as predicted by the model. Third, we show that intangibles usage is also associated with a preference for share repurchases over dividends, which minimize dilution of unvested claims.

1.1 Related literature

An extensive literature examines the asset determinants of corporate leverage. A simple conjecture is that firms tend to fund tangible assets with debt, not least for tax reasons, and adjust net leverage by their choice of cash holdings to achieve self-insurance on future investment needs, and possibly to insure their key employees.

The classic view is that firms hold cash to buffer against future financing constraints (Kim et al., 1998; Almeida et al., 2004; Harford et al., 2014); see Almeida et al. (2014) for a survey. We include this first-order cause in our model, balanced against associated agency costs of managerial discretion (Jensen, 1986; Pinkowitz et al., 2006; Dittmar and Mahrt-Smith, 2007; Harford et al., 2008).[3] Our approach is close to Acharya et al. (2011), who show that maintaining resources in the firm is necessary to motivate managerial human capital. More generally, skilled human capital has direct and indirect claims on profits via deferred compensation, career advancement, share and option grants (Eisfeldt and Papanikolaou, 2013). Accordingly, the amount and safety of corporate assets net of leverage are critical determinants to the return to human capital.

Cash holdings by U.S. companies have been on a long-term rise, as documented by Bates et al. (2009).[4] Our explanation is related to the spread of information technology since the early 1980s and its impact on the productivity of skilled human capital. In a closely related paper, Döttling and Perotti (2017) offer a general equilibrium model of technological progress where rising intangible value can account for major financial trends such as declining interest rates and a reallocation of credit from productive to asset finance. Graham and Leary (2017) and Begenau and Palazzo (2017) find that the recent increase in cash is largely associated with listings of high tech firms.

[3]The conflict is less acute when profitability reflects quasi-rents that require investment to be maintained.
[4]Graham and Leary (2017) point out how a similar pattern occurred earlier in the twentieth century.

While U.S. tax rules on global profitability encourage firms to retain cash abroad (Foley et al., 2007; Harford et al., 2016), Pinkowitz et al. (2016) find that U.S. firms' cash holdings are no higher than their foreign counterparts' once properly controlling for their greater R&D intensity. Thus their higher cash holdings appear to reflect greater usage of intangible assets, in line with our approach.

Other rationales for high corporate cash holdings reflect transaction costs of raising new funding (Miller and Orr, 1966; Mulligan, 1997) or variations in the opportunity cost of holding cash (Azar et al. (2016)).

One of our contributions is to show that HINT firms simply have lower tangible investment needs, which fits with several recent documented facts. The relationship between external fund flows and growth opportunities has decreased over time (Lee et al., 2016), and capital expenditures of U.S. public firms more than halved from 1980 to 2012 (Fu et al., 2015), while stock prices rose. HINT firms appear to invest less not only in the U.S., but also in Europe (Döttling et al., 2017). Philippon and Gutiérrez (2016) also find evidence for a decrease in competition, as well as weakening corporate governance.

Several papers highlight how technological progress has boosted the role of human capital and induced changes in funding and employee compensation choices.[5] Lustig et al. (2011) recognize the impact of technology on the productivity of organizational capital, and are able to explain the rising role and dispersion of managers' pay for performance in large firms.[6] Thakor and Lo (2015) show that cash holdings are essential in a competitive environment where success in R&D is critical.

Our paper also relates to a nascent literature showing that firms choose their leverage ratios in part to offer insurance to risk-averse employees (Berk et al., 2010; Agarwal and Matsa, 2013; Kim et al., 2016). Graham et al. (2016) measure the decline in employees' income following bankruptcy and show that firms grant higher ex-ante wages to compensate for distress risk. We contribute to this literature by showing that even in the absence of bankruptcy or distress costs,

[5]This process is believed to account for a drastic rise in the skill premium since 1980 (see, e.g., Katz and Murphy (1992) and Autor et al. (1998)).

[6]Their estimates suggest managers may be able to claim as much as half of total value of organizational capacity they create. As in our approach, employee risk aversion enables firms to retain more of the value created.

innovative firms may hold more cash and use less leverage in order to insure employees with large equity stakes. Our results do not depend on whether deferred compensation takes the form of debt or equity, though in practice firms overwhelmingly grant unvested equity rather than deferred cash, either by individual contracts or through broader employee stock ownership plans (ESOPs). The choice of equity over fixed compensation may be due to fiscal advantages (Babenko and Tserlukevich, 2009; Hanlon and Shevlin, 2002) or the need to index compensation to the ex-post value of the employee's outside option (Oyer and Schaefer, 2005). It may also be due to the greater credibility of a property grant over a nominal contractual promise.

Our work is closely related to two recent papers. Bolton et al. (2016) develop a theory linking corporate liquidity policies to inalienable human capital. In their model, firms retain risk-averse employees by granting them deferred compensation, and hold cash or credit lines to increase the credibility of these claims. Sun and Zhang (2018) use a dynamic model to show that innovative firms offer employees a long-term contract with back-loaded wages, in order to free up cashflows for upfront investment. A key implication of their model is that borrowing from employees crowds out external debt financing. In contrast, our theory builds on the empirical observation that firms spend less upfront when investing into intangibles, and hence require less external funding. Our model also generates unique predictions about how HINT firms support the value of employees' claims through their resource retention and payout policies.

The rest of the paper is organized as follows. Section 2 develops a model of intangible investment, generating predictions for capital structure, cash holdings, and payouts. Section 3 describes our sampling procedure and empirical methodology. Section 4 presents empirical evidence linking intangibles usage to corporate financing policies. Section 5 concludes. Proofs are in Appendix A, and variable definitions are in Appendix B.

2 Model

We model how the composition of corporate investment affects its optimal funding, liquidity and payout policy. The literature recognizes that tangible and intangible assets differ in their pledgeability. Our insight is that HINT firms need less upfront investment as workers co-invest

their human capital, and that some future value therefore must be assigned to employees.

The firm faces uncertainty over cash flows, so it may face a liquidity shock against which it needs to insure by holding sufficient liquid resources (Holmström and Tirole, 1998). At the same time, the firm relies on critical employees who may leave the firm when receiving attractive outside offers. Retaining human capital requires granting deferred compensation that matches the employees' outside options, which optimally takes the form of unvested share grants if outside options are correlated with firm performance (Oyer, 2004).

We show that a firm with a high intangible asset ratio chooses a more prudent policy to insure both its capital investment program as well as the deferred compensation offered to human capital. A distinct result is that firms' asset composition affects not only their financial structure but also their liquidity and payout policy even for financially unconstrained firms.

2.1 Model setup

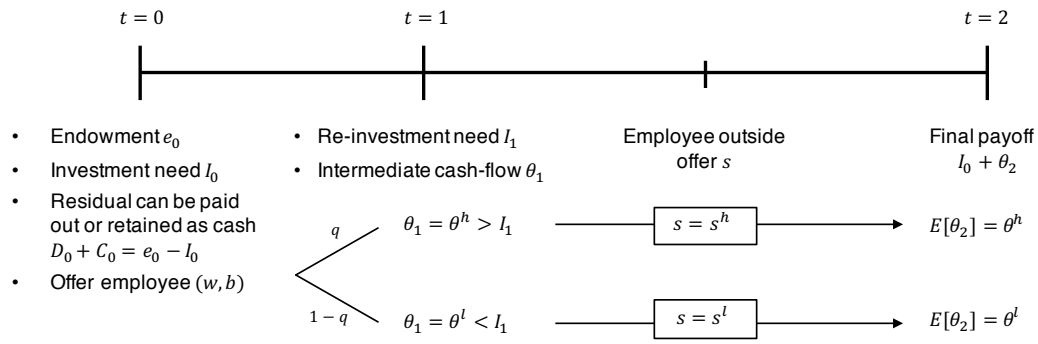
Consider a risk-neutral firm with a mandate to maximize shareholder value, and a risk-averse, highly skilled employee. There are three periods, $t = 0, 1, 2$ and all actions are summarized in Figure 4.

