

Human resource heterogeneity, hold-up and firm cash holdings

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Abstract

Purpose – This paper aims to study the impact of human resource heterogeneity on firms' cash-holding policies.

Design/methodology/approach – The authors construct a proxy for human resource heterogeneity using the dissimilarity in employees' skill structure between the firm and its peers in the same industry.

Findings – The authors report evidence that firms with heterogeneous human resources hold more cash than other firms. This effect is more pronounced in labor-intensive firms and firms more susceptible to hold-up by employees, i.e. firms located in regions with more labor disputes and firms surrounded by more external employment opportunities. In addition, the authors demonstrate that high cash holdings triggered by human resource heterogeneity reduce the scale and efficiency of firms' capital investment.

Originality/value – This study highlights the role of human resource heterogeneity in determining firms' cash policies. This paper adds to the understanding of labor adjustment costs within the firm and provides insights into firms' cash-holding decisions.

Keywords Human resource heterogeneity, Labor adjustment costs, Cash holdings, Hold-up

Paper type Research paper

1. Introduction

In a competitive market, the heterogeneity of resources is the critical source of competitive advantages for the firm (Barney, 1991). As the importance of human resources rises, an increasing number of firms emphasize the heterogeneity of human resources, i.e. the dissimilarity between the firm and its competitors in human resource structure. For example, when describing the transformation of Gree Electric Appliances Inc. (000651.SZ) into a “black light factory”, Mingzhu Dong, the chairperson of Gree, emphasizes that the significant

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increase in the proportion of R&D staff plays an essential role in Gree's intellectualization process. In contrast, Gree's competitor, Bear Electric (002959.SZ), adopts the human resource structure that highlights marketing rather than R&D. In its 2021 annual report, while the number of R&D staff decreases, the number of sales staff increases significantly. These firm practices suggest that heterogeneous human resources are crucial in firm operations, raising the question of how human resource heterogeneity affects firms' cash-holding policies.

Heterogeneous human resources allow the firm to develop unique competitive strategies but imply high labor adjustment costs. When the firm possesses heterogeneous human resources, it needs to make specific investments in employees and has difficulty recruiting employees who meet its needs. Thus, the turnover of existing employees leads to high costs of searching and training and costs associated with productivity losses. To avoid these costs, the firm tends to reduce labor adjustments and maintain employment at a stable level, leading to lower operating flexibility. Because cash reserves act as a buffer against various risks, higher human resource heterogeneity leads firms to hold more precautionary cash.

In addition, we examine whether the relation between human resource heterogeneity and cash holdings is more pronounced when firms are more susceptible to hold-up by employees. Employees can threaten the firm with its specific investments because once they leave the firm, these specific investments lose value. When the firm is more vulnerable to hold-up by employees, as human resource heterogeneity rises, it is harder for the firm to adjust employment, leading to a larger decrease in operating flexibility and a stronger precautionary incentive to hold cash.

We use data from Chinese A-share firms and measure the firms' human resource heterogeneity using the dissimilarity between the firm and its peers in the same industry in terms of the skill structure of employees. We document a positive relationship between human resource heterogeneity and cash holdings, indicating that firms hold more cash in response to decreased operating flexibility caused by heterogeneous human resources. The relationship is more substantial in labor-intensive firms and firms more susceptible to hold-up by employees (i.e. firms located in regions with more labor disputes and firms surrounded by more external employment opportunities) than in other firms. Furthermore, human resource heterogeneity reduces the size and efficiency of the firm's capital investment.

We make two main contributions to the literature. First, we develop a measure of human resource heterogeneity and add to the growing literature on how employees affect the firm's financial decisions. While Ghaly, AnhDang and Stathopoulos (2017) use the share of skilled workers of the firm as a proxy for human resource heterogeneity, we construct a measure by comparing employees' skill structure of the firm with that of its competitors and validate the measure based on the association between employee skills and specific human capital investments proposed by Williamson (1985). Our measure contains information on the distribution of occupations within the firm and allows for a comprehensive analysis of the impact of human resource structure on the firm's financial decisions.

Second, we shed additional light on the determinants of the firm's cash holdings. In particular, we provide new evidence on the role of employees. Recent papers show that firms' cash holdings are affected by employment protection (Cui, John, Pang, & Wu, 2018; Karpuz, Kim, & Ozkan, 2020), regional unemployment benefits (Devos & Rahman, 2018), talent competition (He, 2018) and labor unions (Klasa, Maxwell, & Ortiz-Molina, 2009). We identify human resource heterogeneity as a critical determinant for firms' cash reserves.

Our paper is also related to the literature on the strategic interaction between firms and employees. We prove that the relationship between human resource heterogeneity and the firm's cash holdings is vital when firms are susceptible to employee hold-up risks.

The rest of the paper is organized as follows. [Section 2](#) reviews related literature and develops our main hypotheses. [Section 3](#) describes our empirical design and data. [Sections 4](#) and [5](#) present our main results and further analysis, respectively. [Section 6](#) concludes the paper.

2. Literature review and hypotheses development

2.1 Employees and firm cash holdings

Existing literature argues that cash holdings may be an efficient decision by firms weighing the benefits and costs (the efficiency view) but are often influenced by agency problems in the firm (the agency view). According to the efficiency view, holding cash helps the firm to invest ([Bates, Chang, & Chi, 2018](#); [Cunha & Pollet, 2020](#); [Haushalter, Klasa, & Maxwell, 2007](#)), compete in the market and respond to risks ([Bates, Kahle, & Stulz, 2009](#); [Song & Lee, 2012](#)). The value of cash is higher in firms with financing constraints ([Denis & Sibilkov, 2009](#)). According to the agency view, agency problems impair the efficiency of firms' cash-holding policies. CEO risk-taking motives ([Liu & Mauer, 2011](#)) and managerial power ([Yang, Zhang, & Wu, 2014](#)) are positively related to cash holdings and negatively related to the value of cash. Internal and external governance mechanisms can mitigate agency problems in cash-holding decisions ([Dittmar, Mahrt-Smith, & Servaes, 2003](#); [Pinkowitz, Stulz, & Williamson, 2006](#)).

With the rise of the importance of employees in firm value creation, firms are increasingly influenced by their employees when making cash-holding decisions. Three strands of literature study the impact of employees on firm cash holdings. First, an increase in labor adjustment costs due to labor protection laws prompts the firm to hold precautionary cash ([Beuselinck, Markarian, & Verriest, 2021](#); [Cui *et al.*, 2018](#)). Second, the firm conserves cash to manage employees' perceived risk of becoming unemployed. Studies show that firms increase cash holdings when talent competition intensifies and unemployment insurance benefits rise ([Devos & Rahman, 2018](#); [He, 2018](#)). Third, a larger cash balance allows unionized employees to capture a more significant fraction of firm profits. Lower reported cash holdings improve firms' bargaining positions against unions ([Klasa *et al.*, 2009](#)).

In this paper, we investigate whether firms' cash policies are affected by the structure of human resources. Firms with heterogeneous human resources have difficulty in adjusting their labor demand when facing adverse shocks and in maintaining high cash balances to improve their operating flexibility.

2.2 Hypotheses development

By human resource heterogeneity, we refer to the dissimilarity between the firm and its competitors regarding employees' skill structure. [Barney \(1991\)](#) states that firm resources that have the potential to generate sustained competitive advantages possess four empirical indicators, i.e. value, rareness, imitability and substitutability. Human resources are a critical part of firm resources and a source of new ideas and knowledge in the firm's value creation process. Since human resources are scarce and imperfectly mobile across firms, it is difficult for firms to adjust their human resource structure timely. When the firm possesses heterogeneous human resources, it can implement unique strategies inaccessible for other firms in the same industry and thus maintain a sustained competitive advantage.

