Inventor-base Concentration and Corporate Cash Holdings[*]

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Abstract

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Keywords: inventor-base concentration, cash holdings, transaction motive, precautionary motive, financial constraints, value of cash holdings

JEL classification: G34, O32, O34

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1. Introduction

Investing in employees' human capital is crucial for firms to gain a competitive advantage, but relying heavily on key employees' human capital to maintain this edge can be risky. This risk arises because human capital, unlike physical assets, is subject to voluntary turnover (Cascio, 1991; Chiang and Chiang, 1990; Steffy and Maurer, 1988; Diamond and Rajan, 2000). When key employees leave, they take their valuable expertise with them, resulting in significant losses for the firm (Carnahan and Somaya, 2013; Dokko and Rosenkopf, 2010; Raffiee, 2017; Somaya, Williamson, and Lorinkova, 2008; Jaravel et al., 2018). Despite the known risks of relying on key employees, the finance literature provides little evidence on how this reliance shapes firms' financing policies. To address this gap, we examine how reliance on key inventors in firms' innovation efforts impacts their financing policies, particularly cash holdings.

We focus on inventors for two reasons. First, a firm's patent filing history provides insights into the extent of its reliance on key inventors for innovation. Second, as the economy becomes increasingly knowledge-based, the human capital of inventors is likely to be critical for sustaining competitive advantages and productivity growth.

To measure the degree of reliance on key inventors, we calculate the firm's inventor-base concentration. Specifically, for each inventor in a firm, we assess their patent output over the past five years and construct the Herfindahl index using the proportion of each inventor's output in the firm's total patenting activity (hereafter referred to as "*Inventor concentration*"). The index ranges from zero to one, with higher values indicating greater reliance on a concentrated group of key inventors.

The finance literature identifies two primary motives for firms to hold cash: the transaction motive and the precautionary motive. A concentrated inventor base can influence optimal cash holdings in different ways. On one hand, the potential loss from key employees' voluntary turnover might strengthen the precautionary motive to hold cash. On the other hand, firms with a concentrated inventor base may improve efficiency in utilizing inventors' human capital, thus reducing cash outlays and decreasing the need to hold cash for transaction purposes.

Our empirical analysis begins by investigating the impact of inventor-base concentration on cash holdings. We find a negative relationship between corporate cash holdings and inventor-base concentration. This negative relationship is driven by both between-firm and within-firm variations and is robust across different measures of cash holdings. Economically, a one standard deviation increase in inventor-base concentration leads to a 12.8% decrease in cash holdings.

To address potential endogeneity problems, we use three approaches. First, we control for firm fixed effects in our baseline model, ensuring that our findings are not driven by time-invariant firm characteristics that impact cash holdings. Second, we employ the staggered adoption of the Inevitable Disclosure Doctrine (IDD) by U.S. state courts, which prevents employees with trade secrets from working for competitors but does not directly affect firms' financing policies. Using an instrumental variable approach based on IDD adoption helps establish the causal effect of inventor-base concentration on cash holdings. Third, we examine cross-sectional variations in the negative relationship between cash holdings and inventor-base concentration, finding that the relationship is more pronounced among firms with greater investment opportunities.

Our results support the notion that firms with greater inventor-base concentration have a lower transaction motive to hold cash. To verify that the transaction motive is the mechanism behind this negative impact, we conduct two additional tests.

The transaction motive suggests that optimal cash holdings are positively correlated with a firm's demand for spending cash (Mulligan, 1997). Since SG&A and R&D expenses are major components of costs associated with utilizing inventors' human capital, we anticipate a negative relationship between these costs and inventor-base concentration. In the first test, we demonstrate that inventor-base concentration is associated with relatively low labor costs and R&D expenses per dollar of sales, while it shows no correlation with the non-labor components of SG&A expenses.

In the second test, we explore how the negative relationship between cash holdings and inventor-base concentration varies among firms with different levels of financial constraints. If the cash savings from lower SG&A and R&D expenses is the key channel through which inventor-base concentration negatively impacts cash holdings, the relationship should be more pronounced among financially constrained firms. Our results align with this expectation, indicating that for firms without financial constraints, optimal cash holdings are relatively insensitive to cash flows (Almeida, Campello, and Weisbach, 2004).

To further verify our findings, we examine how inventor-base concentration affects the marginal value of cash holdings. Using the approach in Faulkender and Wang (2006), we find that higher inventor-base concentration negatively impacts the marginal value of cash holdings, consistent with our cash holding model results.

Our paper contributes to two strands of literature. First, it adds to the understanding of corporate cash holdings determinants. Previous studies have identified various firm-level

factors influencing cash holdings, including transaction costs (Mulligan, 1997), business risk (Opler et al., 1999; Bates et al., 2009), R&D smoothing (Brown and Peterson, 2011), CEO incentives (Liu and Mauer, 2011), reliance on principal customers (Itzkowitz, 2013), agency problems (Nikolov and Whited, 2014), technology spillovers (Qiu and Wan, 2015), relationship-specific investments (Bae and Wang, 2015), the cost of carrying cash (Azar et al., 2016; Boileau and Moyen, 2016), and intangible assets (Falato et al., 2022). Our study introduces the strategy of utilizing human capital as another determinant of cash holdings.

Second, this paper contributes to the literature on the human capital strategy of relying on key employees. Prior studies recognize the potential losses from the departure of key employees (Carnahan and Somaya, 2013; Dokko and Rosenkopf, 2010; Raffiee, 2017; Somaya, Williamson, and Lorinkova, 2008; Jaravel et al., 2018). However, they also show that a small number of key employees with superior human capital can make disproportionately large contributions (Fuller and Rothaermel, 2012; Liu, 2014; Tzabbar and Kehoe, 2014). Our paper further demonstrates that the efficiency improvements associated with inventor-base concentration enable firms to maintain lower cash holdings.

2. The Conceptual Framework

2.1 The pros and cons of having a concentrated inventor base

Key employees provide invaluable human capital and contribute significantly to a firm's competitive advantage, but they are often challenging to retain. Unlike physical assets, human capital is inherently tied to employees, and firms do not have full control over it (Eisfeldt and Papanikolaou, 2013; Akins et al., 2020). Employees can voluntarily leave, taking their expertise with them (Carnahan and Somaya, 2013; Dokko and Rosenkopf, 2010;

Raffiee, 2017; Somaya, Williamson, and Lorinkova, 2008; Jaravel et al., 2018). This voluntary turnover can result in significant losses, especially when high-performing employees depart (Shaw, Gupta, and Delery, 2005; Kwon and Rupp, 2013).

For firms that rely on a concentrated inventor base for innovation, a substantial portion of their innovation capabilities hinges on the human capital of key inventors (Groysberg and Lee, 2009; Paruchuri, 2010). These firms' innovation routines are deeply integrated with the inventors' expertise, information, and relationships. If key inventors leave, it can disrupt established innovation processes and severely weaken the firm's innovation capabilities (Tzabbar and Kehoe, 2014). Consequently, relying heavily on key inventors for current innovation activities poses a potential threat to future innovation capabilities (Aime et al., 2010).