At $t = 0$, the firm has access to a project with fixed investment scale I_0, which pays out $I_0 + \theta_2$ in the final period. Here θ_2 is a stochastic cashflow with CDF $F(\theta_2)$, support $[0, \infty)$, and variance σ^2. The firm has an initial cash endowment e_0, stemming from cashflows from previous operations or initial equity. The firm needs to ensure the skilled employee will stay committed to intangible creation within the firm for output to be realized. To ensure retention, compensation must be deferred until final cash flows are realized at $t = 2$. We first consider a contract (w, b) with a fixed payment w at $t = 2$ plus an unvested share grant b that vests after cashflows are realized at $t = 2$. The employee has mean-variance preferences over her final wealth W_2 at $t = 2$, with risk-aversion parameter r:

$$U = \mathbb{E}[W_2] - rVar[W_2]$$

In the interim period the firm has intermediate cash flow θ_1 and some re-investment need

Figure 4: Timeline.



I_1. Realistically, the firm cannot raise additional equity funding at this point, so it either borrows against assets or use retained equity (cash) to cover its net financing need $I_1 - \theta_1$. After observing the firm's re-investment and before the final cash flows at $t = 2$ are realized, the employee receives an outside offer with utility value s. If she accepts she leaves the firm and no output is realized. Contractual renegotiation by either party is not possible. At the beginning of $t = 1$ all agents learn the state of the economy. The state determines (i) the firm's intermediate cash flow θ_1, (ii) the expected value of the final cash flow at $t = 2$, $\mathbb{E}[\theta_2]$, and (iii) the value of the employee's outside option. The ex-ante probability of the good state is q. In the good state, the firms's intermediate cashflows are high, $\theta_1 = \theta^h > I_1$, else $\theta_1 = \theta^l < I_1$. $\mathbb{E}[\theta_2]$ is high in the good state and low otherwise, and is correlated with θ_1, i.e. $\mathbb{E}[\theta_2] = \delta\theta_1$, with $\delta > 1$.

As in Oyer (2004), the value of the employee's outside option is correlated with the performance of the firm. The employee's outside option has utility value s^h in the good state and s^l otherwise, with $s^h > s^l$. The interpretation is that the firm's performance is correlated with its industry peers, which compete more aggressively for talent when it is more valuable.

The main parameter of interest is a firm's intangible-intensity η, defined as the fraction of intangible capital in investment, while $1 - \eta$ is the physical capital share. Thus the amount $\eta I_0 \equiv H$ is intangible and $(1 - \eta)I_0 \equiv K$ is physical capital. The following three assumptions summarize differences between intangible and physical capital:

- Investments in intangible capital require lower upfront outlays, as human capital co-invests

in intangible capital. Let a fraction α of the investment needs to be paid by firms, with the rest $(1-\alpha)$ contributed by the employee (for simplicity, at no effort cost). Total investment by the firm is therefore $I_0^f = [\eta\alpha + (1-\eta)]I_0 = [1-\eta(1-\alpha)]I_0$, while the employee contributes human capital $I_0^w = \eta(1-\alpha)I_0$. The empirical measure of corporate intangible investment $\eta\alpha I_0 = \alpha H$ reflects R&D and organizational capital (measured by SG&A expenditures), while the amount $(1-\eta)I_0 = K$ represents CAPEX. The value of human capital I_0^w contributed by the employee is not recorded as an asset on the balance sheet, but it contributes to future firm value.

- Intangible investments relies on the commitment of high-skill human capital, who has good outside options as their talent is in demand. We assume that the utility value of the employee's outside option is proportional to her human capital, such that the outside option is worth $\eta(1-\alpha)s$. Another interpretation is that employees can walk away with their intangible investment and re-deploy it in a new firm with value s.

- Intangible capital is poor collateral, while physical capital can be fully pledged to external investors and hence support debt financing. We assume that the final cash flow θ_2 cannot be pledged to external investors. Denoting by B_t the firm's borrowing at time t, the borrowing constraint is

$$B_0 + B_1 \leq \psi K,$$

  where $\psi \in [0,1]$ is a parameter that determines the pledgeability of physical capital.

2.2 Free Cash Flow

At $t=0$ the firm has an initial endowment of e_0, independent of θ. It needs to invest I_0^f, so its free cash flow is

$$FCF_0 \equiv e_0 - I_0^f = e_0 - [1-\eta(1-\alpha)]I_0.$$

The firm's free cash flow may be negative, in which case it needs to borrow $B_0 \geq -FCF_0$, else the firm can either pay out its free cash flow as a dividend, or retain it as cash on its balance sheet. To save on notation we denote by C_0 the firm's cash holding net of borrowing (where

$C_0 \leq 0$ indicating net borrowing) and by D_0 any dividend. The firm's budget constraint at $t = 0$ can then be written as

$$C_0 + D_0 = FCF_0.$$

2.3 Precautionary Cash Holding

Upon a low cash flow at $t = 1$ the firm will need to put up a net amount of $I_1 - \theta^l$ to cover its re-investment needs. The firm can either use its net retained cash C_0 or borrow against its tangible assets up to ψK, so its total financial slack is $C_0 + \psi K$. Since $K = (1-\eta)I_0$, the firm's $t = 0$ cash holdings for precautionary reasons must ensure

$$C_0 \geq I_1 - \theta^l - \psi K \equiv C_{PREC} \qquad (PREC)$$

As long as ($PREC$) is satisfied, the firm can always fund its re-investment need I_1.

2.4 Employee Retention

To ensure that the employee refuses an outside offer, the contract (w, b) must satisfy:

$$(1-\alpha)\eta s^h \leq w + b\mathbb{E}[V^h] - rb^2 Var[V^h], \qquad (PC_h)$$

$$(1-\alpha)\eta s^l \leq w + b\mathbb{E}[V^l] - rb^2 Var[V^l]. \qquad (PC_l)$$

Here, V^h and V^l denote the firm's value in the good and in the bad state, respectively.

3 The Firm's Problem and Comparative Statics

The firm maximizes shareholder value, denoted by $\mathbb{V}$, subject to the employee's participation constraints and ensuring it has enough cash to withstand the liquidity shock:

$$\begin{aligned} \max_{C_0,w,b} \quad & \mathbb{V} = (1-b)(q\mathbb{E}[V^h] + (1-q)\mathbb{E}[V^l]) + D_0 - w \\ s.t. \quad & (PC_h), (PC_l), (PREC) \end{aligned} \qquad (1)$$

With three constraints that may or may not bind there are six different cases, we assume that $s^l = 0$ so that the firm needs to satisfy the participation constraint when the employee receives a high offer $s = s^h$. In the bad state the firm's only concern is to ensure that it has enough funding to cover its re-investment need I_1.