Nevertheless, human resource heterogeneity implies high labor adjustment costs. First, specific investment in employees' human capital is required to form heterogeneous human resources. [Williamson \(1985\)](#) posits that the acquisition of certain skills by employees is necessary to develop specific human capital. Firms and employees could benefit from maintaining a continuous employment relationship only if the skills acquired by employees

require great specific investment and the skills are solely meaningful to the firm. If employees' skills require little specific investment, the firm can easily obtain employees with certain skills from the market. If employees' skills are meaningful to other firms, employees can find another job. Hence, high human resource heterogeneity means high human capital specificity. The specific investment made by the firm loses its value once employees leave for another firm.

Second, searching for qualified employees is costly, especially for firms with heterogeneous human resources. Third, it takes time to replace employees, which causes significant disruption to production. Productivity losses are larger when firms' human resources are more heterogeneous.

Confronted with the costs of searching and training employees and the costs associated with productivity losses, a firm with heterogeneous human resources tends to maintain stable employment and avoid adjusting its employees. When the firm experiences adverse shocks, it is not likely to reduce operating costs by adjusting employees, leading to decreased operating flexibility. As a result, the firm is incentivized to hold precautionary cash to cope with various risks. Hence, we propose the first hypothesis as follows:

H1. Human resource heterogeneity is positively related to firm cash holdings.

2.3 Cross-sectional analysis

The positive impact of human resource heterogeneity on cash holdings is more pronounced in labor-intensive firms than in other firms. For labor-intensive firms, human resources play a more critical role than physical resources, and labor costs account for a large share of total costs. The reduction in operating leverage and the increase in precautionary cash triggered by human resource heterogeneity are more significant in these firms than in other firms, leading to our second hypothesis:

H2. The positive relationship between human resource heterogeneity and firm cash holdings is stronger for firms that are more labor-intensive than for other firms.

Hold-up by employees means employees threaten the firm to maintain or enhance their treatment by slacking off or job hopping. Once employees leave the firm, its specific human capital investment loses value. Since human capital cannot be legally transferred, the firm cannot avoid employee turnover through integration (Klein, Crawford, & Alchian, 1978), nor can it explicitly restrict employees' mobility in the contract. Thus, firms are susceptible to employees' hold-up risks.

The relationship between human resource heterogeneity and firm cash holdings depends on firms' vulnerability to employees' hold-up. When firms are less vulnerable to hold-up, it is more difficult for employees to threaten firms through job hopping, and firms are in a stronger bargaining position in determining employee treatment and their appointment and dismissal. The negative impact of human resource heterogeneity on the firm's operating flexibility is weaker, and firms have weaker incentives to conserve cash. In contrast, firms that are more susceptible to employees' hold-up are more sensitive to labor adjustment costs caused by human resource heterogeneity, and the effect of human resource heterogeneity on firms' cash holdings is more pronounced.

Specifically, the strength of the relationship varies with regional labor disputes and external employment opportunities. Regional arbitration of labor disputes is essential for resolving disagreements between employees and firms. Due to labor unions' weak ability to coordinate labor relations in China, employees often request the local government to intervene when there are disagreements between employees and firms (Lu, 2004). In 2007, China passed the *Labor Contract Law* along with the *Law on Mediation and Arbitration of Labor Disputes* specifying that the scope of regional labor disputes includes employees'

access to compensation and social insurance and the termination and dissolution of labor contracts. Hence, the risk of hold-up by employees is higher for firms in regions with more labor disputes and a higher likelihood of employees requesting government intervention on disagreements with firms. The effect of human resource heterogeneity on firm cash holdings is more vital in firms in these regions than in other firms. Thus, we propose H3.1 as follows:

H3.1. The positive relationship between human resource heterogeneity and firm cash holdings is stronger for firms located in regions with more labor disputes than for other firms.

Labor market opportunities make it possible for employees to hold up. Employees with external opportunities have bargaining power through job hopping. Literature shows that outside employment opportunities increase the motive for upward earnings management (Gao, Zhang, & Zhang, 2018) and weaken the disciplinary effect of debt on employee output (Kale, Ryan, & Wang, 2019). Hence, firms surrounded by employment opportunities are exposed to higher hold-up risks and have stronger precautionary incentives to hold cash. For firms in regions that lack employment opportunities, employees are confronted with higher job termination costs and thus increase efforts to improve performance. Therefore, in these regions, employees' hold-up risk is lower, and the effect of human resource heterogeneity on firms' cash holdings is weaker. These arguments yield the following hypothesis:

H3.2. The positive relationship between human resource heterogeneity and firm cash holdings is stronger for firms surrounded by more employment opportunities than for other firms.

3. Data and variable descriptions

3.1 Data

Our sample comprises all the Chinese A-share firms on Shenzhen and Shanghai stock exchanges from 2007 to 2019. From the 30,304 firm-year observations, we exclude 399 observations with negative net assets and 3,015 observations with missing variables. Our final sample comprises 26,890 firm-year observations.

Our primary data source is China Stock Market and Accounting Research Database. Data on employee composition and office addresses of listed firms is from RESSET Database. The text features of Management Discussion and Analysis (MD&A) are from WinGo Textual Analysis Database. In addition, we manually collect data on local labor disputes and opening dates and addresses of high-speed rail (HSR) stations. Other regional macroeconomic data is from the National Bureau of Statistics of China.

3.2 Variable construction

3.2.1 Measuring human resource heterogeneity. We measure the firm's human resource heterogeneity using the dissimilarity between the firm and its peers in the same industry in terms of the skill structure of employees. The more similar the firm and its peers are in the employee's skill structure, the lower the costs of searching for and training employees, and the lower the heterogeneity of human resources.

Specifically, we take three steps to calculate the measure for human resource heterogeneity. First, based on the composition of employees disclosed in MD&A, we classify employees into six categories based on skills (administration, operation (or production), marketing, R&D, finance and others) and construct a six-dimension human resource vector for each firm. Second, we calculate cosine similarity in the skill structure of employees between the firm and its peers within the same industry and year. As is shown in Equation (1), the cosine similarity in the skill

structure of employees between firms A and B is computed as the scalar product of firms' human resource sectors (H_A and H_B) divided by the product of their lengths.

$$\text{Cosine similarity in employees' skill structure between firms A and B} = \frac{H_A H_B}{\|H_A\| \|H_B\|} \quad (1)$$

For example, Welltech (002058.SZ) and FSL Lighting (000541.SZ) belong to the instrumentation manufacturing industry. Figure 1 displays the skill structure of employees of the two firms disclosed in their 2019 annual reports. In both firms, operational employees account for the highest proportion of total employees (51.2% and 77.2%, respectively), while financial employees account for the lowest (3.5% and 0.6%, respectively). Appendix 1 presents the calculation of the cosine similarity in employees' skill structure between the two firms. A value of 0.937 indicates that the two firms show a high degree of similarity in the employees' skill structure.

Third, after calculating the cosine similarity in employees' skill structure between the sample firm and every other firm in the same industry and year, we take the average and use its opposite as a proxy for human resource heterogeneity. Firms with higher *Heter* are more differentiated from their industry peers in employees' skill structure.

3.2.2 Measuring regional labor disputes. Firms in regions with more labor disputes are more vulnerable to hold-up by employees. We manually collect regional data on labor disputes from *China Labor Statistical Yearbook*. *Perdis* is an indicator variable that takes one if the number of labor disputes filed per 10,000 people in the province where the sample firm is located exceeds the annual mean.

