The Journal of FINANCE
The Journal of THE AMERICAN FINANCE ASSOCIATION

THE JOURNAL OF FINANCE • VOL. LXXVI, NO. 1 • FEBRUARY 2021

Inalienable Customer Capital, Corporate Liquidity, and Stock Returns

WINSTON WEI DOU, YAN JI, DAVID REIBSTEIN, and WEI WU*

ABSTRACT

We develop a model in which customer capital depends on key talents' contribution and pure brand recognition. Customer capital guarantees stable demand but is fragile to financial constraints risk if retained mainly by talents, who tend to quit financially constrained firms, damaging customer capital. Using a proprietary, granular brand-perception survey, we construct a firm-level measure of the inalienability of customer capital (ICC) that captures the degree to which customer capital depends on talents. Firms with higher ICC have higher average returns, higher talent turnover, and more precautionary financial policies. The ICC-sorted long-short portfolio's spread comoves with financial constraints factor.

CUSTOMER CAPITAL—CUSTOMERS' BRAND LOYALTY to a firm—is among a firm's most important intangible assets. In particular, customer capital helps stabilize the capacity of demand flows by creating entry barriers and durable advantages over competitors (e.g., Bronnenberg, Dubé, and Gentzkow (2012)).

*Winston Wei Dou and David Reibstein are with University of Pennsylvania. Yan Ji is at Hong Kong University of Science and Technology. Wei Wu is with Texas A&M University. The paper was previously circulated as "Customer Capital, Financial Constraints, and Stock Returns." We are grateful to Wei Xiong (the Editor), an anonymous Associate Editor, and two anonymous referees for constructive suggestions. We thank Hengjie Ai; Markus Baldauf; Frederico Belo; Alex Belyakov; Christa Bouwman; Adrian Buss; Jeffrey Cai; Zhanhui Chen; Will Diamond; Lukasz Drozd; Bernard Dumas; Paolo Fulghieri; Alexandre Garel; Lorenzo Garlappi; Ron Giammarino; Stefano Giglio; Vincent Glode; Itay Goldstein; Naveen Gondhi; Francois Gourio; Jillian Grennan; Po-Hsuan Hsu; Shiyang Huang; Chuan-Yang Hwang; Don Keim; Leonid Kogan; Adam Kolasinski; Doron Levit; Dongmei Li; Kai Li; Xiaoji Lin; Asaf Manela; Neil Morgan; Christian Opp; Pascal Maenhout; Hernan Ortiz-Molina; Carolin Pflueger; Yue Qiu; Adriano Rampini; Nick Roussanov; Leena Rudanko; Dejanir Silva; Alp Simsek; Bruno Solnik; Rob Stambaugh; Roberto Steri; Sheridan Titman; Kumar Venkataraman; Jessica Wachter; Neng Wang; James Weston; Toni Whited; Yu Xu; Jialin Yu; Morad Zekhnini; Lu Zhang; Bart Zhou; John Zhu; as well as seminar participants at HKU, HKUST, INSEAD, NTU, Philadelphia Fed, SMU, Texas A&M, UBC, Wharton, AFA, EFA, CFEA, MFA, NFA, Rising Five-Star Workshop at Columbia, and AMA for their comments. We also thank Michael Sussman, John Gerzema, Anna Blender, and Dami Rosanwo of the BAV Group for sharing the data, and Ed Lebar and Alina Sorescu for guidance on data processing. We thank Dian Yuan, Haowen Dong, and Hezel Gadzikwa for excellent research assistance. Winston Dou is grateful for the financial support of the Rodney L. White Center for Financial Research. The authors do not have conflicts of interest to disclose, as defined in *The Journal of Finance* disclosure policy.

Correspondence: Winston Wei Dou, University of Pennsylvania, 2318 Steinberg Hall-Dietrich Hall, 3620 Locust Walk, Philadelphia, PA 19104; e-mail: wdou@wharton.upenn.edu.