Assuming that (PC_h) and ($PREC$) are satisfied, the value of the firm is

$$V^i = C_0 + \underbrace{(\theta^i - I_1)}_{\text{Net cashflow } t=1} + \underbrace{(I_0 + \theta_2)}_{\text{Cashflow } t=2} \tag{2}$$

where $i = h$ denotes the good state and $i = l$ the bad state. Hence, we have

$$\begin{aligned} \mathbb{E}[V^i] &= C_0 + I_0 + (1+\delta)\theta^i - I_1, \\ Var[V^i] &= \sigma^s. \end{aligned}$$

Inspecting these values, the firm's compensation choice is:

Lemma 1. *Conditional on the firm offering some stock compensation ($b > 0$), it prefers insuring the worker by hoarding cash C_0 rather than offering a fixed deferred cash payment w, i.e. $w = 0$.*

Proof. The net cost of higher cash holdings for shareholder is $\frac{\partial \mathbb{V}}{\partial C_0} - 1 = -b$, while the cost of an increase in w is $\frac{\partial \mathbb{V}}{\partial C_0} = -1$. This net cost matches the benefit in terms of satisfying (PC_h), i.e. the RHS of (PC_h) increases by b for a marginal increase in C_0, and by 1 for a marginal increase in w. However, only C_0 helps alleviating ($PREC$). Hence, shareholders prefer to increase C_0 rather than w. □

The crucial insight from lemma 1 is that once the firm pays stock compensation ($b > 0$), the employee has an indirect claim on the firm's cash holdings. For any given level of expected compensation the firm can insure the worker either by a deferred cash payment w or by hoarding cash, as (PC_h) shows. Intuitively, once the employee has a claim of a fraction b on the firm, $1/b$ units of cash have the same value to the employee as one unit of a fixed deferred payment w. The firm may however prefer to hoard cash, which has the additional advantage to insure

the firm investment coverage in the bad state. In other words, cash is a more flexible form of insurance, as it protects the employee in the good state and insulates firm reinvestment in the bad state.

Real world firms may prefer to offer some deferred fixed compensation for other reasons not modeled here. Hoarding cash is associated with agency discretion (Jensen 1976). Yet the result highlights how cash not only insures firms against liquidity shocks, but also workers who hold unvested equity. This finding can thus be seen as a refinement of the known precautionary motive of HINT firms (Falato et al., 2013).

Given lemma 1 $w = 0$, the problem of the firm requires choosing C_0 and b subject to (PC_h) and ($PREC$). We first solve the problem assuming that (PC_h) binds and ($PREC$) remains slack, then analyze the second case when ($PREC$) binds.

Slack precautionary constraint. When (PC_h) binds and ($PREC$) is slack, maximizing (1) w.r.t. b gives the following optimal level for the firm's share grant

$$b = (1-q)\frac{(1+\delta)\Delta\theta}{2r\sigma^2}, \tag{3}$$

where $\Delta\theta \equiv \theta^h - \theta^l$. Optimal cash holdings then follow as a residual from (PC_h):

$$C_0 = (1-\alpha)\eta\frac{s^h r\sigma^2}{(1-q)\Delta\theta} + (1-q)\Delta\theta - [2\theta^h + I_0 - I_1] \equiv C_{PC}. \tag{4}$$

In this case the firm chooses cash holdings such as to provide just enough insurance to match the employee's outside option in the good state. This case applies if C_{PC} exceeds the cash holdings necessary for precautionary reasons, i.e. if

$$C_{PC} \geq C_{PREC}. \tag{5}$$

Binding precautionary constraint. In contrast, if $C_{PC} < C_{PREC}$, then ($PREC$) binds and the firm's cash holdings follow immediately as $C_0 = C_{PREC}$. Because ($PREC$) does not depend on b, in this case shareholder value $\mathbb{V}$ strictly decreases in b, implying that the firm chooses the

lowest level of b consistent with (PC_h). Plugging in $C_0 = C_{PREC}$ into (PC_h) and rearranging yields the following quadratic equation that implicitly defines b for the case $C_{PC} < C_{PREC}$:

$$-(1-\alpha)\eta s^h + b[\delta\theta^h + \Delta\theta + [1-\psi(1-\eta)]I_0] - rb^2\sigma^2 = 0. \tag{6}$$

In this second case, the firm retains enough cash to withstand the liquidity shock in the bad state at $t = 1$. While (PC_h) also binds, the firm over-insures the employee.

The following proposition summarizes the solution.

Proposition 1. *Assume that* $(1-q)\frac{(1+\delta)\Delta\theta}{2r\sigma^2} \leq 1$. *The optimal net cash holding* C_0 *and unvested share grant* b *are given by*

$$C_0 = \begin{cases} C_{PC} & \text{, if } C_{PC} \geq C_{PREC} \\ C_{PREC} & \text{, else,} \end{cases}$$

$$b = \begin{cases} (1-q)\frac{(1+\delta)\Delta\theta}{2r\sigma^2} & \text{, if } C_{PC} \geq C_{PREC} \\ \frac{[\delta\theta^h+\Delta\theta+[1-\psi(1-\eta)]I_0]-\sqrt{[\delta\theta^h+\Delta\theta+[1-\psi(1-\eta)]I_0]^2-4(1-\alpha)\eta s^h r\sigma^2}}{2r\sigma^2} & \text{, else,} \end{cases}$$

where C_{PC} *and* C_{PREC} *are defined in (4) and (PREC), respectively.*

3.1 Comparative Statics

This section summarizes the comparative statics driving the corporate financing choice.

Proposition 2. *(i) HINT firms have higher free cash flow and lower observed investment spending:*

$$\frac{dFCF_0}{d\eta} \geq 0, \frac{dI_0^f}{d\eta} \geq 0$$

(ii) HINT firms grant more deferred stock compensation:

$$\frac{db}{d\eta} \geq 0$$

(iii) HINT firms hold more cash, irrespective of whether (PREC) binds:

$$\frac{dC_0}{d\eta} \geq 0$$

(iv) Cash holdings of HINT firms are more sensitive to employee outside options:

$$\frac{dC_0}{ds^h d\eta} \geq 0$$

Free cash flow. Proposition 2 highlights the key results. First, HINT firms have higher free cash flow and lower observed investment spending, since some fraction α of intangible investment is provided by employees human capital, so that the firm's investment $I_0^f = [1 - \eta(1-\alpha)]$ decreases in its intangible capital η. Figure 3 shows that HINT firms indeed invest less for a given level of cash flows, and as a result have higher free cash flow. Philippon and Gutiérrez (2016) and Döttling et al. (2017) show that both in the U.S. and Europe HINT firms have consistently lower investment rates. Since not all intangible investment appears on the firm's balance sheet, overall investment may be underestimated.

Deferred stock compensation. Second, HINT firms grant more deferred stock compensation. To see this result inspect the optimal stock compensation b in proposition 2. If $C_{PC} \geq C_{PREC}$ the optimal b is at an interior solution and hence not a function of η. On the other hand, if ($PREC$) binds then b is pinned down by the employee's participation constraint and follows from (6). An increase in intangible-intensity η leads the firm to offer more stock compensation. Let the left hand side of (6) as a function $g(b;\eta)$, s.t. the optimal b is defined by $g(b;\eta) = 0$. Figure 5 plots $g(b;\eta)$ for two different values of η, η' and η'', with $\eta'' > \eta'$. While there are generally two solutions to $g(b;\eta) = 0$, the firm optimally chooses the smaller value (since shareholder value $\mathbb{V}$ decreases in b), denoted b' and b'' in figure 5.

Inspecting (6), the intercept $g(0;\eta) = -(1-\alpha)\eta s^h$ is below zero and decreases in η. While $g(b;\eta'')$ has a higher slope thatn $g(b;\eta')$, we show in appendix **??** that the intersection point where $g(b;\eta') = g(b;\eta'')$ is above zero. Consequently, an increase in η results in a higher deferred share grant, $b'' > b'$, as drawn in figure 5.