3.2.3 Measuring external employment opportunities. We employ the presence of a HSR station within 30km of the sample firm (*Rail*) as the proxy for labor market opportunities available to employees. The operation of HSR is a significant improvement in transportation infrastructure and contributes to the cross-regional migration of human capital (Wang, Lan, Zhang, & Hou, 2020) for at least two reasons. First, HSR construction promotes the cross-regional flow of information, reduces the information asymmetry between employees and nonlocal firms and lowers the job searching costs for employees. Second, with the advantages of punctuality, efficiency and broad coverage, the HSR network decreases the cost of employees' family visits. Thus, HSR construction can boost employees' nonlocal employment. HSR construction surrounding the firm is positively associated with external opportunities for employees. We first convert the sample firm's office address into latitude and longitude and then calculate the sample firm's distance to each HSR station that has

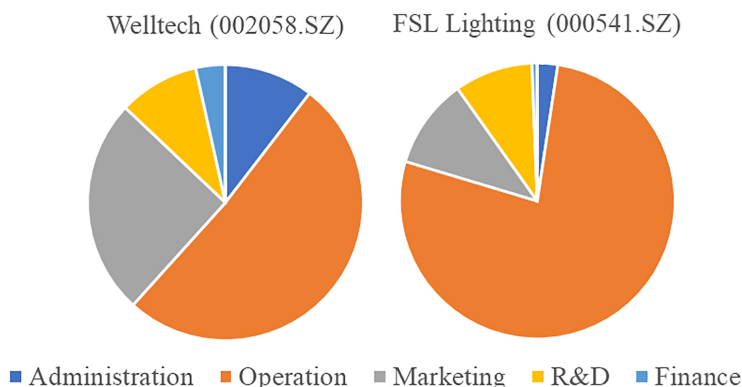


Figure 1.
Employees' skill
structure: Welltech
(002058.SZ) versus
FSL Lighting
(000541.SZ)

started operation. *Rail* takes one if there is an HSR station within 30km of the sample firm, implying that more external employment opportunities surround the firm.

3.2.4 Other variables. The dependent variable, *Cash*, is measured as the sum of cash, marketable securities and short-term investments divided by total assets. Variable definitions are provided in [Appendix 2](#). All continuous variables are winsorized at the 1st and 99th percentiles. Based on the industry classification from *Guidance on Industry Classification of Listed Firms* issued by the Chinese Securities Regulatory Commission in 2012, we use the one-digit classification for nonmanufacturing firms and merge the three-digit classification into broad categories for manufacturing firms following the 2001 version guidance. We adopt the OLS regression in main tests and present the results based on standard errors clustered by firm. Industry and year fixed effects are controlled in all regressions.

3.3 Descriptive statistics

Panel A of [Table 1](#) reports descriptive statistics for variables used in main regressions. *Cash* has a mean value of 0.176 and *Heter* has a mean value of -0.765 , suggesting that employees' skill structure in most sample firms is similar to that of their competitors. Regarding the probability of hold-up by employees, 75.1% of sample firms are located in regions where the

	<i>N</i>	Mean	SD	Min	Median	Max
<i>A. Main variables</i>						
<i>Cash</i>	26,890	0.176	0.124	0.012	0.143	0.618
<i>Heter</i>	26,890	-0.765	0.184	-0.957	-0.837	-0.169
<i>Apay</i>	26,890	11.670	8.318	1.808	9.609	54.410
<i>Eduinput</i>	26,890	0.147	0.159	0.000	0.105	0.872
<i>Laborinten</i>	26,890	-14.470	1.010	-17.610	-14.340	-12.470
<i>Perdis</i>	26,890	0.750	0.433	0.000	1.000	1.000
<i>Rail</i>	26,890	0.693	0.462	0.000	1.000	1.000
<i>B. Control variables</i>						
<i>Ocf</i>	26,890	0.045	0.074	-0.191	0.044	0.252
<i>Sdsale</i>	26,890	0.041	0.038	0.004	0.030	0.247
<i>Lev</i>	26,890	0.190	0.161	0.000	0.166	0.630
<i>Size</i>	26,890	22.110	1.290	19.430	21.950	26.020
<i>Btm</i>	26,890	0.443	0.312	0.031	0.363	1.640
<i>Indcomp</i>	26,890	-0.065	0.076	-0.403	-0.040	-0.015
<i>Dual</i>	26,890	0.232	0.422	0.000	0.000	1.000
<i>Firstshr</i>	26,890	0.345	0.149	0.086	0.323	0.742
<i>Age</i>	26,890	10.700	6.542	1.000	10.000	29.000
<i>Soe</i>	26,890	0.430	0.495	0.000	0.000	1.000

Panel B correlation

	<i>Cash</i>	<i>Heter</i>	<i>Apay</i>	<i>Eduinput</i>	<i>Rdratio</i>	<i>Rail</i>	<i>Perdis</i>
<i>Heter</i>	0.129***						
<i>Apay</i>	0.069***	0.252***					
<i>Eduinput</i>	-0.022 ***	0.123***	0.577***				
<i>Rdratio</i>	0.151***	0.164***	0.305***	0.103***			
<i>Rail</i>	0.100***	0.109***	0.199***	0.075***	0.156***		
<i>Perdis</i>	0.064***	0.120***	0.153***	0.015**	0.114***	0.166***	
<i>IPOHeter</i>	0.126***	0.470***	0.187***	0.113***	0.156***	0.125***	0.056***

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively

Table 1.
Panel A summary
statistics

number of labor disputes is higher than the annual mean, and 69.3% of sample firms have an HSR station within 30km of the firm.

Panel B of Table 1 tabulates the Pearson correlation coefficients among our variables of interest. *Heter* is positively correlated with *Apay* and *Eduinput*, indicating that firms with higher human resource heterogeneity pay higher compensation to their employees and invest more in employees' training, which to some extent validates our measure of *Heter*. *Heter* is also significantly correlated with *Cash*, suggesting a strong and positive association between human resource heterogeneity and firms' cash holdings. In addition, the correlation coefficients between *Cash* and proxies for hold-up by employees, *Perdis* and *Rail*, are positive and significant, showing that firms hold more cash when they are more susceptible to employee hold-up.

4. Empirical results

4.1 Validating human resource heterogeneity

We perform a battery of tests to validate our measure for human resource heterogeneity. First, we regress *Heter* on the potential determinants of human resource heterogeneity and report the results in Table 2. The dependent variable in column (1) is *Heter*. The regression coefficient on *Rdratio* is positive and significant, indicating that firms with more R&D staff present higher human resource heterogeneity. The coefficient on *Mdasimilar* is significantly negative, which is consistent with the expectation that the heterogeneity of the firm's management system is positively associated with human resource heterogeneity. In addition, human resource heterogeneity is lower in firms with higher levels of cash flow and debt ratios while higher in firms with higher operating volatility, greater growth opportunities and in regions with more educated workers.