While prior research underscores the risks of depending on key inventors, it also highlights certain advantages of a concentrated inventor base. Specifically, firms that depend on key inventors are likely to offer them better internal promotions, thereby reducing the risk of voluntary turnover. Supporting this idea, studies show that as productivity and career advancement opportunities for key inventors increase within a firm, their incentives to leave for competitors or to start their own ventures decrease (Hoisl, 2007; Cassiman and Ueda, 2006; Kacperczyk, 2013; Sorensen and Sharkey, 2014).

2.2 Inventor-base concentration and cash holdings

The economics and finance literature has identified various theories explaining why firms hold cash. Among these theories, the transaction motive and the precautionary motive are particularly relevant to utilizing employees' human capital.

The theory of the transaction motive argues that firms need to hold cash when there are transaction costs associated with converting noncash financial assets into cash. The optimal level of cash holdings in a particular firm depends on the firm's demand for spending cash, such as paying wages (Mulligan, 1997). To the extent that a concentrated inventor base enhances the firm's efficiency in utilizing inventors' human capital and hence reduces the demand for cash spending, the transaction motive suggests that firms with a concentrated inventor base have a relatively low level of optimal cash holdings.

The theory of the precautionary motive states that firms need to hold cash to cope with adverse shocks when access to capital markets is costly (Bates et al., 2009). Cash held as a tool to hedge risk is especially valuable to firms with financial constraints and many growth opportunities (Brown and Peterson, 2011; Mikkelson and Partch, 2003; Opler et al., 1999). The loss of key inventors would force firms to incur significant expenses on hiring and training new inventors as replacements. Thus, for firms that rely on key inventors for technology innovation, the precautionary motive to hold cash might be particularly strong, and hence the optimal level of cash holdings might be relatively high.

Ultimately, it is an empirical question whether the optimal level of cash holdings is relatively low (the transaction motive) or relatively high (the precautionary motive) in firms with a concentrated inventor base.

3. Sample Formation, Variable Constructions, and the Empirical Model

3.1. The data sources

We gather information about patents and inventors from the United States Patent and Trademark Office's (USPTO) PatentsView database. This database contains detailed

information about each patent granted between 1976 and 2021, including the date of application, technology classes (classified using the Cooperative Patent Classification), a list of assignees (typically firms or their subsidiaries where the research was conducted), and a list of inventors. Importantly, the PatentsView database provides a unique identifier for each assignee and inventor, allowing us to track inventor-firm employment relationships over time.

We match the patents and patent assignees with U.S. public firms using the database provided by Stoffman et al. (2022), referred to as the SYW database. This database identifies the connection between patents and CRSP firms for patents granted from 1926 to 2021. By using the SYW database, we link the patents in the PatentsView database to the U.S. public firms that filed the patents and connect the inventors in the PatentsView database to the U.S. public firms where they work.

We obtain information about the fundamentals of U.S. public firms from Compustat and information about stock returns of U.S. public firms from CRSP.

3.2. Measures of inventor-base concentration

To measure a firm's reliance on key inventors, we calculate the Herfindahl index based on each inventor's share of the firm's total patenting output over the past five years (i.e., *Inventor concentration*). The share of an inventor's output is determined by dividing the number of patents filed by that inventor during this period by the total number of patents filed by all inventors in the firm during the same period. If a patent is filed by multiple inventors as collaborators, each inventor is considered to have contributed *1/n* of the patent. The Herfindahl index ranges from 0 to 1, with a higher value indicating a greater reliance on key inventors for the firm's innovation production.

In robustness tests, we compute an alternative measure of inventor-base concentration by calculating the proportion of patents filed by the most prolific inventor within the firm over the past five years relative to all patents filed by the firm during the same period.

3.3. The empirical model

To investigate the impact of a strategy that relies on a concentrated inventor base on a firm's cash holdings, we run pooled OLS regressions using the following empirical model:

$$Cash_{f,t} = \beta_1 Inventor\ concentration_{f,t} + \beta_2 Firm\ characteristics_{f,t} + Industry/Firm\ FE_f + Year\ FE_t + e_{f,t}. \quad (1)$$

The dependent variable, $Cash_{f,t}$, represents firm f's cash holdings at the end of year *t*. We measure cash holdings using three variables based on prior studies. The first measure, *Cash/assets*, is the ratio of cash and marketable securities to the total value of book assets, which is the most common measure of cash holdings in the literature. The second measure, *Net cash/assets*, is the ratio of cash and marketable securities minus total debt to the total value of book assets, accounting for debt as negative cash. The third measure is the ratio of cash to net sales. Since sales figures tend to be volatile, we use the logarithm of this ratio to avoid extreme values caused by low sales.

$Firm\ characteristics_{f,t}$ denotes a set of firm characteristics that are likely to impact a firm's optimal level of cash holdings. Following Qiu and Wan (2015), we control for the following firm attributes:

- *Logarithm of sales*: The logarithm of one plus net sales in the year.

- *Book to market*: The ratio of book value of assets to market value of assets.
- *ROA*: The ratio of income before extraordinary items to book value of assets captures the firm's profitability.
- *Earnings volatility*: The standard deviation of income before extraordinary items in the past ten years scaled by total book value of assets.
- *Sales growth*: The average annual sales growth rate over the past ten years.
- *Stock returns*: The cumulative stock return in the past twelve months.

Since firms that rely on a small number of key inventors are more likely to pursue innovation within a narrower scope of technological classes, the concentration of a firm's inventor base might be correlated with its technology concentration. Therefore, in addition to the set of firm controls used in Qiu and Wan (2015), we also control for the firms' technology concentration:

- *Technology Concentration*: The Herfindahl index based on the share of patents filed by the firm across different patent classes over the past five years.

To control for the effects of unobserved industry or firm characteristics that may be associated with both inventor-base concentration and cash holdings, we include industry or firm fixed effects in our regression model. Additionally, to account for any shocks affecting firms during the same time period, we also include year fixed effects.

3.4. Sample formation and overview

Our sample comprises firm-year observations from Compustat and CRSP for U.S.-based firms with common shares traded on the NYSE, NASDAQ, or AMEX, and a history of filing at least one patent with the USPTO in the past five years. To eliminate firms with

minimal economic impact, we only include firms with book assets of at least ten million dollars and positive net sales. To avoid including financially distressed firms, we also only include firms with a positive book value of equity. Additionally, we exclude utility firms (SIC codes 4900-4999) and financial firms (SIC codes 6000-6999) because their performance and financing decisions are heavily influenced by regulations.

Our sample period begins in 1980, the earliest year in which we can measure a firm's patenting activity over a five-year period (for example, the first five-year period covered is 1976-1980). The PatentsView and SYW databases have data available up to 2021 as of the writing of this paper. Given the typical lag between patent application and grant, patents applied for up to 2019 are unlikely to be truncated. Therefore, our last sample year is 2019. Our final sample consists of 51,084 firm-year observations from 5,231 innovative firms.