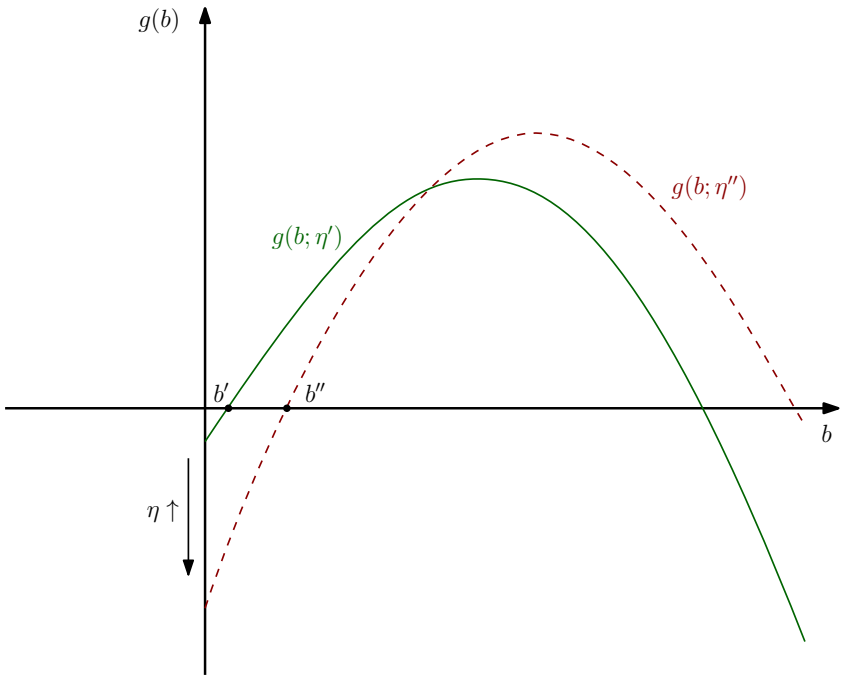


Figure 5: The effect of an increase in η on b.

Cash holdings. Proposition 2 further shows that HINT firms hold more cash. Cash holdings increase in η, as it can readily seen from the expression for C_{PC} and C_{PREC}, defined in equations (4) and ($PREC$) respectively.

While in both cases cash holdings increase in η, they do so for different reasons. If ($PREC$) binds, the firm's cash holdings are given by $C_0 = C_{PREC}$, and determined by the need to hold sufficient liquid resources to withstand the liquidity shock in the bad state. In this case, cash holdings increase in η because intangible capital has a lower debt capacity than physical capital, such that HINT firms need to hold more cash to withstand the liquidity shock.

When if ($PREC$) is slack, cash holdings are at the interior solution $C_0 = C_{PC}$, pinned down by the retention motive. In this case, cash holdings increase in η, the scale of intangible capital.

A distinctive implication of the retention motive that distinguishes it from the traditional capital insurance motive is that HINT firm's cash holdings should be more sensitive to the value of outside options. This can easily be seen by inspecting the value expression of C_{PC} in (4). Clearly, the second derivative of C_{PC} w.r.t. s^h and η is positive, as stated point (iv) of proposition 2.

3.2 Payout policy

We next consider how intangible capital affects corporate payout policy. Dividend policy creates a second internal conflict in the firm. As dividends are only paid out to vested shareholders, they reduce the value of the employee's unvested equity.[7]We assume the employee can observe the firm payout before it chooses whether to accept its ouside option. As a result, a firm that relies on human capital will avoid a large dividend at $t = 1$ such that the value of b falls below the employee's outside option. Thus dividend payments reduce shareholder value whenever the project's present value exceeds the agency cost of retaining cash until $t = 2$.

A more interesting possibility arises when the firm can pay a dividend at $t = 2$, just before the employee's shares vest. By this date the employee has contributed her human capital to production and cannot depart to start an own firm. A dividend payment thus transfers value from the employee to shareholders, without affecting the project's return. Were highly-skilled employees anticipating this possibility they would leave the firm at $t = 1$.Thus the creation of intangible assets via the commitment of human capital over time has to resolve a double-sided moral hazard problem. Co-investment at $t = 0$ will occur only if the firm can build a reputation for refraining from large dividends before deferred equity grants vest.

A payout policy that favors repurchases over dividends reduces moral hazard cost while supporting the value of unvested shares.[8]Let the firm's total shares be normalized to 1, and denote the market values of the firm prior to and after a repurchase as V_{NR} and V_R, respectively. Assume that firm owners have a cash need they need to satisfy at time $t = 1$.

Repurchasing a fraction x of shares at fair market value requires the firm to spend xV_{NR}, reducing firm's value to $V_R = (1 - x)V_{NR}$, but the employee's unvested equity stake concurrently rises to $\omega' = \omega/(1 - x)$. While for a risk-neutral agent the value of the stake would be unchanged ($b'V_R = bV_{NR}$), a risk-averse employee suffers some utility loss from holding a larger claim on a riskier pool of assets. Nevertheless, the negative effect is much smaller than from a dividend payout.

[7]While dividend-protected grants may be an option they are in practice most uncommon, probably because deferred claims may still be fully diluted.

[8]While not in the model, there may be valid reasons (e.g. related to fiscal rules or control issues) to favor dividends over repurchases.

Firms may seek various solutions to the commitment problem. We do not explicitly model how it may be solved by building reputation via an appropriate payout policy in a dynamic setting, and simply note how it would require significant cash retention and a preference for repurchases in payout policy.

4 Empirical Implications

We discuss the main implications and possible avenues for empirical testing. Overall, a human capital retention motive seems consistent with the evolution in corporate practices.

4.1 Empirical Predictions

4.1.1 Corporate financing

The model offers the following predictions on intangibles and corporate financing:

- **Prediction 1.** HINT firms have lower net leverage than LINT firms.
- **Prediction 2.** HINT firms pledge a larger fraction of total equity to employees than LINT firms.
- As HINT employees have more unvested claims, retaining cash holdings is more efficient than granting deferred cash.

Testing these predictions first requires a good proxy for firms' usage of intangible capital (η in the model). Corporate financial statements do not capitalize intangible investment.[9]. Eisfeldt and Papanikolaou (2013) and Peters and Taylor (2016) construct proxies by capitalizing spending on SG&A and R&D expenses, and show they are associated with high intangibles usage. A major challenge is that many firms do not separately report individual spending categories in SG&A expenses, so it is hard to measure separately investment into diverse intangibles such as brand development, organization culture, data analysis or supply-chain management.

Predictions 1 and 2 may be tested by relating proxies of intangible assets with corporate net leverage and employee compensation, even for firms not financially constrained. Prediction 2

[9]Its contribution to firm value appears in market prices, so the market to book ratio is a measure of asset quality and growth prospects.

would ideally require data on the amount of shares granted to employees, or total unvested equity. Since 2004 US firms report the amount of shares that belong to employees in their 10-K filings. Annual share grants to employees can be measured using the procedure of Bergman and Jenter (2007).

4.1.2 Resource retention and payout policies

Our theory offers the following predictions about how intangibles usage affects retention and payout policies:[10]

- **Prediction 3.** HINT firms retain a higher share of their free cashflows than LINT firms, and thus hold more cash as a share of total assets.
- **Prediction 4.** The positive association between retained cash and the value of employees' outside options is stronger among HINT than LINT firms.
- **Prediction 5.** Repurchases constitute a higher fraction of payouts to external investors at HINT than LINT firms.

HINT firms would retain more cash even if they were never financially constrained. This is because holding liquid resources supports the value of unvested equity granted to employees, thus reducing ex-ante compensation costs and future equity dilution. This prediction may be tested by relating intangibles with either total cash holdings or the fraction of free cashflows retained rather than paid out.