Human resource heterogeneity should be persistent over the years due to the costs of labor adjustments. We test the persistence of human resource heterogeneity and tabulate the

	(1) <i>Heter</i>		(2) <i>Heter</i> _{t+1}	
	Coefficients	t-statistic	Coefficients	t-statistic
<i>Heter</i>			0.724***	(74.556)
<i>Rdratio</i>	0.105***	(6.509)	0.012**	(2.348)
<i>Ocf</i>	-0.035**	(-1.971)	-0.029***	(-3.035)
<i>Sdsale</i>	0.197***	(4.052)	0.059***	(2.833)
<i>Lev</i>	-0.041***	(-3.442)	-0.010**	(-2.210)
<i>Size</i>	0.003	(1.433)	0.000	(0.365)
<i>Btm</i>	-0.025***	(-3.998)	-0.007***	(-2.632)
<i>Indcomp</i>	-0.175***	(-3.831)	0.012	(0.727)
<i>Dual</i>	0.002	(0.502)	-0.001	(-0.674)
<i>Firstshr</i>	-0.006	(-0.543)	0.001	(0.326)
<i>Age</i>	-0.000	(-1.556)	0.000	(0.430)
<i>Soe</i>	-0.004	(-1.053)	-0.004**	(-2.550)
<i>Abovecoll</i>	0.110***	(4.014)	0.048***	(5.169)
<i>Popu</i>	0.001	(0.446)	0.002**	(2.080)
<i>Mdasimilar</i>	-0.085***	(-6.364)	-0.032***	(-5.791)
Constant	-0.855***	(-16.718)	-0.215***	(-11.073)
Industry fixed effects	Yes		Yes	
Year fixed effects	Yes		Yes	
Observations	26,316		25,982	
Adjusted R-squared	0.457		0.743	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. OLS regression is adopted and standard errors are clustered at firm level

Table 2.
Determinants for
human resource
heterogeneity

results in column (2), with *Heter* in year $t+1$ as the dependent variable. The coefficient on *Heter* in year t is 0.724 and significant at the 1% level. Adjusted R-square rises from 0.457 in column (1) to 0.743, revealing that human resource heterogeneity in listed firms has been highly persistent over the years.

Second, we examine the relation between *Heter* and labor costs within the firm. Searching for and training new employees are more costly for firms with heterogeneous human resources. Thus, we expect that *Heter* positively affects compensation per employee (*Apay*) and training costs per employee (*Eduinput*). In 2002, the *Decision of the State Council on Vigorously Developing Vocational Education* (No. 35 [2005] of the State Council) required the listed firms to allocate a certain percentage of employee compensation for education and training. In 2006, *Opinions on the Administration of Drawing and Use of ‘Enterprises’ Funds for the Education and Training of Employees* (No. 317 [2006] of the Ministry of Finance) further clarified the scope of funds for education and training of employees and required listed firms fully accrue and rationally use the funds. Because a portion of funds for labor unions is used for employees’ education and training, most listed firms disclose the sum of education expenses and labor union expenses. Hence, we utilize the sum of education and labor union expenses divided by the number of employees, *Eduinput*, as a proxy for employee training costs.

We construct the regression model as shown in Equation (2), where the dependent variables are *Apay* and *Eduinput*. Table 3 reports the results. We find that human resource heterogeneity has positive and significant effects on compensation per employee and training costs per employee. Coefficients on control variables show that firms with lower financial leverage, larger size and higher shareholding by the largest shareholder pay more to employees. State-owned firms invest more in employees, which is consistent with prior literature.

Overall, the results in Tables 2 and 3 validate *Heter* as a proxy for human resource heterogeneity.

$$Apay_{i,t} \text{ OR } Eduinput_{i,t} = \beta_0 + \beta_1 Heter_{i,t} + \beta_2 Controls_{i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \tag{2}$$

	(1) <i>Apay</i>		(2) <i>Eduinput</i>	
	Coefficients	<i>t</i> -statistic	Coefficients	<i>t</i> -statistic
<i>Heter</i>	8.138***	(9.214)	0.059***	(4.084)
<i>Ocf</i>	−0.308	(−0.315)	0.005	(0.261)
<i>Sdsale</i>	7.003***	(2.827)	0.004	(0.113)
<i>Lev</i>	−2.918***	(−4.024)	−0.079***	(−6.270)
<i>Size</i>	1.060***	(8.437)	0.020***	(8.438)
<i>Btm</i>	−0.864**	(−2.222)	−0.001	(−0.099)
<i>Indcomp</i>	9.844***	(4.942)	−0.021	(−0.568)
<i>Dual</i>	0.034	(0.195)	−0.013***	(−3.842)
<i>Firstshr</i>	1.267*	(1.744)	0.055***	(3.846)
<i>Age</i>	0.040**	(2.150)	0.000	(0.975)
<i>Soe</i>	1.233***	(4.617)	0.072***	(14.775)
Constant	−11.573***	(−4.238)	−0.332***	(−6.593)
Industry fixed effects	Yes		Yes	
Year fixed effects	Yes		Yes	
Observations	26,890		26,890	
Adjusted <i>R</i> -squared	0.255		0.231	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. OLS regression is adopted and standard errors are clustered at firm level

Table 3.
Human resource
heterogeneity and
labor costs

4.2 Baseline results

We test H1 using the baseline model shown in Equation (3), where the dependent variable is *Cash*, and report the results in Table 4. The coefficient on *Heter* is 0.054 and significant at the 1% level, suggesting that higher human resource heterogeneity increases firms' cash holdings, supporting H1. Economically, after controlling for other factors, a one standard deviation increase in human resource heterogeneity is associated with 8.013% ($= 0.054 \times 0.184/0.124$) more cash holdings by the firm.

$$Cash_{i,t} = \beta_0 + \beta_1 Heter_{i,t} + \beta_2 Controls_{i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (3)$$

	Coefficients	<i>Cash</i>	<i>t</i> -statistic
<i>Heter</i>	0.054***		(5.482)
<i>Ocf</i>	0.203***		(13.376)
<i>Sdsale</i>	0.168***		(4.307)
<i>Lev</i>	-0.241***		(-23.005)
<i>Size</i>	0.000		(0.025)
<i>Btm</i>	-0.015***		(-2.753)
<i>Indcomp</i>	-0.199***		(-5.530)
<i>Dual</i>	0.007**		(2.428)
<i>Firstshr</i>	0.025**		(2.490)
<i>Age</i>	-0.001***		(-2.802)
<i>Soe</i>	0.004		(1.187)
Constant	0.191***		(5.146)
Industry fixed effects		Yes	
Year fixed effects		Yes	
Observations		26,890	
Adjusted <i>R</i> -squared		0.231	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. OLS regression is adopted and standard errors are clustered at firm level

Table 4.

Human resource
heterogeneity and cash
holdings

The coefficients on control variables suggest that firms with lower financial leverage, higher operating cash flows and greater operating risks hold more cash. Firms facing fewer growth opportunities and fiercer industry competition have a smaller cash balance. Coefficients on governance variables show that firms with the CEO chairing the board and higher shareholding by the largest shareholder maintain larger cash reserves.

We add the interaction of *Heter* with labor intensity (*Laborinten*) to Equation (3) to examine whether our results vary with labor intensity. We report the results in Table 5. Coefficients on *Heter*×*Laborinten* and *Heter* are 0.024 and 0.402, respectively, which are positive and significant at the 1% level. These results indicate that the positive effect of human resource heterogeneity on firms' cash holdings is more substantial in labor-intensive firms, supporting H2.

4.3 The effect of hold-up by employees

We then examine the effect of hold-up by employees on the relationship between human resource heterogeneity and firms' cash holdings. We incorporate into Equation (3) the interaction between *Heter* and the threat of hold-up by employees, measured by labor

Table 5.
The effect of labor
intensity

	Coefficients	Cash	t-statistic
<i>Heter</i>	0.402***		(3.822)
<i>Heter</i> × <i>Laborinten</i>	0.024***		(3.364)
<i>Laborinten</i>	0.007		(1.232)
<i>Ocf</i>	0.216***		(14.482)
<i>Sdsale</i>	0.168***		(4.380)
<i>Lev</i>	−0.243***		(−23.083)
<i>Size</i>	−0.002		(−1.189)
<i>Btm</i>	−0.017***		(−2.982)
<i>Indcomp</i>	−0.199***		(−5.495)
<i>Dual</i>	0.007**		(2.396)
<i>Firstshr</i>	0.025**		(2.575)
<i>Age</i>	−0.001***		(−2.919)
<i>Soe</i>	0.005		(1.605)
Constant	0.342***		(3.819)
Industry fixed effects		Yes	
Year fixed effects		Yes	
Observations		26,890	
Adjusted R-squared		0.236	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. OLS regression is adopted and standard errors are clustered at firm level

disputes in the region where the firm is located (*Perdis*) and external employment opportunities surrounding the firm (*Rail*). Results are tabulated in Table 6.