Table 1 presents the summary statistics of the sample firms' characteristics. We show that an average firm in our sample has net sales of 5.2 billion dollars, a book-to-market ratio of 0.637, a return on assets (ROA) ratio of 0.078, and a cash-to-assets ratio of 0.197. Notably, the average firm has an *Inventor concentration* value of 0.237.

Table 2 shows the correlations among the variables listed in Table 1. There are negative correlations between cash holding measures and inventor-base concentration. It is important to note that there are no extremely high correlations among these variables that would cause concern about multicollinearity.

4. Empirical Analyses

In this section we perform a series of tests to establish the causal impact of inventor-base concentration on cash holdings.

4.1. Regression results of the baseline models

The regression results of the baseline models are summarized in Table 3. In column (1), we run a panel regression, controlling for industry and year fixed effects. Consistent with expectations, we show that firms with larger sizes, lower book-to-market ratios, higher profitability, higher earnings volatility, higher sales growth, and higher past stock returns hold more cash. Importantly, we find that the coefficient for *Inventor concentration* is significantly negative, supporting the notion that inventor-base concentration reduces the transaction motive for firms to hold cash. The effect of inventor-base concentration on cash holdings is economically significant: a one standard deviation increase in *Inventor concentration* leads to a 12.8% decrease in cash holdings.

In columns (2) and (3), we examine whether the negative relationship between cash holdings and inventor-based concentration is driven by cross-sectional or time-series variations. In column (2), we calculate the time-series mean values of all variables and run a cross-sectional regression. The coefficient for *Inventor concentration* remains significantly negative, indicating that the negative relationship is at least partially driven by cross-sectional variation. In column (3), we control for firm fixed effects instead of industry fixed effects, and the coefficient for *Inventor concentration* remains significantly negative, suggesting that the negative relationship is also driven by time-series variations.

In columns (4) and (5), we use *Net cash/assets* and *Logarithm of cash/sales* as dependent variables, respectively. The coefficients for *Inventor concentration* remain significantly negative in these models.

In summary, the regression results presented in Table 3 show a significantly negative effect of inventor-base concentration on the level of cash holdings, suggesting that a concentrated inventor base reduces firms' transaction motive to hold cash.

4.2. Instrumental variable regressions

Given that our baseline models control for firm fixed effects, it is unlikely that our main findings are driven by the correlation between inventor-base concentration and some unobserved, time-invariant firm characteristics associated with cash holdings. Nevertheless, it is possible that inventor-base concentration is correlated with unobserved, time-variant firm characteristics that are also correlated with cash holdings. To mitigate this potential endogeneity concern, we use an instrumental variable approach.

To construct the instrumental variable, we employ the staggered adoption of the Inevitable Disclosure Doctrine (IDD) by U.S. state courts. IDD prevents employees with knowledge of a firm's trade secrets from working for another firm. An instrumental variable based on the staggered recognition of the IDD by state courts is appealing for two reasons. First, state courts adopt the IDD to protect trade secrets for firms located in the state. The purpose of this adoption is to reduce the risk of competitors obtaining these secrets from departing employees, which is directly related to the firm's incentive to rely on key inventors in innovation production. Therefore, the instrumental variable is likely to satisfy the relevance condition. [1]

[1] Inventor-based concentration could reflect both the risks of information leakage and the costs of retaining key inventors. On one hand, the reduced risk of information leakage following IDD adoption may encourage firms to rely more heavily on key inventors. On the other hand, IDD adoption might deter firms from incurring the higher costs associated with retaining those inventors. Therefore, whether inventor-based concentration is positively or negatively associated with IDD adoption remains an empirical question.

Second, the staggered adoption of the IDD is exogenous to firms, and the motivation behind the IDD is unrelated to incentivizing cash holdings. Hence, the adoption of the IDD is unlikely to impact the level of cash holdings beyond its correlation with inventor-base concentration, satisfying the exclusion condition for a valid instrumental variable.

Following Chen et al. (2021), we measure a firm's IDD protection based on its headquarters location. Specifically, we create a dummy variable that equals one if the firm's headquarters is located in a state that has adopted IDD and zero otherwise. We then use this IDD dummy as an instrumental variable for *Inventor concentration*. We obtain historical headquarters information from Bai et al. (2020) for the period before 1987, Compact Disclosure for 1987-2001, and Compustat for after 2001. Information about the IDD adoption year in each state is from Klasa et al. (2018).

Table 4 presents the results of the instrumental variable regressions. Column (1) shows the results of the first-stage regression, where *Inventor concentration* is the dependent variable. The independent variables include firm characteristics and the IDD dummy. Given that the value of the IDD dummy is entirely determined by the firm identity and the year, we include industry and year dummies instead of firm and year dummies to avoid multicollinearity. We show that *Inventor concentration* is negatively related to sales, earnings volatility, and sales growth, and positively related to the book-to-market ratio, profitability, and technology concentration. Importantly, *Inventor concentration* has a significant positive association with the IDD dummy.

Columns (2) – (4) show the results of the second-stage regressions, where the dependent variables are *Cash/assets*, *Net cash/assets*, and *Logarithm of cash/sales*, respectively. All coefficients of instrumented *Inventor concentration* remain significantly negative.

In summary, the results in Table 4 mitigate the concern about the endogeneity problem caused by unobserved time-variant firm characteristics and further support the prior evidence on the negative impact of inventor-base concentration on cash holdings.

4.5. Subsample analyses

To further verify the negative impact of inventor-base concentration on cash holdings, we perform subsample analyses in this subsection. We divide the firm-year observations into two subsamples according to the firms' growth opportunities. If firms' strategies for utilizing inventors' human capital impact their financing policies, such as cash holdings, this impact is likely to be more pronounced for firms where inventors play a substantial role in their business prospects. Since technological innovation tends to be more important for firms with more growth opportunities, and inventors play a key role in this innovation, we expect the negative impact of inventor-base concentration on cash holdings to be more pronounced for firms with higher growth opportunities. We determine firms' growth opportunities using four measures:

- *Tobin's Q*: The ratio of the market value of assets to the book value of assets.
- *Sales growth*: The average growth rate of net sales over the past ten years.
- *R&D intensity*: The ratio of R&D expenses to the book value of assets.
- *Innovativeness*: The ratio of citation-weighted number of patents filed in the subsequent year to the book value of assets, where the citation is the total number of citations received within the three-year period from the patent award date scaled

by the median number of citations received among patents in the same technology class-year cell.[2]

For each year, we use the top (bottom) 30th percentile of the sample as the threshold for high (low) growth opportunities and form two subsamples based on each of these four measures. We then run panel regressions using these subsamples.