The model has some cyclical implications. As HINT firms' employees can depart with some of intangible capital created, HINT firms have a stronger motive to increase the utility value of their compensation during good times when outside options are high. Testing this prediction would require empirical variation in the value of employees' outside options. A possible strategy is to examine state-level variation in the adoption of non-disclosure agreements, which limit employees' ability to transfer their knowledge to a competitor.

Prediction 5 is based on optimal payout policy from Section 3.2. Dividends dilute employees' unvested claims (both fixed and shared-based), raising the chance employees prefer their outside option. In contrast, repurchases are less dilutive as they increase an employee's ownership stake

[10]Prediction 3 follows directly from Proposition 2(iii), Prediction 4 follows directly from Proposition 2(iv).

in the firm's equity. Empirical tests can examine the association between intangible capital and firms' payout ratios, defined as the annual amount of cash spent on share repurchases divided by total cash payouts. Notably, our theoretical implication is for shares repurchased from external shareholders, so empirical measures of the payout ratio should exclude cash used to repurchase employees' shares. Fama and French (2001) propose a procedure to account for these payments.

4.1.3 Identification challenges

Empirical estimates of the relationship between intangible assets and corporate policies may be biased by omitted variables that affect both the structure of firms' assets and their financing or payout practices. This is a challenging problem, because firms' growing reliance on intangible capital can be attributed to technological progress over time. Major technological developments rarely occur suddenly, and they affect many of the choices that firms make.

One possible approach for empirically identifying the model's predictions over time is to examine technology changes within a particular industry. Individual industries sometimes experience technological breakthroughs exogenous to firm conditions at the time. Sectors as diverse as pharmaceutics and bookstores are possible examples.It may also be possible to examine a traditional industry at the time when firms are prompted to innovate after increasing competition from emerging markets.

Probably the most direct test of the retention hypothesis is by identifying episodes of exogenous changes to employees' outside options, perhaps in response to regulatory changes or tax policies.

4.2 Reconciling recent corporate trends

Remarkable changes have occurred in corporate practices over the last few decades. One of the most striking is a significant decrease in the amount of traditional investment. Capital expenditures have fallen by more than half since 1980, and aggregate net investment by U.S. firms has steadily declined since 2000 (Fu et al., 2015; Philippon and Gutiérrez Gallardo, 2017). Whatever the underlying cause of these trends, it does not seem to be associated with lower profits or traditional measure of investment opportunities. Recent data shows how the correla-

tion between investment outlays and Q has been negative since the mid-1990s (Lee et al., 2016; Philippon and Gutiérrez Gallardo, 2017).

The reduction in investment spending has concurred with a change in corporate financing. Lee et al. (2016) find that the amount of external financing raised by firms in high-growth industries has declined since the 1990s. The lower reliance on external capital is concentrated among firms that spend less on investment and repurchase more shares.

Another significant change is the pronounced rise in cash holdings since 1980, and the associated decline in net leverage. The literature has offered numerous explanations. Recent work highlight the changing composition of the U.S. economy with more innovative firms. Bates et al. (2009) show that growth in cash holdings is positively related to R&D spending, and Falato et al. (2013) associate it with the stock of intangible assets. The relationship between firm characteristics and cash holdings seems not to have changed over time, but the share of innovative firms has risen. These firms hold more cash on average, especially in the growth stage of their life cycles (Graham and Leary, 2017; Begenau and Palazzo, 2017). In related work, Pinkowitz et al. (2016) show that U.S. and European firms with similar characteristics hold the same amount of cash, yet the higher cash holdings in the U.S. can be explained by a small number of high-R&D firms.

The form of corporate payouts has also changed dramatically since 1980. The fraction of firms paying cash dividends has declined significantly (Fama and French, 2001), especially among firms with positive retained earnings (DeAngelo et al., 2006). In this time period firms have shifted from dividends to share repurchases in their payout policy (Grullon and Michaely, 2002).

In summary, relative to 1980 U.S. firms now spend less on investment relative to their market value, rely less on external financing, hold more cash and prefer repurchases over dividends.These trends are consistent with our simple insight that firms rely on human capital contributions to create intangible capital. The increased use of human capital can explain the observed decline in measurable investment spending, especially among high-growth firms. Retaining skilled employees requires firms to defer their compensation and support its value prior to vesting, which can explain why innovative firms raise less external funding, hold more cash, and favor share repurchases.

We view the retention motive for prudent financial policy as a component of a general precau-

tionary motive, next to the need to insure adequate funding for future investment needs. While implications are quite similar for both drivers, the distinctive feature of the retention motive concerns the need to safeguard future returns to human capital. Detailed data on deferred compensation is needed to measure intangible capital more precisely.

Our model predicts that high intangible firms prefers repurchases to dividends to avoid diluting unvested claims. Firms concerned about financial constraints because of less tangible assets may also avoid dividends, as they suggest a commitment to regular payments.

4.3 Implications for financial statements

Our model builds on the insight that intangible assets embedded in skilled human capital constitute much of an innovative firm's value. As they cannot be reliably measured, their contribution to firm value is difficult to quantify.

Since human capital investment is not fully recorded in firm balance sheets, their total investment activity may have been strongly underestimated while *measurable* investment spending has declined. As the market value equity will reflect this capital, a part of the market-to-book ratio and Q reflect the value of current rather than future opportunities. Consistent with this view, Peters and Taylor (2016) find that the classical Q theory of investment has more explanatory power when spending on intangibles is included in investment and intangible assets are capitalized.

References

Acharya, Viral V., Stewart C. Myers, and Raghuram G. Rajan, 2011, The internal governance of firms, *The Journal of Finance* 66, 689–720.

Agarwal, Ashwini, and David Matsa, 2013, Labor unemployment risk and corporate financing decisions, *Journal of Financial Economics* 108, 449–470.

Almeida, Heitor, and Murillo Campello, 2007, Financial constraints, asset tangibility, and corporate investment, *Review of Financial Studies* 20, 1429–1460.

Almeida, Heitor, Murillo Campello, Igor Cunha, and Michael S. Weisbach, 2014, Corporate liquidity management: A conceptual framework and survey, *Annu. Rev. Financ. Econ.* 6, 135–162.

Almeida, Heitor, Murillo Campello, and Michael S. Weisbach, 2004, The cash flow sensitivity of cash, *Journal of Finance* 59, 1777–1804.

Andrews, Donald, 1993, Tests for parameter instability and structural change with unknown change point, *Econometrica* 61, 821–856.

Autor, David H., Lawrence F. Katz, and Alan B. Krueger, 1998, Computing inequality: Have computers changed the labor market?, *The Quarterly Journal of Economics* 113, 1169–1213.

Azar, José A, Jean-François Kagy, and Martin C Schmalz, 2016, Can changes in the cost of carry explain the dynamics of corporate "cash" holdings?, *Review of Financial Studies* 29, 2194–2240.

Babenko, Ilona, and Yuri Tserlukevich, 2009, Analyzing the tax benefits from employee stock options, *Journal of Finance* 64, 1797–1825.

Babina, Tania, 2017, Destructive creation at work: How financial distress spurs entrepreneurship, Columbia University Working Paper.

Bates, Thomas W., Kathleen M. Kahle, and Ren M. Stulz, 2009, Why do U.S. firms hold so much more cash than they used to?, *Journal of Finance* 64, 1985–2021.

Begenau, Juliane, and Berardino Palazzo, 2017, Firm selection and corporate cash holdings, Harvard Business School Working Paper.

Bergman, Nittai K., and Dirk Jenter, 2007, Employee sentiment and stock option compensation, *Journal of Financial Economics* 84, 677–712.