In column (1), the coefficient on *Heter*×*Perdis* is positive and significant, while the coefficient on *Heter* is statistically insignificant after adding the interaction term, implying

Table 6.
The effect of hold-up
by employees

	(1) Cash		(2) Cash		(3) Cash	
	Coefficients	t-statistic	Coefficients	t-statistic	Coefficients	t-statistic
<i>Heter</i>	0.007	(0.449)	0.019*	(1.673)	−0.015	(−1.002)
<i>Heter</i> × <i>Perdis</i>	0.058***	(3.486)			0.050***	(2.953)
<i>Perdis</i>	0.047***	(3.426)	0.001	(0.464)	0.041***	(2.917)
<i>Heter</i> × <i>Rail</i>			0.049***	(3.841)	0.041***	(3.160)
<i>Rail</i>	0.012***	(4.078)	0.051***	(4.826)	0.045***	(4.139)
<i>Ocf</i>	0.204***	(13.470)	0.203***	(13.374)	0.204***	(13.464)
<i>Sdsale</i>	0.164***	(4.220)	0.165***	(4.210)	0.163***	(4.197)
<i>Lev</i>	−0.238***	(−22.777)	−0.239***	(−22.764)	−0.239***	(−22.785)
<i>Size</i>	−0.000	(−0.177)	−0.000	(−0.080)	−0.000	(−0.156)
<i>Btm</i>	−0.016***	(−2.819)	−0.016***	(−2.840)	−0.016***	(−2.878)
<i>Indcomp</i>	−0.196***	(−5.446)	−0.198***	(−5.512)	−0.198***	(−5.506)
<i>Dual</i>	0.007**	(2.364)	0.007**	(2.278)	0.007**	(2.307)
<i>Firstshr</i>	0.024**	(2.392)	0.024**	(2.390)	0.024**	(2.371)
<i>Age</i>	−0.001***	(−2.821)	−0.001***	(−2.772)	−0.001***	(−2.807)
<i>Soe</i>	0.004	(1.031)	0.004	(1.030)	0.003	(0.966)
Constant	0.164***	(4.390)	0.170***	(4.561)	0.146***	(3.921)
Industry fixed effects	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
Observations	26,890		26,890		26,890	
Adjusted R-squared	0.234		0.234		0.234	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. OLS regression is adopted and standard errors are clustered at firm level

that the positive effect of human resource heterogeneity on firms' cash holdings is concentrated in regions with more labor disputes. In column (2), coefficients on *Heter*×*Rail* and *Heter* are significantly positive, suggesting that if the firm has an HSR station nearby, i.e. more external employment opportunities are available for employees, human resource heterogeneity has a stronger effect on firms' cash holdings. In column (3), we include all the interaction terms in the regression and the results are qualitatively the same.

Collectively, the results in Table 6 support Hypotheses 3.1 and 3.2. They suggest that the association between human resource heterogeneity and firms' cash holdings is more pronounced where firms are more vulnerable to employees' hold-up.

4.4 Endogeneity issues

The OLS regression results are consistent with our hypotheses but may be subject to two types of endogeneity. The first is reverse causality. Abundant cash enables the firm to implement exceptional talent strategies, leading to high human resource heterogeneity. The second is the omission of correlated variables. For instance, an alternative explanation for our results is that firms implementing innovation strategies possess heterogeneous human resources and maintain ample cash reserves for potential investment opportunities.

We address such endogeneity concerns using three approaches. First, following Chen, Chen, Hsu and Podolski (2016), we conduct a change analysis. By doing so, the cross-firm variation is differentiated away, allowing us to focus on the time-series variation. Hence, reverse causality and omitted variable bias are alleviated in this setting. Specifically, we regress the change in human resource heterogeneity between $t-1$ and t ($\Delta Heter$) against the change in cash holdings between $t-1$ and t ($\Delta Cash$). Likewise, all control variables are converted from level variables to changes between $t-1$ and t . The results in panel A of Table 7 suggest that the positive and significant relationship between human resource heterogeneity and firms' cash holdings holds in the change analysis setting.

Second, we further control for firm fixed effects in the regressions. We do not control for firm fixed effects in baseline results because characteristics of human resources are persistent over time for each particular firm. The results are tabulated in panel B of Table 7. The coefficient on *Heter* is still positive and significant, suggesting a causal effect of human resource heterogeneity on firms' cash holdings.

Third, we use the instrumental variable approach to mitigate any remaining endogeneity concerns. Lemmon, Roberts and Zender (2008) find that the majority of variation in leverage ratios is driven by an unobserved time-invariant effect and this feature of leverage is robust to firm exit and is present prior to the initial public offering (IPO). Drawing on the literature, we employ the firm's human resource heterogeneity at the time of the IPO (*IPOHeter*) as an instrumental variable.

The variation in human resource heterogeneity is primarily determined by factors that remain stable for long periods. The firm's initial attributes of human resources have long-term and far-reaching effects on its subsequent attributes of human resources. Thus, our instrument satisfies the relevance criteria. In the meantime, human resource heterogeneity at the time of the IPO is largely unexplained by currently identified firm characteristics and has little impact on current cash holdings. Hence, our instrument is likely to satisfy the exclusion criteria as well.

Results obtained using the instrumental variable approach in the framework of a two-stage least-squares (2SLS) regression are reported in Panel C of Table 7. The first-stage regression is presented in column (1). *IPOHeter* is significantly and positively related to *Heter*. The instrument also passes the relevance test as the F -statistic from the joint test of excluded instruments is significant at the 1% level. Column (2) shows the second stage of the 2SLS regressions with *Cash* as the dependent variable. Similar to the OLS regressions, we

Panel A change analysis

	Coefficients	$\Delta Cash$	<i>t</i> -statistic
$\Delta Heter$	0.014**		(1.962)
ΔOcf	0.194***		(21.535)
$\Delta Sdsale$	0.029		(1.020)
ΔLev	-0.058***		(-5.657)
$\Delta Size$	0.028***		(8.484)
ΔBtm	0.004		(1.340)
$\Delta Indcomp$	-0.040		(-1.331)
Age	0.001***		(13.835)
Soe	0.003***		(4.355)
Constant	-0.004		(-1.143)
Industry fixed effects		Yes	
Year fixed effects		Yes	
Observations		24,207	
Adjusted <i>R</i> -squared		0.086	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. OLS regression is adopted and standard errors are clustered at firm level

Panel B controlling for firm fixed effects

	Coefficients	<i>Cash</i>	<i>t</i> -statistic
<i>Heter</i>	0.022***		(2.600)
<i>Ocf</i>	0.170***		(13.469)
<i>Sdsale</i>	0.044		(1.470)
<i>Lev</i>	-0.179***		(-16.093)
<i>Size</i>	-0.003		(-1.265)
<i>Btm</i>	-0.004		(-0.897)
<i>Indcomp</i>	-0.220***		(-6.215)
<i>Dual</i>	0.005*		(1.800)
<i>Firstshr</i>	0.057***		(3.623)
<i>Age</i>	0.002***		(5.129)
<i>Soe</i>	-0.009		(-1.238)
Constant	0.218***		(3.830)
Firm fixed effects		Yes	
Industry fixed effects		Yes	
Year fixed effects		Yes	
Observations		26,890	
Adjusted <i>R</i> -squared		0.103	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. Standard errors are clustered at firm level