Table 5 presents the regression results. For the subsamples divided by *Tobin's Q* or *Sales growth*, the coefficient for *Inventor concentration* is significant only in the high-growth subsample (columns (1) and (3)) and insignificant in the low-growth subsample (columns (2) and (4)). In the subsamples based on *R&D intensity* or *Innovativeness*, both coefficients for *Inventor concentration* are significantly negative. However, the coefficient magnitude is larger for the subsample of firms with high growth opportunities (columns (5) and (7)) than for those with low growth opportunities (columns (6) and (8)). [3]

Overall, the results in Table 5 indicate that the negative impact of inventor-base concentration on cash holdings is more pronounced for firms with greater growth opportunities. If the negative relationship were driven by some unobservable firm characteristic, that characteristic would need to affect the relationship in a pattern similar to the one documented in the table.

4.6. Robustness tests with additional explanatory variables

[2] To capture a firm's forward-looking innovative capability, we use innovation output measured in the subsequent year. However, the results remain qualitatively similar when innovation output from the prior year is used instead.

[3] In untabulated results, we confirm that the difference in the magnitude of these two coefficients is statistically significant between columns (5) and (6) or between columns (7) and (8).

Inventor-base concentration is negatively related to firm size, a known determinant of cash holdings. Although we have controlled for firm size by including the logarithm of sales as an explanatory variable, it is essential to ensure that our findings are not influenced by a size effect not fully captured by sales magnitude. In this section, we replicate the baseline model from Table 3, incorporating additional explanatory variables likely correlated with firm size. The regression results are presented in Table 6.

First, since firms that file fewer patents tend to be smaller and have fewer inventors, we control for the number of patents filed by the firm over the past five years, as well as the number of inventors in the firm. Panel A shows that all coefficients for *Inventor concentration* remain significantly negative, except for the one in column (3), which becomes insignificant.

Second, we control for firm age, as younger firms are generally smaller. Firm age is measured as the number of years between the observation year and the year the firm's data first appeared in Compustat. In Panel B, we demonstrate that all coefficients for *Inventor concentration* remain significantly negative after accounting for firm age.

Finally, we control for institutional ownership, as institutional investors tend to hold shares in larger firms and may influence corporate cash policies. Institutional ownership is measured as the ratio of the firm's common shares held by institutional investors to total shares outstanding. In Panel C, we show that all coefficients for *Inventor concentration* remain significantly negative after controlling for institutional ownership.

4.7. Alternative measure of inventor-base concentration

Thus far, we have utilized the Herfindahl index, which is based on the share of patents across all inventors, as a measure of inventor-base concentration. To verify the robustness of

our findings, we also use an alternative measure: the proportion of patents filed by the most prolific inventor within the firm over the past five years among all patents filed by the firm during the same period. Table 7 replicates the analysis from Table 3 using this alternative measure and produces results that are qualitatively comparable to those obtained using the Herfindahl index.

5. The Mechanism

The negative relation between inventor-base concentration and cash holdings suggests that the reduced transaction motive is the mechanism through which this negative relation arises. We perform three tests to assess this conjecture.

5.1. Inventor-base concentration and the costs of utilizing inventors' human capital

If the transaction motive is the mechanism by which inventor-base concentration negatively affects cash holdings, then firms with a concentrated inventor base may incur relatively low cash outlays associated with utilizing human capital. Prior research indicates that a significant portion of SG&A expenses are labor-related (e.g., Banker et al., 2019; Chen et al., 2024). To obtain more direct evidence on the effect of inventor-base concentration on the demand for cash spending, we examine how SG&A expenses and their components relate to inventor-base concentration.

Compustat categorizes SG&A expenses (*XSGA*) into five components: R&D (*XRD*), Staff (*XLR*), Pension (*XPR*), Rent (*XRENT*), and Advertising (*XAD*). Following Chen et al. (2024), we classify *XRENT* and *XAD* as components unlikely to be related to human capital expenditures. We then investigate the relationship between *Inventor concentration* and four

variables: 1) total SG&A expenses per dollar of sales, 2) labor costs (*XLR* + *XP*R) per dollar of sales, 3) R&D expenses (*XRD*) per dollar of sales, and 4) non-labor costs (*XRENT* + *XAD*) per dollar of sales.[4] The regression results are shown in Table 8.

In columns (1) to (3), we find that total SG&A expenses per dollar of sales, labor costs per dollar of sales, and R&D expenses per dollar of sales are each negatively associated with *Inventor concentration*, even after controlling for firm characteristics and applying firm and year fixed effects. These findings support the notion that inventor-base concentration reduces the cash demand related to utilizing human capital.

As a falsification test, in column (4), we examine the relationship between non-labor costs and inventor-base concentration. Consistent with expectations, the coefficient for *Inventor concentration* is insignificant.

Mulligan (1997) suggests that the transaction motive for holding cash is positively linked to the demand for spending cash, such as for wage payments. The results in Table 8 indicate that inventor-base concentration reduces the demand for spending cash on labor costs, supporting the idea that the transaction motive is the mechanism through which inventor-base concentration negatively impacts cash holdings.

5.2. Financial constraints and the negative relation between inventor-base concentration and cash holdings

If the reduction in the costs of utilizing inventors' human capital is the mechanism, then the negative impact of inventor-base concentration on cash holdings should be more pronounced for firms that are subject to financial constraints. This is because cash holdings

[4] Some firms may report R&D expenses under the Cost of Goods Sold. In these cases, R&D expenses are excluded from total SG&A expenses.

are likely to be sensitive (insensitive) to cash flows for firms that are (not) subject to financial constraints (Almeida et al., 2004).

Following the literature, we determine the extent to which a firm is subject to financial constraints based on three criteria: 1) whether the firm has a credit rating and thus access to public bond markets in the year; 2) whether the firm pays cash dividends in the year; and 3) whether the firm is categorized as a big or small firm in the year, where a big (small) firm has a market capitalization above (below) the 70th (30th) percentile of all NYSE firms. We then divide the firm-year observations into two subsamples based on these classification schemes and run the baseline regressions using the subsamples.

Table 9 presents the results. We show that the coefficients for *Inventor concentration* are statistically significant only for firms with no credit ratings, firms paying no cash dividends, and firms classified as small. These results suggest that the negative relationship between cash holdings and inventor-base concentration arises only among firms subject to financial constraints, further supporting the conjecture that the reduction in the costs of utilizing inventors' human capital is the mechanism.