DOI: 10.1111/jofi.12960

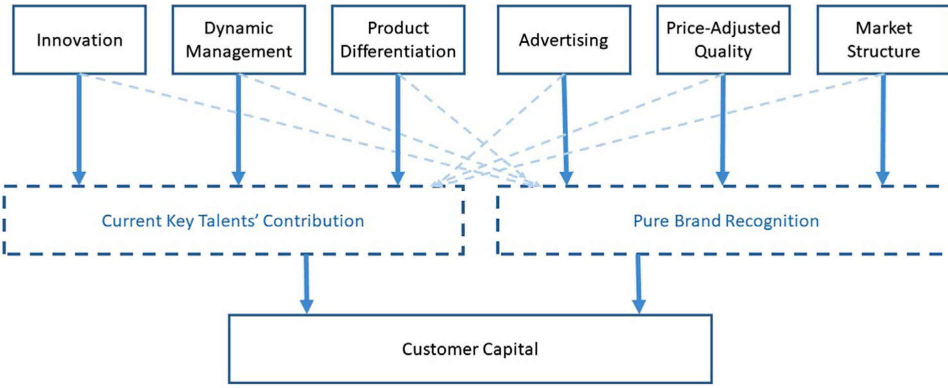

Figure 1. Different channels of developing and maintaining customer capital. The solid arrows represent primary channels, whereas the dashed arrows represent secondary channels. (Color figure can be viewed at wileyonlinelibrary.com)

Thus, while it does not appear on the balance sheet explicitly, developing and maintaining customer capital is essential for a firm's survival, growth, profitability, and ultimately valuation.[1] However, little is known about how customer capital systematically affects stock prices or which primitive forces shape the relationship between customer capital and stock returns.

In this paper, we study the asset pricing implications of the interaction between financial constraints and the *inalienability of customer capital* (*ICC*), that is, the extent to which a firm's customer capital depends on key talents. We show that the ICC is priced in the cross section because firms differ in their exposure to aggregate financial constraints shocks. One prominent example of financial constraints shocks is shocks to external financing costs (e.g., Bolton, Chen, and Wang (2013), Gilchrist et al. (2017), Belo, Lin, and Yang (2019)).

Conceptually, customer capital is a synthesis of various intangible assets. Figure 1 shows that developing and maintaining customer capital depends on innovation, dynamic management, and product differentiation, primarily through the unique contribution of current key talents, as well as on advertising, price-adjusted product quality, and market structure, primarily through pure brand recognition. Firms whose customer capital depends more on the unique contribution of current key talents than on pure brand recognition are more exposed to financial constraints risk because when firms are financially constrained, key talents are likely to leave, damaging the firm's associated customer capital. Retaining key talents imposes operating leverage on firms. By contrast, pure brand recognition is largely immune to key talent turnover. Thus, during periods of heightened financial constraints risk, firms whose customer capital is more talent-dependent suffer more because (i) they are more

[1] As Rudanko (2017) emphasizes, customer capital is crucial for the other assets of a firm to be profitable. One example demonstrating the necessity of customer capital is the well-known bankruptcy of Iridium due to its failure to develop and maintain customer capital.

likely to experience key talent turnover due to higher operating leverage and (ii) they tend to lose a larger fraction of customer capital upon the departure of key talents due to the greater dependence of customer capital on key talents. Such heterogeneous exposure to financial constraints risk is further amplified in a feedback loop because the loss of customer capital reduces future revenue.