Panel C two-stage regression with the instrumental variable

	(1) <i>Heter</i>		(2) <i>Cash</i>	
	Coefficients	<i>t</i> -statistic	Coefficients	<i>t</i> -statistic
<i>IPOHeter</i>	0.218***	(38.189)		
<i>Heter</i>			0.224***	(10.033)
<i>Ocf</i>	-0.019	(-1.224)	0.215***	(16.364)
<i>Sdsale</i>	0.246***	(7.962)	0.014	(0.509)
<i>Lev</i>	-0.077***	(-9.780)	-0.255***	(-36.420)
<i>Size</i>	0.008***	(6.301)	-0.004***	(-3.435)
<i>Btm</i>	-0.028***	(-5.842)	-0.011***	(-2.665)

Table 7.
Endogeneity and
instrumental variables

(continued)

Panel C two-stage regression with the instrumental variable				
	(1) <i>Heter</i>		(2) <i>Cash</i>	
	Coefficients	<i>t</i> -statistic	Coefficients	<i>t</i> -statistic
<i>Indcomp</i>	−0.192***	(−6.997)	−0.178***	(−7.414)
<i>Dual</i>	0.006**	(2.512)	0.006***	(3.161)
<i>Firstshr</i>	−0.008	(−0.999)	0.041***	(6.311)
<i>Age</i>	−0.001***	(−2.753)	−0.001***	(−3.907)
<i>Soe</i>	−0.002	(−0.764)	0.003	(1.392)
Constant	−0.821***	(−31.136)	0.430***	(13.513)
Industry fixed effects	Yes		Yes	
Year fixed effects	Yes		Yes	
Observations	17,148		17,148	
Adjusted <i>R</i> -squared	0.430		0.236	
<i>F</i> -statistic of the IV	1458.4			

Note(s): Two-stage least-squares regression is adopted. Standard errors are clustered at firm level and *t*-statistics are reported in parentheses. *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively

Table 7.

document a positive relationship between human resource heterogeneity and firms' cash holdings.

To summarize, we perform a battery of tests to alleviate endogeneity concerns and find that our main conclusion holds. Results in Table 7 suggest a causal relationship between human resource heterogeneity and firms' cash holdings.

4.5 Robustness tests

In this section, we conduct various tests to ensure that our main findings are robust to alternative model specifications and variable definitions.

4.5.1 Alternative variable definitions. We first replace our measure of human resource heterogeneity, *Heter*, with several alternative measures, namely, *Heter1* and *Rdratio*. We calculate the industry-year average of employees' skill structure and define *Heter1* using the dissimilarity in employees' skill structure between the sample firm and the industry-year average. *Rdratio* measures the proportion of R&D staff among total employees, which is used by Ghaly et al. (2017) as a proxy for labor heterogeneity. Results indicate that our findings are robust to alternative measures of human resource heterogeneity.

When we analyze cross-sectional differences in the effects of human resource heterogeneity on firms' cash holdings, we use the natural logarithm of the number of employees scaled by total assets to proxy for labor intensity. If we measure labor intensity using the natural logarithm of the increase in accrued salaries scaled by total sales, or the natural logarithm of cash paid to employees scaled by cash paid for fixed assets, the results remain unchanged. In addition, our findings are robust to using the presence of an HSR station within 20km of the sample firm as a proxy for *Rail*.

4.5.2 Effect of noncompete provisions. In recent years, many firms use noncompete provisions to restrict the mobility of core employees and protect trade secrets, which is especially common in innovative firms. Firms can use noncompete provisions instead of holding cash when facing labor adjustment costs. However, noncompete provisions do not significantly affect our results for at least two reasons. First, noncompete provisions cannot wholly prevent employees' turnover. The rules for adjudicating noncompete disputes in China state that the employer shall not enter a noncompete agreement with all its employees, but only with specific employees. The signing of noncompete provisions should be based on the premise that employees know the trade secrets [1]. Therefore, noncompete provisions can

only reduce the loss of senior management and technical personnel to a certain extent. Second, the signing of noncompete provisions imposes costs on the firm. The employer must provide compensation when entering a noncompete and confidentiality agreement with employees. If the payment is significantly lower than the minimum wage and insufficient to meet employees' living needs, or the employer fails to pay the compensation for more than three months after the termination of the employment contract, the noncompete provisions shall be invalid [2].

Since we cannot observe the use of noncompete provisions among listed firms, we cannot empirically compare the cost of using noncompete provisions with the costs of maintaining cash reserves. Compared to other firms, high-tech firms are more sensitive to adjustment costs arising from human resource heterogeneity and incentivized to use noncompete provisions. Therefore, if entering a noncompete agreement is a less costly way to reduce employee turnover, we expect the effect of human resource heterogeneity on firms' cash holdings to be weaker among high-tech firms.

To support the above analysis, we incorporate into Equation (3) the interaction of *Heter* with *Htech*, the indicator for high-tech firms. Based on *China Statistical Yearbook on Science and Technology*, we identify firms from the following industries as high-tech firms: chemical raw material and product manufacturing; pharmaceutical manufacturing; special equipment manufacturing; transport equipment manufacturing; computer and communications equipment manufacturing; instrumentation manufacturing; information transmission, software and information technology services; and scientific research and technology services. The results show that the positive relationship between human resource heterogeneity and firms' cash holdings is stronger in high-tech firms. They imply that noncompete provisions do not entirely prevent employees' turnover, and a larger cash balance is essential for firms to deal with the labor adjustment costs caused by human resource heterogeneity.

4.5.3 Firm investment opportunities and strategic characteristics. An alternative explanation for our results is that firms with more investment opportunities have more heterogeneous human resources while holding more cash for investing. To rule out this alternative explanation, we include investment opportunities (*TQ*) and innovation tendency in the firm's strategy (*Inno*) in Equation (3). *Inno* is measured by the innovation index of MD&A text obtained from the WinGo Textual Analysis Database. Similar results are obtained. In further analysis, we investigate the effect of human resource heterogeneity on firms' capital investment.

5. Further analysis

5.1 Human resource heterogeneity and capital investment

In baseline regressions, we find that heterogeneous human resources increase firms' cash holdings, which has a twofold impact on firms' investment decisions. First, maintaining high cash reserves weakens firms' ability to invest in fixed assets and leads to underinvestment. Second, a larger cash balance is associated with higher levels of investment (Denis & Sibilkov, 2009). As heterogeneous human resources lead to higher labor adjustment costs, firms are less resilient in their operations and more vulnerable to adverse shocks. For these firms, holding cash helps to avoid underinvestment and positively affects their capital investment.