5.3. How does inventor-base concentration impact the marginal value of cash holdings?

Our final test examines how inventor-base concentration impacts the marginal value of cash holdings. If the reduction in the costs of utilizing inventors' human capital lessens the need for hoarding cash, then, ceteris paribus, the marginal value of cash holdings should be lower for firms with a concentrated inventor base. To test this hypothesis, we use the approach outlined by Faulkender and Wang (2006):

$$r_{i,t} - R_{i,t}^{B} = \beta_0 + \beta_1 Inventor\ concentration \times \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_2 Inventor\ concentration$$
$$+ \beta_3 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_4 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \beta_5 \frac{\Delta NA_{i,t}}{M_{i,t-1}} + \beta_6 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \beta_7 \frac{\Delta I_{i,t}}{M_{i,t-1}} + \beta_8 \frac{\Delta D_{i,t}}{M_{i,t-1}}$$
$$+ \beta_9 \frac{C_{i,t-1}}{M_{i,t-1}} + \beta_{10} L_{i,t} + \beta_{11} \frac{NF_{i,t}}{M_{i,t-1}} + \beta_{12} \frac{C_{i,t-1}}{M_{i,t-1}} \times \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_{13} L_{i,t} \times \frac{\Delta C_{i,t}}{M_{i,t-1}}$$
$$+ \varepsilon_{i,t}, \qquad (2)$$

where ΔX indicates a change in X from year $t-1$ to t, and $r_{i,t}$ is the stock return over the period from year $t-1$ to t, $R_{i,t}^{B}$ is the Fama and French (1993) size and book-to-market matched portfolio return from year $t-1$ to t, $M_{i,t-1}$ is the market value of equity at the end of year $t-1$, $C_{i,t}$ is the cash holdings at the end of year t, $E_{i,t}$ is the earnings before extraordinary items in year t, $RD_{i,t}$ is the R&D expenses in year t, $I_{i,t}$ is the interest expenses in year t, $D_{i,t}$ is the cash dividends paid in year t, $L_{i,t}$ is ratio of total debt to the sum of total debt and the market value of equity at the end of year t, and $NF_{i,t}$ is the new finance in year t, which is equal to the sum of net new equity issues and net new debt issues in the year.

The variable of interest is the interaction of *Inventor concentration* with $\frac{\Delta C_{i,t}}{M_{i,t-1}}$, and all control variables are exactly as in Faulkender and Wang (2006). Table 10 presents the regression results. Consistent with expectations, the coefficient for $Inventor\ concentration \times \frac{\Delta C_{i,t}}{M_{i,t-1}}$ is significantly negative, suggesting that inventor-base concentration reduces the marginal value of cash holdings. The results support the conjecture that with lower demand for spending cash, ceteris paribus, the market value of cash is lower for firms with a more concentrated inventor base.

To summarize, the results in Table 8 – 10 shed lights on how inventor-base concentration negatively impacts cash holdings. Specifically, by reducing the labor costs and R&D expenses per dollar of sales, inventor-base concentration reduces the transaction motive to hold cash as well.

6. Conclusions

Using a large and unique dataset that tracks the career paths of inventors in U.S. public firms, we investigate how inventor-base concentration impacts corporate cash holdings. On the one hand, a concentrated inventor base enhances the efficiency of utilizing inventors' human capital, reducing the transaction motive to hold cash; on the other hand, the potential loss due to key inventors' departure may increase the precautionary motive to hold cash. Supporting the notion of reducing the transaction motive to hold cash, our results indicate a negative relationship between cash holdings and inventor-base concentration.

To identify a causal link, we utilize an instrumental variable approach, leveraging the staggered adoption of the Inevitable Disclosure Doctrine (IDD) by U.S. state courts. Additionally, we show that the negative relationship is more pronounced when the inventors' human capital is likely to be more important to the firm—specifically, when the firm has more growth opportunities.

We perform several tests to further elucidate the mechanism through which inventor-base concentration negatively impacts corporate cash holdings. First, we show that inventor-base concentration is associated with lower labor costs and R&D expenses per dollar of sales, suggesting that it reduces the demand for cash expenditures on utilizing inventors' human capital. Second, we demonstrate that the negative relationship is more pronounced for firms

facing financial constraints, which are more likely to benefit from efficiency gains in utilizing inventors' human capital. Finally, we show that the value of cash holdings is negatively related to inventor-base concentration.

We conclude that inventor-base concentration has a negative impact on optimal cash holdings by reducing the demand for cash spending. The results highlight the importance of understanding a firm's human capital strategies when evaluating its financing policy.

Appendix: Variable definitions

Measures of inventor-base concentration	
Inventor concentration	The Herfindahl index based on the share of each inventor's patenting output over the five-year period up to year *t*. The share of an inventor's output is calculated as the number of patents filed by the inventor during the period scaled by the total number of patents filed by all inventors in the firm during the same period. For a patent filed by *n* inventors as collaborators, each inventor is deemed to have produced *1/n* patents.
Top inventor's share	The proportion of the most prolific inventor's output in the firm's total patenting output over the five-year period up to year *t*. The most productive inventor is the inventor who filed the greatest number of patents during the period. For a patent filed by *n* inventors as collaborators, each inventor is deemed to have produced *1/n* patents.
Measures of cash holdings	
Cash/assets	(Cash and marketable securities) / (the total value of book assets)
Net cash/assets	(Cash and marketable securities – long-term debt – short-term debt) / (the total value of book assets)
Logarithm of cash/sales	Log(1 + cash and marketable securities / net sales).
Firm characteristics for explaining cash holdings	
Sales	Net sales in 2021 dollar.
Book to market	(The book value of shareholders' equities) / (the market value of shareholders' equities)
ROA	(Income before extraordinary items) / (the book value of total assets)
Earnings volatility	The standard deviation of income before extraordinary items in the past ten-year period scaled by the book value of total assets.
Sales growth	The average annual sales growth rate in the past ten-year period.
Stock return	The cumulative stock return over the past 12-month period.
Technology concentration	The Herfindahl index based on the share of a firm's patents across technological classes over the five-year period up to year *t*. The share of a technological class is calculated as the number of patents in the class filed by the firm during the period scaled by the total number of patents filed by the firm during the same period.
Firm characteristics for explaining the marginal value of cash holdings	
ΔCash/ME	(Change in cash and marketable securities from *t-1* to *t*) / (the market value of shareholders' equities).
ΔEarnings/ME	(Change in earnings income from *t-1* to *t*) / (the market value of shareholders' equities), where earnings = income before extraordinary income + interest expenses + deferred tax + investment tax credits.
ΔNet Assets/ME	(Change in net assets from *t-1* to *t*) / (the market value of shareholders' equities), where net assets = (the book value of total assets) – (cash and marketable securities).

ΔR&D/ME	(Change in R&D expenses from *t-1* to *t*) / (the market value of shareholders' equities). The value of R&D expenses is set to zero if missing.
ΔInterest/ME	(Change in interest expenses from *t-1* to *t*) / (the market value of shareholders' equities).
ΔDividends/ME	(Change in cash dividends from *t-1* to *t*) / (the market value of shareholders' equities).
Debt/ME	(Long-term debt + short-term debt) / (the market value of shareholders' equities).
New Finance/ME	(Net new equity issues + net new debt issues) / (the market value of shareholders' equities).