Berk, Jonathan, Richard Stanton, and Josef Zechner, 2010, Human capital, bankruptcy and capital structure, *Journal of Finance* 65, 891–926.

Bolton, Patrick, Neng Wang, and Jinqiang Yang, 2016, Liquidity and risk management: Coordinating investment and compensation policies, Columbia University and NBER Working Paper.

Corrado, Carol A., and Charles R. Hulten, 2010, How do you measure a "technological revolution"?, *American Economic Review* 100, 99–104.

DeAngelo, Harry, Linda DeAngelo, and René M. Stulz, 2006, Dividend policy and the earned/contributed capital mix: a test of the life-cycle theory, *Journal of Financial Economics* 81, 227–254.

Dittmar, Amy, and Jan Mahrt-Smith, 2007, Corporate governance and the value of cash holdings, *Journal of Financial Economics* 83, 599–634.

Döttling, Robin, Germán Gutiérrez, and Thomas Philippon, 2017, Is there an investment gap in advanced economies? If so, why?, Prepared for the ECB Forum on Central Banking.

Döttling, Robin, and Enrico C. Perotti, 2017, Secular trends and technological progress .

Eisfeldt, Andrea L, and Dimitris Papanikolaou, 2013, Organization capital and the cross-section of expected returns, *The Journal of Finance* 68, 1365–1406.

Falato, Antonio, Dalida Kadyrzhanova, and Jae W. Sim, 2013, Rising intangible capital, shrinking debt capacity, and the US corporate savings glut, Finance and Economics Discussion Series Working Paper 2013-67.

Fama, Eugene F, and Kenneth R French, 2001, Disappearing dividends: changing firm characteristics or lower propensity to pay?, *Journal of Financial Economics* 60, 3–43.

Foley, C. Fritz, Jay C. Hartzell, Sheridan Titman, and Garry Twite, 2007, Why do firms hold so much cash? A tax-based explanation, *Journal of Financial Economics* 86, 579–607.

Froot, Kenneth A., David S. Scharfstein, and Jeremy C. Stein, 1993, Risk management: Coordinating corporate investment and financing policies, *The Journal of Finance* 48, 1629–1658.

Fu, Fangjian, Sheng Huang, and Rong Wang, 2015, Why do US firms invest less over time?, Singapore Management University Working Paper.

Graham, John, Hyunseob Kim, Si Li, and Jiaping Qiu, 2016, Employee costs of corporate bankruptcy, Duke University Working Paper.

Graham, John, and Mark Leary, 2017, The evolution of corporate cash, Duke University Working Paper.

Grullon, Gustavo, and Roni Michaely, 2002, Dividends, share repurchases, and the substitution hypothesis, *The Journal of Finance* 57, 1649–1684.

Hanlon, Michelle, and Terry Shevlin, 2002, The tax benefits of employee stock options: The accounting and implications, *Accounting Horizons* 16, 1–16.

Harford, Jarrad, Sandy Klasa, and William Maxwell, 2014, Refinancing risk and cash holdings, *Journal of Finance* 69, 975–1012.

Harford, Jarrad, Sattar Mansi, and William Maxwell, 2008, Corporate governance and firm cash holdings in the US, *Journal of Financial Economics* 87, 535–555.

Harford, Jarrad, Cong Wang, and Kuo Zhang, 2016, Foreign cash: Taxes, internal capital markets, and agency problems, University of Washington Working Paper.

Hart, Oliver, and John Moore, 1994, A theory of debt based on the inalienability of human capital, *The Quarterly Journal of Economics* 109, 841–79.

Holmström, Bengt, and Jean Tirole, 1998, Private and public supply of liquidity, *Journal of political Economy* 106, 1–40.

Jensen, Michael C., 1986, Agency cost of free cash flow, corporate finance, and takeovers, *Corporate Finance, and Takeovers. American Economic Review* 76.

Katz, Lawrence F., and Kevin M. Murphy, 1992, Changes in relative wages, 1963-1987: Supply and demand factors, *The Quarterly Journal of Economics* 107, pp. 35–78.

Kim, E. Han, David C. Mauer, and Ann E. Sherman, 1998, The determinants of corporate liquidity: theory and evidence, *Journal of Financial and Quantitative Analysis* 33, 335–359.

Kim, E. Han, Ernst Maug, and Christoph Schneider, 2016, Labor representation in governance as an insurance mechanism, University of Michigan Working Paper.

Lee, Dong Wook, Hyun-Han Shin, and René Stulz, 2016, Why does capital no longer flow more to the industries with the best growth opportunities?, Ohio State University Working Paper.

Lustig, Hanno, Chad Syverson, and Stijn van Nieuwerburgh, 2011, Technological change and the growing inequality in managerial compensation, *Journal of Financial Economics* 99, 601–627.

Miller, Merton H., and Daniel Orr, 1966, A model of the demand for money by firms, *Quarterly Journal of Economics* 80, 413–435.

Mulligan, Casey B., 1997, Scale economies, the value of time, and the demand for money: Longitudinal evidence from firms, *Journal of Political Economy* 105, 1061–1079.

Opler, Tim, Lee Pinkowitz, René Stulz, and Rohan Williamson, 1999, The determinants and implications of corporate cash holdings, *Journal of Financial Economics* 52, 3–46.

Oyer, Paul, 2004, Why do firms use incentives that have no incentive effects?, *The Journal of Finance* 59, 1619–1650.

Oyer, Paul, and Scott Schaefer, 2005, Why do some firms give stock options to all employees?: An empirical examination of alternative theories, *Journal of Financial Economics* 76, 99–133.

Peters, Ryan H., and Lucian A. Taylor, 2016, Intangible capital and the investment-q relation, Forthcoming, *Journal of Financial Economics*.

Philippon, Thomas, and Germán Gutiérrez, 2016, Investment-less growth: An empirical investigation New York University Working Paper.

Philippon, Thomas, and Germán Gutiérrez Gallardo, 2017, Declining competition and investment in the u.s. New York University Working Paper.

Pinkowitz, Lee, René Stulz, and Rohan Williamson, 2006, Do firms in countries with poor protection of investor rights hold more cash?, *Journal of Finance* 61, 2725–2751.

Pinkowitz, Lee, René Stulz, and Rohan Williamson, 2016, Do U.S. firms hold more cash than foreign firms do?, *Review of Financial Studies* 29, 309–348.

Sun, Qi, and Mindy X. Zhang, 2018, Financing intangible capital, Shanghai University of Finance and Economics Working Paper.

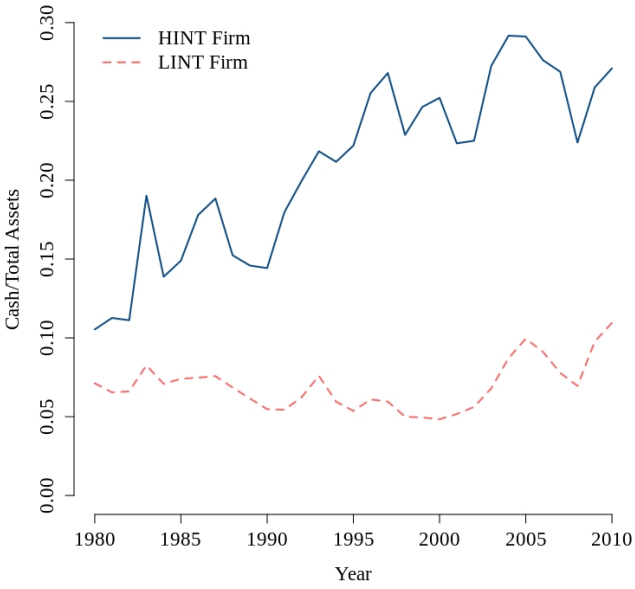
Thakor, Richard T., and Andrew W. Lo, 2015, Competition and R&D financing decisions: Theory and evidence from the biopharmaceutical industry, NBER Working Paper.