To examine how human resource heterogeneity affects firms' capital investment through increasing cash holdings, we establish a structural equation model as displayed in Figure 2. We follow Richardson (2006), estimate the model in Equation (4) and take the residual for each firm-year. In Equation (4), the dependent variable is the firm-level investment (*PPEInv*) at year *t*, which is cash paid for fixed assets scaled by total assets. The independent variables include asset size (*Size*), financial leverage (*Lev*), growth in sales (*Growth*), annual market

return (*Ret*), age (*Age*), level of cash (*Cash*) and investment level (*PPEInv*) at year $t-1$. Industry and year fixed effects are included in the regressions. *UnderInv* takes the absolute of the residual with a negative residual and zero otherwise.

$$PPEInv_{i,t} = \beta_0 + \beta_1 Size_{i,t-1} + \beta_2 Lev_{i,t-1} + \beta_3 Growth_{i,t-1} + \beta_4 Ret_{i,t-1} + \beta_5 Age_{i,t-1} + \beta_6 Cash_{i,t-1} + \beta_7 Invest_{i,t-1} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (4)$$

Results are tabulated in Table 8. The findings in column (1) are consistent with the baseline results that human resource heterogeneity increases firms' cash holdings. In column (2), the dependent variable is *PPEInv*. The coefficient on *Heter* is statistically insignificant, and the coefficient on *Cash* is negative and significant, suggesting that through holding greater cash reserves, human resource heterogeneity harms the firm's capital investment. In column (3), with *Underinv* as the dependent variable, coefficients on *Heter* and *Cash* are negative and

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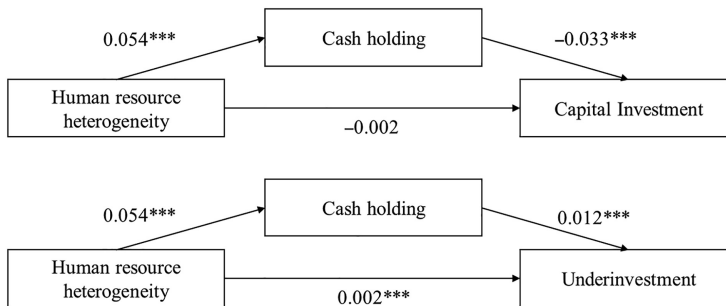


Figure 2.
Path analysis

	(1) <i>Cash</i>		(2) <i>PPEInv</i>		(3) <i>UnderInv</i>	
	Coefficients	z-statistic	Coefficients	z-statistic	Coefficients	z-statistic
<i>Cash</i>			-0.033^{***}	(-13.490)	0.012^{***}	(13.785)
<i>Heter</i>	0.054^{***}	(11.063)	-0.002	(-1.095)	0.002^{***}	(2.671)
<i>Ocf</i>	0.203^{***}	(21.062)	0.105^{***}	(27.197)	-0.023^{***}	(-16.193)
<i>Sdsale</i>	0.168^{***}	(9.120)	-0.058^{***}	(-8.004)	0.003	(1.124)
<i>Lev</i>	-0.241^{***}	(-48.222)	0.024^{***}	(11.820)	0.000	(0.366)
<i>Size</i>	0.000	(0.056)	0.005^{***}	(16.146)	-0.001^{***}	(-7.537)
<i>Btm</i>	-0.015^{***}	(-5.009)	-0.011^{***}	(-9.338)	0.002^{***}	(3.912)
<i>Indcomp</i>	-0.199^{***}	(-10.225)	-0.035^{***}	(-4.575)	0.004	(1.489)
<i>Dual</i>	0.007^{***}	(4.221)	0.004^{***}	(5.493)	-0.000	(-0.264)
<i>Firstshr</i>	0.025^{***}	(5.036)	-0.001	(-0.463)	0.001	(0.986)
<i>Age</i>	-0.001^{***}	(-5.920)	-0.002^{***}	(-31.513)	-0.000^{***}	(-4.855)
<i>Soe</i>	0.004^{**}	(2.394)	-0.003^{***}	(-5.039)	-0.001^{**}	(-2.296)
var(e. <i>Cash</i>)	0.012^{***}	(115.953)				
var(e. <i>PPEInv</i>)			0.002^{***}	(115.953)		
var(e. <i>UnderInv</i>)					0.000^{***}	(115.953)
Constant	0.191^{***}		-0.046^{***}		0.035^{***}	(14.343)
Industry fixed effects	Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes	
Observations	26,890		26,890		26,890	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively

Table 8.
Human resource
heterogeneity and firm
investment: a path
analysis

Table 9.

Human resource
heterogeneity and
value of cash

	(1) ΔRet		(2) ΔRet	
	Coefficients	t-statistic	Coefficients	t-statistic
<i>Heter</i>			0.025	(1.369)
<i>Heter</i> × $\Delta C/M$			0.238	(1.310)
$\Delta C/M$	0.251***	(3.199)	0.444***	(2.772)
$\Delta E/M$	0.907***	(15.593)	0.906***	(15.574)
$\Delta NA/M$	0.104***	(2.941)	0.103***	(2.922)
$\Delta RD/M$	3.316***	(6.851)	3.344***	(6.916)
$\Delta Div/M$	2.575***	(7.337)	2.583***	(7.359)
$\Delta Int/M$	-1.185***	(-2.737)	-1.163***	(-2.676)
<i>Lagged C/M</i>	0.169***	(7.606)	0.169***	(7.592)
<i>Lever</i>	-0.044**	(-2.185)	-0.041**	(-2.058)
<i>NF/M</i>	-0.003	(-0.353)	-0.003	(-0.426)
<i>Lagged C/M</i> × $\Delta C/M$	-0.240	(-1.214)	-0.260	(-1.318)
<i>Lever</i> × $\Delta C/M$	-0.092	(-0.496)	-0.119	(-0.647)
Constant	-0.034	(-1.404)	-0.014	(-0.490)
Industry fixed effects	Yes		Yes	
Year fixed effects	Yes		Yes	
Observations	22,614		22,614	
Adjusted R-squared	0.050		0.051	

Note(s): *, ** and *** represent significance levels of 0.10, 0.05 and 0.01, respectively. OLS regression is adopted and standard errors are clustered at firm level

significant, which further supports the view that high cash holdings caused by heterogeneous human resources limit the firm's ability to invest.

5.2 Human resource heterogeneity and the value of cash holdings

In this subsection, we extend our analysis and provide further evidence on how human resource heterogeneity affects the market's valuation of the firm's cash holdings. On the one hand, the value of cash should be enhanced when firms increase the level of cash holdings to avoid the negative impact of decreased operation flexibility and cope with uncertainty. On the other hand, heterogeneous human resources require high cash holdings, which can diminish the firm's ability to invest the fixed assets, resulting in a lower value of cash.

To examine the effect of human resource heterogeneity on the value of cash holdings, we follow Dittmar and Mahrt-Smith (2007) and use the model as shown in Equation (5), where ΔRet refers to excess stock returns, measured using the difference between annual stock return and its industry average.

$$\begin{aligned}
 \Delta Ret_{i,t} = & \beta_0 + \beta_1 \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_2 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \beta_3 \frac{\Delta NA_{i,t}}{M_{i,t-1}} + \beta_4 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \beta_5 \frac{\Delta Div_{i,t}}{M_{i,t-1}} + \beta_6 \frac{\Delta Int_{i,t}}{M_{i,t-1}} \\
 & + \beta_7 \frac{C_{i,t-1}}{M_{i,t-1}} + \beta_8 Lever_{i,t} + \beta_9 \frac{NF_{i,t}}{M_{i,t-1}} + \beta_{10} \frac{C_{i,t-1}}{M_{i,t-1}} \times \frac{\Delta C_{i,t}}{M_{i,t-1}} + \beta_{11} Lever_{i,t} \times \frac{\Delta C_{i,t}}{M_{i,t-1}} \\
 & + \sum Industry + \sum Year + \varepsilon_{i,t}
 \end{aligned} \tag{5}$$

Table 9 reports the results. In column (1), the coefficient on $\Delta C/M$ is 0.251 and significant at the 1% level, suggesting that the marginal value of cash holdings is positive. In column (2), the coefficient on the interaction term *Heter*× $\Delta C/M$ is 0.238, but statistically insignificant. For firms with heterogenous human resources, high cash reserves increase operational flexibility but limit their capital investment, resulting in no significant increase in the value of cash holdings.