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Table 1
Summary statistics

This table presents the summary statistics of the variables used in the baseline model (Equation (1)). The sample consists of all firm-year observations in Compustat/CRSP from 1980 to 2019 that satisfy the following criteria: 1) the firm is headquartered in the U.S.; 2) the firm has positive net sales and book equity, and the value of book assets is greater than 10 million dollars; 3) the firm is not in the finance (SIC codes 6000–6999) or utilities (SIC codes 4900–4999) industries; 4) the firm's stock is traded on the NYSE, NASDAQ, or AMEX, with a share code of either 10 or 11 in CRSP; 5) he firm filed at least one patent over the past five-year period. There are 51,084 firm-year observations in the sample. All ratios are winsorized at the 1st and 99th percentiles. Detailed variable definitions are provided in the Appendix.

Variables	*N*	*Mean*	*STD*	*Min*	*25%*	*Median*	*75%*	*Max*
Cash/assets	51,084	0.197	0.218	0.001	0.033	0.111	0.289	0.904
Net cash/assets	50,880	0.002	0.325	-0.602	-0.236	-0.055	0.202	0.878
Logarithm of cash/sales	51,084	0.303	0.658	-0.008	0.028	0.098	0.297	10.928
Inventor concentration	51,084	0.237	0.277	0	0.042	0.133	0.333	1
Sales (in million dollars)	51,084	5,233	21,565	0.001	110	503	2,463	555,947
Book to market	51,084	0.637	0.498	0.035	0.289	0.508	0.838	2.731
ROA	51,084	0.078	0.180	-0.749	0.050	0.118	0.173	0.363
Earnings volatility	51,084	0.081	0.120	0.007	0.022	0.038	0.082	0.778
Sales growth	51,084	0.269	0.608	-0.113	0.056	0.118	0.235	4.737
Stock return	51,084	0.191	0.815	-0.987	-0.194	0.077	0.375	25.080
Technology concentration	51,084	0.487	0.324	0.014	0.219	0.403	0.722	1

Table 2
Correlations

This table presents the Pearson correlation coefficients among the variables in the sample described in Table 1. Detailed variable definitions are provided in the Appendix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Cash/assets										
(2) Net cash/assets	0.883									
(3) Logarithm of cash/sales	0.704	0.573								
(4) Inventor concentration	-0.086	-0.074	-0.066							
(5) Logarithm of sales	-0.467	-0.453	-0.470	-0.282						
(6) Book to market	-0.252	-0.208	-0.159	0.169	-0.020					
(7) ROA	-0.471	-0.358	-0.565	-0.001	0.539	-0.016				
(8) Earnings volatility	0.382	0.344	0.285	0.006	-0.408	-0.088	-0.533			
(9) Sales growth	0.308	0.240	0.311	0.001	-0.264	-0.142	-0.309	0.208		
(10) Stock return	0.074	0.086	0.029	0.002	-0.024	-0.252	0.105	-0.006	0.015	
(11) Technology concentration	0.084	0.076	0.055	0.666	-0.375	0.073	-0.103	0.112	0.085	0.004

Table 3
Inventor-base concentration and cash holdings

This table examines how the balance of cash holdings is related to inventor-base concentration. In columns (1)–(3), the dependent variable is *Cash/assets*, while in columns (4)–(5), the dependent variables are *Net cash/assets* and *Logarithm of cash/sales*, respectively. Column (1) controls for industry and year fixed effects, column (2) uses the time-series average of the variables, and the other columns control for firm and year fixed effects. Detailed variable definitions are provided in the Appendix. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Cash/assets	*Cash/assets*	*Cash/assets*	*Net cash/assets*	*Logarithm of cash/sales*
	(1)	(2)	(3)	(4)	(5)
Inventor concentration	-0.091***	-0.169***	-0.021***	-0.132***	-0.231***
	(0.008)	(0.012)	(0.006)	(0.013)	(0.019)
Logarithm of sales	-0.033***	-0.029***	-0.053***	-0.056***	-0.106***
	(0.001)	(0.001)	(0.003)	(0.002)	(0.005)
Book to market	-0.060***	-0.097***	-0.017***	-0.059***	-0.124***
	(0.003)	(0.005)	(0.002)	(0.005)	(0.009)
ROA	-0.204***	-0.376***	0.066***	-0.061***	-1.317***
	(0.013)	(0.022)	(0.011)	(0.019)	(0.052)
Earnings volatility	0.087***	0.077***	-0.031*	0.192***	-0.598***
	(0.018)	(0.029)	(0.019)	(0.026)	(0.062)
Sales growth	0.035***	0.015***	0.005	0.037***	0.082***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.014)
Stock return	0.013***	0.037***	0.006***	0.023***	0.030***
	(0.001)	(0.006)	(0.001)	(0.002)	(0.004)
Technology concentration	0.005	0.040***	0.004	-0.009	-0.083***
	(0.007)	(0.011)	(0.006)	(0.012)	(0.019)
Industry dummies	Yes	No	No	No	No
Firm dummies	No	No	Yes	Yes	Yes
Year dummies	Yes	No	Yes	Yes	Yes
Observations	51,084	5,231	51,084	50,880	51,084
Adjusted R^2	0.456	0.487	0.787	0.379	0.471

Table 4
Inventor-base concentration and cash holdings: the instrumental variable approach

This table examines the relationship between the balance of cash holdings and inventor-base concentration using the instrumental variable approach. Column (1) shows the first-stage regression, where the dependent variable is *Inventor concentration*, and the instrumental variable is the dummy for headquarters in a state that adopted the Inevitable Disclosure Doctrine (IDD). Columns (2)–(4) show the second-stage regressions, with the dependent variables being *Cash/assets*, *Net cash/assets*, and *Logarithm of cash/sales*, respectively. Detailed variable definitions are provided in the Appendix. All regressions control for industry and year fixed effects. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	1st-stage	*2nd-stage*		
	Inventor concentration	*Cash/assets*	*Net cash/assets*	*Logarithm of cash/sales*
	(1)	(2)	(3)	(4)
Dummy for headquarter in	0.016***			
an IDD state	(0.004)			
Inventor concentration (instrumented)		-1.569***	-2.718***	-1.806***
		(0.256)	(0.407)	(0.682)
Logarithm of sales	-0.021***	-0.063***	-0.109***	-0.139***
	(0.001)	(0.005)	(0.009)	(0.015)
Book to market	0.029***	-0.015*	0.018	-0.077***
	(0.004)	(0.008)	(0.013)	(0.022)
ROA	0.106***	-0.044	0.217***	-1.147***
	(0.012)	(0.031)	(0.048)	(0.088)
Earnings volatility	-0.048***	0.012	0.060*	-0.679***
	(0.016)	(0.022)	(0.033)	(0.073)
Sales growth	-0.014***	0.014***	0.0001	0.060***
	(0.003)	(0.005)	(0.008)	(0.018)
Stock return	0.001	0.016***	0.026***	0.032***
	(0.001)	(0.001)	(0.002)	(0.004)
Technology concentration	0.512***	0.763***	1.315***	0.724**
	(0.008)	(0.131)	(0.209)	(0.350)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	51,084	51,084	50,880	51,084
Adjusted R^2	0.520	0.452	0.377	0.467