Zábojnik, Ján, 2018, Firm reputation and employee startups, Queen's Unversity Ontario Working Paper.

Figure 1: Intangibles Usage, Corporate Cash Holdings, and Net Leverage

Cash Holdings and Net leverage are plotted for the median HINT and LINT firm. HINT firms have an *Intangibles Ratio* in the highest tercile of the sample distribution, and LINT firms have an *Intangibles Ratio* in the lowest tercile. *Intangibles Ratio* is the firm's stock of intangible assets divided by the sum of intangible assets and net PP&E. The stock of intangible assets and intangible investment are measured according to Peters and Taylor (2016). The sample contains all U.S. non-financial and utilities firms in Compustat with assets greater than $5 million and more than 5 years of available data.

Panel A. Cash Holdings



Panel B. Net Leverage

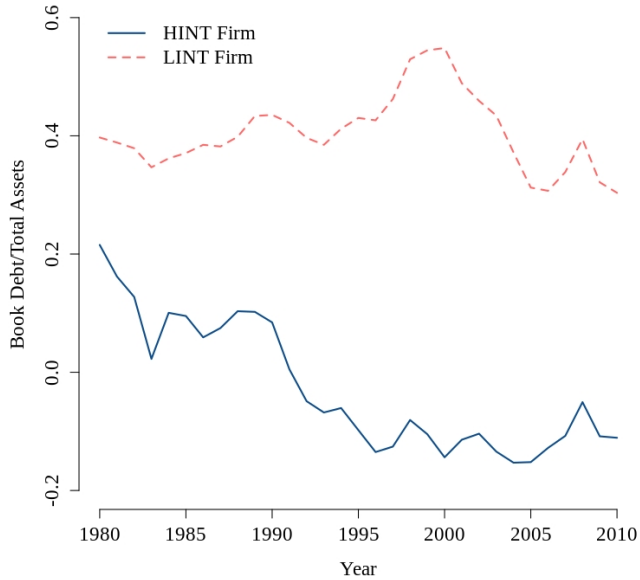


Figure 2: Intangibles Usage and Size of Cashflows

Plots show median operating and free cashflows over time for HINT and LINT firms. Operating cash inflows are prior to investment, but after interest payments and taxes. Free cashflows are operating cashflows minus tangible and intangible investment. Both are scaled by book capital including intangible assets. HINT firms have an *Intangibles Ratio* in the highest tercile of the sample distribution, LINT firms in the lowest tercile. *Intangibles Ratio* is the stock of intangibles divided by the total capital, including net PP&E, measured according to Peters and Taylor (2016). All U.S. non-financial and utilities firms in Compustat with assets greater than $5 million and more than 5 years of data.

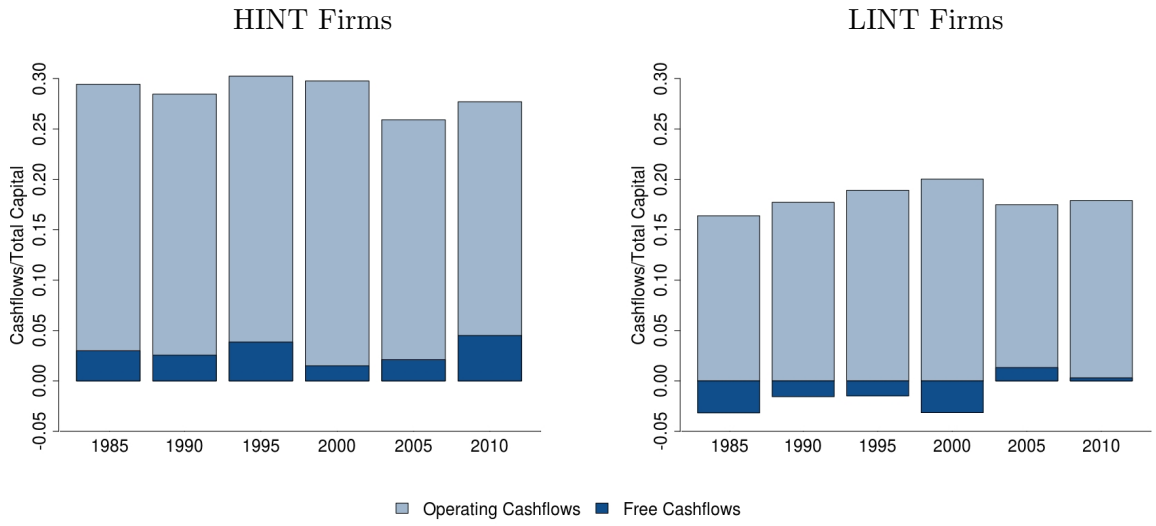


Figure 3: Intangibles Usage and Composition of Operating Cashflows

Plots shows the fraction of operating cashflows spent on tangible and intangible investment, as well as free cashflows that remain after investment. Operating cashflows are measured as cash inflows prior to any investment expenditures, but after interest payments and taxes. Free cashflows are operating cashflows minus tangible and intangible investment. Tangible investment is measured as the annual change in net PP&E. Intangible investment is measured according to Peters and Taylor (2016) and includes spending on R&D, organizational capital, and the acquisition of intangibles. HINT firms have an *Intangibles Ratio* in the highest tercile of the sample distribution, and LINT firms have an *Intangibles Ratio* in the lowest tercile. *Intangibles Ratio* is the firm's stock of intangible assets divided by the sum of intangible assets and net PP&E. The sample contains all U.S. non-financial and utilities firms in Compustat with assets greater than $5 million and more than 5 years of available data.