6. Conclusion

Barney (1991) states that the search for sources of sustained competitive advantages must focus on firm resource heterogeneity and immobility. We analyze the impact of human resource heterogeneity on firms' cash holdings. Firms with heterogeneous human resources are more likely to develop sustained competitive advantages but face higher labor adjustment costs. When the firm possesses human resources different from its peers, it has difficulty obtaining employees in the market. It needs to make more specific investments in employees. Thus, the firm should maintain employment at a stable level and avoid adjusting its employees. When the firm experience adverse shocks, it is less likely to reduce operating costs by adjusting employees, leading to lower operating flexibility and more precautionary cash.

Taking Chinese A-share nonfinancial listed firms from 2007 to 2019 as the sample, we construct a proxy for human resource heterogeneity based on the skill structure of employees. Baseline regressions reveal a significantly positive relationship between human resource heterogeneity and firms' cash holdings. We find that this relationship is more pronounced in more labor-intensive firms and firms more vulnerable to hold-up by employees, i.e. firms in regions with more labor disputes and firms surrounded by more external employment opportunities, than in other firms. We further show that high cash reserves caused by human resource heterogeneity constrain firms' capital investment and lead to underinvestment.

Our paper contributes to the literature on the role of employees in firms' financial decisions. We develop a measure of human resource heterogeneity by comparing the employees' skill structure of the firm with its peers in the same industry. Several recent papers examine the effect of labor adjustment costs on firms' financial decisions. They show that high labor adjustment costs reduce the firm's operating flexibility, increase its cost of equity (Chen, Kacperczyk, & Ortiz-Molina, 2011), decrease its use of debt financing (Serfling, 2016) and facilitate the adoption of cost-saving production methods (Bena, Ortiz-Molina, & Simintzi, 2021). We add to this literature by establishing that human resource heterogeneity can be a critical determinant of the firm's financial decisions. Our paper is also related to the literature on hold-up by employees. We show that human resource heterogeneity is more strongly associated with cash holdings at firms more susceptible to hold-up by employees. Taken together, the evidence in our paper suggests that human resource heterogeneity is an additional important factor in firms' cash-holding decisions.

Notes

1. The Chinalawinfo Pkulaw Database, see <https://www.pkulaw.com/payz/cc530e480d4624219980e7551215a74e4b3e0564e7937489bdfb.html?keyword=%E7%AB%9E%E4%B8%9A%E9%99%90%E5%88%B6>.
2. The Chinalawinfo Pkulaw Database, see <https://www.pkulaw.com/payz/cc530e480d4624218a090e17aad52c42fa9f12bd21939bd7bdfb.html?keyword=%E7%AB%9E%E4%B8%9A%E9%99%90%E5%88%B6%20>.

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Appendix 1

Calculation of the cosine similarity in employees' skill structure between the two firms

Firm code	Firm name	Classification of employees' skills					Total number of employees
		Administration	Operations (or production)	Marketing	R&D	Finance	
002058.SZ	Welltech	21	103	51	19	7	201
000541.SZ	FSL Lighting	180	5,825	795	694	47	7,541
Cosine similarity of employees' skill structure = $\frac{H_A H_T}{\ H_A\ \ H_T\ }$							0.937

Appendix 2

Variable definition

Variable	Definition	Calculation
<i>A. Main variables</i>		
<i>Cash</i>	Cash holdings	The sum of cash, marketable securities and short-term investments divided by total assets
<i>Heter</i>	Human resource heterogeneity	We classify employees into six categories based on their skills (administration, operation (or production), marketing, R&D, finance and others), construct a six-dimension human resource vector for each firm, calculate cosine similarity in the skill structure of employees between the firm and its peers within the same industry and year, take the average, and use its opposite as a proxy for human resource heterogeneity
<i>Apay</i>	Salaries per employee	Accrued salaries (in 10,000 yuan) divided by the number of employees
<i>Eduinput</i>	Training costs per employee	The sum of education and labor union expenses (in 10,000 yuan) divided by the number of employees
<i>Laborinten</i>	Labor intensity	The natural logarithm of the number of employees divided by total assets
<i>Perdis</i>	Regional labor disputes	An indicator variable for firms in regions where the number of labor disputes exceeds the annual mean
<i>Rail</i>	External employment opportunities	An indicator variable for a high-speed rail station within 30 km of the firm
<i>B. Control variables</i>		
<i>Ocf</i>	Operating cash flow	Net cash flow from operating activities divided by total assets
<i>Sdsale</i>	Operating risk	The standard deviation of sales revenue for the past eight quarters
<i>Lev</i>	Financial leverage	Interest-bearing liabilities divided by total assets
(continued)		

Variable	Definition	Calculation
<i>Size</i>	Firm size	The natural logarithm of total assets
<i>Btm</i>	Growth opportunities	Book value of equity divided by stock market value
<i>Indcomp</i>	Market competition	The opposite of the Herfindahl–Hirschman index calculated using the sales revenue of listed firms in the same industry
<i>Dual</i>	CEO duality	An indicator variable for the CEO chairing the board
<i>Firstshr</i>	Shareholding by the largest shareholder	The proportion of shares held by the largest shareholder
<i>Age</i>	Firm age	The number of years since listing
<i>Soe</i>	State ownership	An indicator variable for firms controlled by governments above the county level
<i>C. Other variables</i>		
<i>Abovecoll</i>	Education level of the regional population	The proportion of the population with a bachelor's degree or above in the province where the firm is located
<i>Popu</i>	Population density	The natural logarithm of the total population at the end of the year in the province where the firm is located
<i>Rdratio</i>	Proportion of R&D staff	The number of R&D staff divided by the number of employees
<i>Mdasimilar</i>	Management system heterogeneity	The similarity in the text of Management Discussion and Analysis (MD&A) between the firm and its peers within the same industry
<i>IPOHeter</i>	Human resource heterogeneity at the time of the IPO	The dissimilarity in the skill structure of employees between the firm and its peers within the same industry at the time of the IPO
<i>PPEInv</i>	Capital investment	Cash paid for fixed assets scaled by total assets
<i>UnderInv</i>	Underinvestment	We estimate the model in Equation (4) and take the residual for each firm-year. <i>UnderInv</i> takes the absolute of the residual with a negative residual and zero otherwise
ΔRet	Excess stock return	Annual stock return minus average annual stock return in the industry
$\Delta C/M$	Change in cash holdings	Change in cash holdings from year $t-1$ to t divided by the market value of equity at year $t-1$
$\Delta E/M$	Change in earnings before interest and tax	Change in earnings before interest and tax from year $t-1$ to t divided by the market value of equity at year $t-1$
$\Delta NA/M$	Change in net assets	Change in net assets from year $t-1$ to t divided by the market value of equity at year $t-1$
$\Delta RD/M$	Change in R&D expenditures	Change in R&D expenditures from year $t-1$ to t divided by the market value of equity at year $t-1$
$\Delta Div/M$	Change in dividend	Change in dividend from year $t-1$ to t divided by the market value of equity at year $t-1$
$\Delta Int/M$	Change in interest expenses	Change in interest expenses from year $t-1$ to t divided by the market value of equity at year $t-1$
<i>Lever</i>	Total leverage	Total liabilities divided by the sum of total liabilities and market value of equity
<i>NF/M</i>	Net finance	The sum of net new equity issues and net new debt issues divided by the market value of equity at year $t-1$

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