Table 5
Inventor-base concentration and cash holdings: cross-sectional variations in growth opportunities

This table examines how the negative relationship between the balance of cash holdings and inventor-base concentration varies across subsamples classified according to firms' growth opportunities. The dependent variable is *Cash/assets*. In columns (1)–(2), (3)–(4), (5)–(6), and (7)–(8), the sample is partitioned based on *Tobin's Q* (the ratio of the market value of assets to the book value of assets), *Sales growth* (the average growth rate of net sales over the past ten years), *R&D intensity* (the ratio of R&D expenses to the book value of assets), and *Innovativeness* (the ratio of the citation-weighted number of patents filed in the subsequent year to the book value of assets, where the citation is the total number of citations received within the three-year period from the patent award date scaled by the median number of citations received among patents in the same technology class-year cell), respectively. "Low" ("High") indicates that the firm-year observation is in the bottom (top) 30% of all observations for the same year. All columns control for firm and year fixed effects. Detailed variable definitions are provided in the Appendix. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Tobin's Q		*Sales growth*		*R&D intensity*		*Innovativeness*	
	Low	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inventor concentration	-0.012	-0.025*	-0.006	-0.053***	-0.012*	-0.042***	-0.014*	-0.038**
	(0.008)	(0.015)	(0.010)	(0.014)	(0.007)	(0.016)	(0.007)	(0.017)
Logarithm of sales	-0.048***	-0.059***	-0.046***	-0.060***	-0.028***	-0.069***	-0.060***	-0.053***
	(0.005)	(0.005)	(0.007)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Book to market	-0.010***	0.062***	-0.011***	-0.026***	-0.013***	-0.019***	-0.013***	-0.024***
	(0.003)	(0.020)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.005)
ROA	0.070***	0.062***	0.075***	0.093***	0.025	0.103***	0.080***	0.083***
	(0.021)	(0.018)	(0.018)	(0.017)	(0.023)	(0.015)	(0.015)	(0.017)
Earnings volatility	0.073***	-0.140***	-0.060**	-0.088***	0.054	-0.120***	-0.035	-0.029
	(0.028)	(0.032)	(0.029)	(0.031)	(0.041)	(0.025)	(0.024)	(0.028)
Sales growth	-0.010	0.012**	-0.103**	0.010**	-0.018	0.014***	0.002	0.011**
	(0.018)	(0.005)	(0.052)	(0.005)	(0.012)	(0.005)	(0.007)	(0.005)
Stock return	0.007***	0.006***	0.008***	0.007***	0.005***	0.005***	0.006***	0.006***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Technology concentration	0.005	0.020	0.010	0.020*	0.001	0.017	0.004	0.006
	(0.007)	(0.013)	(0.008)	(0.012)	(0.006)	(0.013)	(0.006)	(0.013)
Firm dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15,335	15,335	15,335	15,335	15,335	15,335	22,982	16,763
Adjusted R^2	0.805	0.781	0.836	0.796	0.713	0.784	0.791	0.796

Table 6
Inventor-base concentration and cash holdings: robustness tests with additional control variables

This table replicates Table 3, with additional variables included as a robustness check. In Panel A, the number of patents filed over the past five years and the number of inventors employed by the firm are added as explanatory variables. In Panel B, firm age is included as an explanatory variable, measured as the number of years between the observation year and the first year the firm appeared in Compustat. In Panel C, institutional ownership is included as an explanatory variable, defined as the ratio of the firm's common shares held by institutional investors to the total shares outstanding. Firm controls reported in Table 3 are included but not shown. Detailed variable definitions are provided in the Appendix. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: control for the number of patents and the number of inventors

	Cash/assets	*Cash/assets*	*Cash/assets*	*Net cash/assets*	*Logarithm of cash/sales*
	(1)	(2)	(3)	(4)	(5)
Inventor concentration	-0.043***	-0.123***	-0.007	-0.066***	-0.033*
	(0.008)	(0.014)	(0.007)	(0.014)	(0.020)
Logarithm of # of patents	0.025***	0.036***	0.012***	0.036***	0.052***
	(0.002)	(0.004)	(0.003)	(0.004)	(0.007)
Logarithm of # of inventors	0.005*	-0.003	0.004	0.006	0.061***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.009)
Firm controls	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	No	No	No	No
Firm dummies	No	No	Yes	Yes	Yes
Year dummies	Yes	No	Yes	Yes	Yes
Observations	51,084	5,231	51,084	50,880	51,084
Adjusted R^2	0.475	0.504	0.788	0.396	0.497

Panel B: control for firm age

	Cash/assets	*Cash/assets*	*Cash/assets*	*Net cash/assets*	*Logarithm of cash/sales*
	(1)	(2)	(3)	(4)	(5)
Inventor concentration	-0.087***	-0.166***	-0.021***	-0.129***	-0.233***
	(0.008)	(0.012)	(0.006)	(0.013)	(0.019)
Logarithm of firm age	-0.027***	-0.021***	-0.011*	-0.023***	0.017**
	(0.003)	(0.004)	(0.006)	(0.005)	(0.009)
Firm controls	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	No	No	No	No
Firm dummies	No	No	Yes	Yes	Yes
Year dummies	Yes	No	Yes	Yes	Yes
Observations	51,084	5,231	51,084	50,880	51,084
Adjusted R^2	0.461	0.490	0.787	0.381	0.472

Panel C: control for institutional ownership

	Cash/assets	*Cash/assets*	*Cash/assets*	*Net cash/assets*	*Logarithm of cash/sales*

	(1)	(2)	(3)	(4)	(5)
Inventor concentration	-0.076***	-0.103***	-0.017***	-0.113***	-0.189***
	(0.007)	(0.012)	(0.006)	(0.013)	(0.018)
Institutional ownership	0.134***	0.251***	0.072***	0.177***	0.397***
	(0.009)	(0.010)	(0.007)	(0.014)	(0.027)
Firm controls	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	No	No	No	No
Firm dummies	No	No	Yes	Yes	Yes
Year dummies	Yes	No	Yes	Yes	Yes
Observations	51,084	5,231	51,084	50,880	51,084
Adjusted R^2	0.472	0.548	0.789	0.392	0.487

Table 7
Inventor-base concentration and cash holdings: the alternative measure of inventor-base concentration