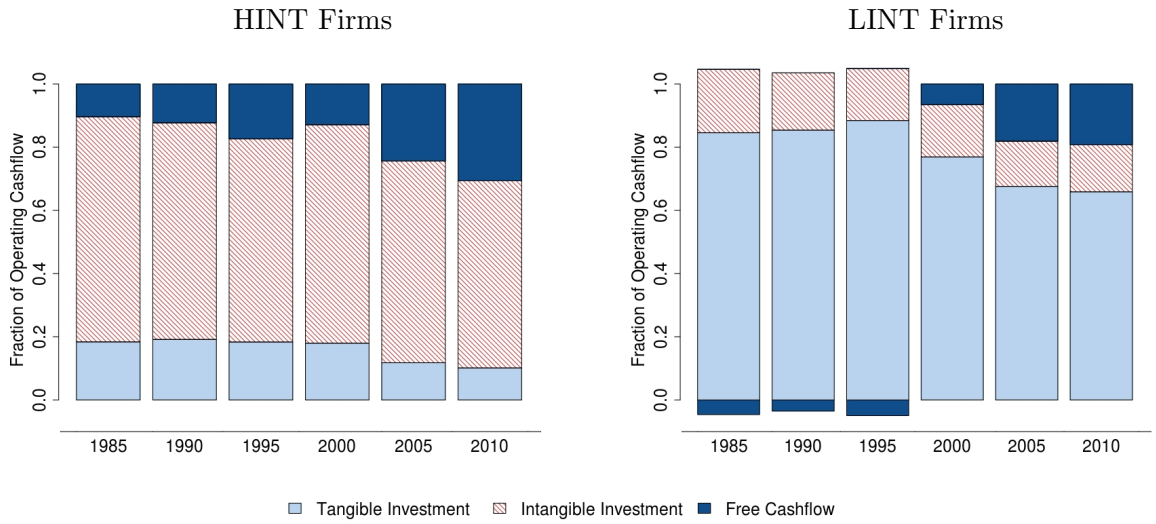


Figure 4: Intangibles Usage and Composition of Free Cashflows

Plots shows the fraction of free cashflows that are retained, spent on share repurchases, and paid out as dividends. Free cashflows are operating cashflows minus tangible and intangible investment. Tangible investment is measured as the annual change in net PP&E. Intangible investment is measured according to Peters and Taylor (2016) and includes spending on R&D, organizational capital, and the acquisition of intangibles. Retained cash is free cashflows minus cash spent on repurchases and dividends. Repurchases exclude cash spent on repurchasing shares to fulfill employee stock option exercises, following the procedure of Fama and French (2001). HINT firms have an *Intangibles Ratio* in the highest tercile of the sample distribution, and LINT firms have an *Intangibles Ratio* in the lowest tercile. *Intangibles Ratio* is the firm's stock of intangible assets divided by the sum of intangible assets and net PP&E. The sample contains all U.S. non-financial and utilities firms in Compustat with assets greater than $5 million and more than 5 years of available data.

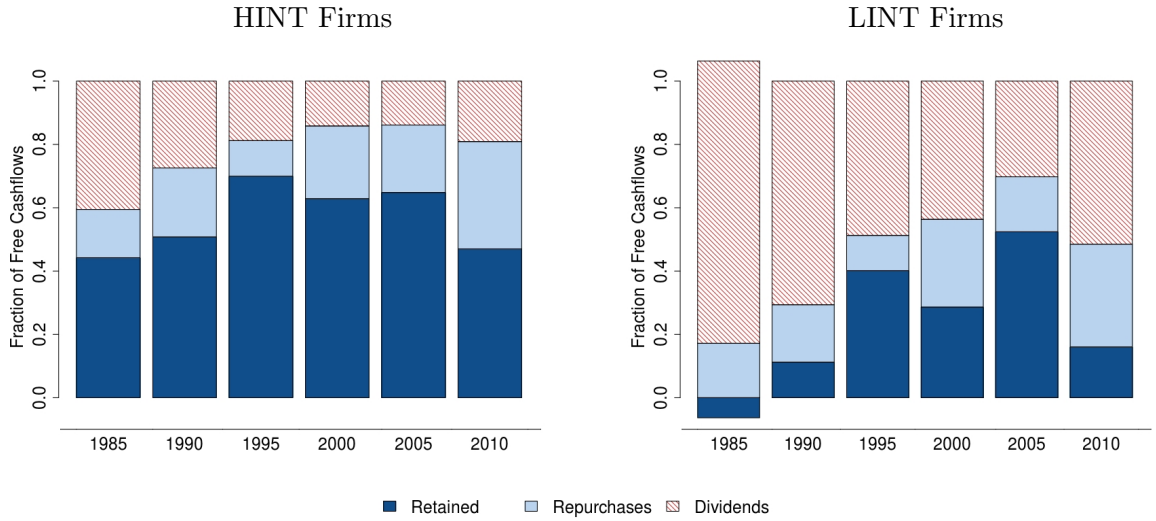


Table 1: Intangibles Usage and Corporate Financing

Values of various corporate financing measures are shown for the median HINT and LINT firm. Net Leverage is book leverage minus cash holdings divided by total assets. Total assets is the sum of PP&E and intangible assets, measured as in Peters and Taylor (2016). Operating cashflows are cash inflows prior to any investment expenditures, but after interest payments and taxes, scaled by total assets. Free cashflows are operating cashflows minus tangible and intangible investment, divided by operating cashflows. Deferred equity pay is the annual Blac-Scholes value of stock option grants to all employees excluding top-5 executives, divided by market capitalization. HINT firms have an *Intangibles Ratio* in the highest tercile of the sample distribution, and LINT firms have an *Intangibles Ratio* in the lowest tercile. *Intangibles Ratio* is the firm's stock of intangible assets divided by the sum of intangible assets and net PP&E. The sample contains all U.S. non-financial and utilities firms in Compustat with assets greater than $5 million and more than 5 years of available data. Some columns are restricted to only firms that pay dividends in a year or that are in the S&P 500.

	All firms		Dividened payers		S&P 500 firms	
	HINT	LINT	HINT	LINT	HINT	LINT
Net Leverage						
1980–1989	0.10	0.38	0.05	0.33	0.09	0.33
1990–1999	-0.07	0.44	0.01	0.38	0.06	0.40
2000–2009	-0.12	0.41	0.09	0.38	0.03	0.38
Total	-0.03	0.41	0.05	0.35	0.05	0.36
Operating Cashflows						
1980–1989	0.29	0.17	0.35	0.20	0.33	0.18
1990–1999	0.30	0.19	0.37	0.22	0.37	0.19
2000–2009	0.26	0.18	0.37	0.21	0.42	0.23
Total	0.29	0.19	0.36	0.21	0.38	0.19
Free Cashflows						
1980–1989	0.15	-0.06	0.23	0.04	0.23	-0.02
1990–1999	0.16	-0.03	0.28	0.17	0.32	0.10
2000–2009	0.19	0.12	0.37	0.21	0.39	0.23
Total	0.18	0.01	0.30	0.12	0.35	0.08
Deferred Equity Pay						
1980–1989	NA	NA	NA	NA	NA	NA
1990–1999	0.012	0.004	0.005	0.003	0.006	0.003
2000–2009	0.018	0.008	0.008	0.005	0.009	0.005
Total	0.018	0.006	0.007	0.004	0.008	0.004

Table 2: Intangibles Usage, Resource Retention and Payouts Industries

Values of various retention and payout measures are shown for the median HINT and LINT firm. Retained Cash is free cashflows minus cash spent on repurchases and dividends, divided by free cashflows. Cash Holdings is cash divided by total assets. Total assets is the sum of PP&E and intangible assets, measured as in Peters and Taylor (2016). Payout Ratio is cash spent on repurchases divided by this number and dividend payouts. Repurchases exclude cash spent on repurchasing shares to fulfill employee stock option exercises, following the procedure of Fama and French (2001). HINT firms have an *Intangibles Ratio* in the highest tercile of the sample distribution, and LINT firms have an *Intangibles Ratio* in the lowest tercile. *Intangibles Ratio* is the firm's stock of intangible assets divided by the sum of intangible assets and net PP&E. The sample contains all U.S. non-financial and utilities firms in Compustat with assets greater than $5 million and more than 5 years of available data. Some columns are restricted to only firms that pay dividends in a year or that are in the S&P 500.

	All firms		Dividened payers		S&P 500 firms	
	HINT	LINT	HINT	LINT	HINT	LINT
Retained Cash						
1980–1989	0.96	0.67	0.51	0.29	0.40	0.28
1990–1999	1	0.86	0.52	0.38	0.54	0.39
2000–2009	1	0.94	0.51	0.46	0.52	0.44
Total	1	0.83	0.52	0.36	0.50	0.36
Cash Holdings						
1980–1989	0.15	0.07	0.14	0.06	0.14	0.05
1990–1999	0.22	0.06	0.15	0.04	0.12	0.03
2000–2009	0.26	0.07	0.18	0.06	0.26	0.07
Total	0.23	0.07	0.16	0.05	0.20	0.05
Payout Ratio						
1980–1989	0.35	0.20	0.13	0.09	0.19	0.14
1990–1999	0.54	0.31	0.17	0.11	0.38	0.19
2000–2009	0.65	0.41	0.26	0.16	0.56	0.33
Total	0.55	0.29	0.19	0.11	0.45	0.20