This table replicates Table 1 using an alternative measure of inventor-base concentration. The alternative measure is calculated as the proportion of patents filed by the most prolific inventor within the firm over the past five years to the total patents filed by the firm over the same period. Detailed variable definitions are provided in the Appendix. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Cash/assets	*Cash/assets*	*Cash/assets*	*Net cash/assets*	*Logarithm of cash/sales*
	(1)	(2)	(3)	(5)	(6)
Top inventor's share	-0.091***	-0.165***	-0.022***	-0.130***	-0.269***
	(0.007)	(0.012)	(0.006)	(0.013)	(0.020)
Logarithm of sales	-0.034***	-0.030***	-0.053***	-0.058***	-0.110***
	(0.001)	(0.002)	(0.003)	(0.002)	(0.005)
Book to market	-0.060***	-0.097***	-0.017***	-0.059***	-0.123***
	(0.003)	(0.005)	(0.002)	(0.005)	(0.009)
ROA	-0.202***	-0.375***	0.066***	-0.058***	-1.307***
	(0.013)	(0.022)	(0.011)	(0.019)	(0.051)
Earnings volatility	0.086***	0.078***	-0.032*	0.191***	-0.602***
	(0.018)	(0.029)	(0.019)	(0.026)	(0.061)
Sales growth	0.035***	0.015***	0.005	0.037***	0.082***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.014)
Stock return	0.013***	0.037***	0.006***	0.023***	0.030***
	(0.001)	(0.006)	(0.001)	(0.002)	(0.004)
Technology concentration	-0.001	0.024**	0.003	-0.019*	-0.082***
	(0.007)	(0.011)	(0.005)	(0.011)	(0.018)
Industry dummies	Yes	No	No	No	No
Firm dummies	No	No	Yes	Yes	Yes
Year dummies	Yes	No	Yes	Yes	Yes
Observations	51,084	5,231	51,084	50,880	51,084
Adjusted R^2	0.456	0.487	0.787	0.379	0.473

Table 8
Inventor-base concentration and the expenditures on human capital

This table examines the relationship between inventor-base concentration and human capital expenditures per dollar of sales. In columns (1) through (4), the dependent variables are *SG&A/sales*, *Labor costs/sales*, *R&D/sales*, and *Non-labor costs/sales*, respectively. Labor costs comprise staff and pension expenses reported under SG&A, while non-labor costs include rent and advertising expenses reported under SG&A. Detailed definitions of all variables are provided in the Appendix. All columns control for firm and year fixed effects. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	SG&A/sales	*Labor costs/sales*	*R&D/sales*	*Non-labor costs/sales*
	(1)	(2)	(3)	(4)
Inventor concentration	-0.036***	-0.007***	-0.063*	-0.002
	(0.009)	(0.003)	(0.036)	(0.001)
Logarithm of sales	-0.085***	0.003**	-0.575***	-0.006***
	(0.006)	(0.001)	(0.040)	(0.001)
Book to market	-0.030***	0.004***	-0.101***	-0.001*
	(0.004)	(0.001)	(0.019)	(0.001)
ROA	-0.829***	-0.008**	-1.423***	-0.058***
	(0.029)	(0.004)	(0.130)	(0.003)
Earnings volatility	-0.134***	0.009*	-1.286***	-0.005
	(0.035)	(0.005)	(0.179)	(0.004)
Sales growth	-0.012	-0.007***	-0.330***	-0.002
	(0.011)	(0.002)	(0.066)	(0.001)
Stock return	-0.002	0.001***	-0.011	-0.001**
	(0.002)	(0.0002)	(0.007)	(0.0002)
Technology concentration	-0.010	-0.001	-0.136***	0.00005
	(0.008)	(0.002)	(0.036)	(0.001)
Firm dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Observations	47,467	47,467	51,084	47,467
Adjusted R^2	0.879	0.657	0.745	0.798

Table 9
Inventor-base concentration and cash holdings: cross-sectional variations in financial constraints

This table examines how the negative relationship between the balance of cash holdings and inventor-base concentration varies across subsamples classified according to the financial constraints faced by the firms. The dependent variable is *Cash/assets*. In columns (1)–(2), (3)–(4), and (5)–(6), the sample is partitioned based on whether the firm is rated by S&P, whether the firm paid dividends in the year, and whether the firm has a big or small market capitalization, respectively. "Big" ("Small") indicates that the firm is larger (smaller) than the 70th (30th) percentile of market capitalization among NYSE firms in the year. All columns control for firm and year fixed effects. Detailed variable definitions are provided in the Appendix. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Credit ratings		*Cash dividends*		*Market cap*	
	Yes	*No*	*Yes*	*No*	*Big*	*Small*
	(1)	(2)	(3)	(4)	(5)	(6)
Inventor concentration	-0.007	-0.021***	0.003	-0.032***	-0.020	-0.020**
	(0.009)	(0.007)	(0.008)	(0.009)	(0.012)	(0.008)
Logarithm of sales	-0.041***	-0.056***	-0.032***	-0.064***	-0.038***	-0.066***
	(0.007)	(0.003)	(0.004)	(0.004)	(0.006)	(0.004)
Book to market	-0.016***	-0.018***	-0.012***	-0.018***	-0.008	-0.012***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.006)	(0.003)
ROA	0.015	0.076***	0.088***	0.077***	0.056	0.086***
	(0.032)	(0.012)	(0.021)	(0.013)	(0.041)	(0.012)
Earnings volatility	0.093	-0.043**	0.267***	-0.066***	0.148**	-0.062***
	(0.105)	(0.019)	(0.059)	(0.021)	(0.074)	(0.020)
Sales growth	0.022	0.005	-0.026*	0.008**	0.008	0.006
	(0.015)	(0.004)	(0.015)	(0.004)	(0.014)	(0.004)
Stock return	0.006***	0.006***	0.007***	0.006***	0.011***	0.005***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)	(0.001)
Technology concentration	-0.006	0.010	-0.006	0.011	0.014	0.009
	(0.008)	(0.006)	(0.007)	(0.008)	(0.013)	(0.007)
Firm dummies	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,477	41,607	22,200	28,884	10,105	27,854
Adjusted R^2	0.754	0.785	0.708	0.772	0.787	0.790

Table 10
Inventor-base concentration and the value of cash holdings

This table examines how inventor-base concentration impacts the marginal value of cash holdings, using the exact approach from Faulkender and Wang (2006). The dependent variable $r_{i,t} - R_{i,t}$, where $r_{i,t}$ is the cumulative return over the past 12 months and $R_{i,t}$ is the Fama and French (1993) size and book-to-market matched portfolio return during the same period. Detailed variable definitions are provided in the Appendix. The standard errors of the estimated coefficients, shown in parentheses, are heteroscedasticity-robust and allow for clustering at the firm level. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Abnormal stock return
	(1)
Inventor concentration × ΔCash/ME	-0.262***
	(0.050)
Inventor concentration	0.014
	(0.011)
ΔCash/ME	1.393***
	(0.033)
ΔEarnings/ME	-0.00004
	(0.001)
ΔNet Assets/ME	0.126***
	(0.005)
ΔR&D/ME	-0.521***
	(0.068)
ΔInterest/ME	-0.331***
	(0.081)
ΔDividends/ME	0.230***
	(0.077)
Lagged Cash/ME	0.464***
	(0.013)
Debt/ME	-0.624***
	(0.016)
New Finance/ME	0.461***
	(0.023)
Lagged Cash/ME × ΔCash/ME	-0.035***
	(0.006)
Debt/ME × ΔCash/ME	-1.243***
	(0.066)
Year dummies	Yes
Observations	42,604
Adjusted R^2	0.168