The concept of the ICC is built on the notion proposed by Hart and Moore (1994) and Bolton, Wang, and Yang (2019b) that human capital is inalienable; that is, a firm's capital becomes less profitable or can be (partially) taken away by key talents when they depart, in other words, key talents cannot be replaced without cost. Unlike physical capital or other types of intangible capital, such as patents, customer capital that relies heavily on the unique contribution of current key talents can be taken away or seriously reduced with their departure because of limited legal enforceability. The ICC can therefore be viewed as one concrete and important example of the inalienability of human capital.[2]

Our major contribution lies in examining how the ICC interacts with financial constraints and investigating the asset pricing implications of this interaction. Like Whited and Wu (2006) and Buehlmaier and Whited (2018), we focus on aggregate financial constraints shocks, which impact the marginal value of internal funds of all firms simultaneously. Such shocks have been shown to carry a negative market price of risk (e.g., Whited and Wu (2006), Buehlmaier and Whited (2018)). As our main theoretical contribution, we show that firms' exposure to financial constraints shocks is simultaneously reflected in two cross sections: firms have higher liquidity-driven talent turnover and higher average returns if (i) their customer capital is more talent-dependent (i.e., higher ICC) and (ii) they are more financially constrained. The cross-equation restrictions implied by the model predictions on both turnover and returns in the two cross sections overidentify the same asset pricing factor, namely, the financial constraints factor. Such overidentification makes our model more quantitatively disciplined. The empirical analyses rely on measuring the ICC, which is challenging. As our main empirical contribution, we introduce a measure of the ICC that is based on a proprietary, granular brand perception survey database. Using this measure, we provide empirical evidence that strongly supports the theoretical predictions.

We start by developing a dynamic model to illustrate the key underlying mechanism. A firm's external financing is costly, which motivates retained earnings and imposes financial constraints risk on the firm. The marginal value of its internal funds is determined jointly by the endogenous level of firm-specific cash holdings, the endogenous level of the ICC, and the exogenous level of financial constraints risk. The latter is time-varying and driven by aggregate shocks to financing costs. Such shocks are referred to as *financial constraints shocks* and are the only systematic shocks in the model. Customer capital guarantees stable demand flows and is maintained in part by key

[2] The ICC is also linked to other types of inalienable capital associated with key talents, such as their social capital (e.g., Arrow (1999), Glaeser et al. (1999), Durlauf (2002), Sobel (2002), Durlauf and Fafchamps (2005)).

talents. The contract between key talents and shareholders features two-sided limited commitment. On the one hand, key talents have outside options and limited commitment to the firm, and thus maintaining talent-dependent customer capital requires that the firm compensates such talents, which increases the firm's operating leverage. On the other hand, shareholders will choose to let key talents go if retaining them becomes too costly. Thus, heterogeneous levels of the ICC lead to different exposures to aggregate financial constraints shocks, which lead in turn to spreads in both (risk-adjusted) average stock returns and talent turnover rates.

More precisely, shareholders face an intertemporal trade-off between risk and returns when deciding whether to retain talent-dependent customer capital. Although retaining talent-dependent customer capital normally brings positive net cash flows, the associated operating leverage increases firms' exposure to financial constraints risk. When firms' financial constraints are tightened, key talents may find it optimal to *escape from a sinking ship* or *jump to a safer boat* so to speak (e.g., Brown and Matsa (2016), Babina (2020), Baghai et al. (2017)).[3] Alternatively, the firm may find it optimal to reduce operating leverage by replacing incumbent talents with less-cash-compensated new talents (e.g., Gilson and Vetsuypens (1993)). Thus, customer capital is less sensitive to financial constraints risk if it depends more on customers' pure brand recognition while it is more sensitive to financial constraints risk if the contribution of current key talents is essential because the effective cost of compensation increases with the marginal value of the firm's internal funds. Equilibrium liquidity-driven talent turnover due to financial constraints, which is commonly observed in the data, is the key to our model's mechanism. By contrast, there is no turnover in equilibrium in standard models of inalienable human capital, such as those of Hart and Moore (1994), Lustig, Syverson, and Nieuwerburgh (2011), Eisfeldt and Papanikolaou (2013), and Bolton, Wang, and Yang (2019b).

After illustrating the key mechanisms, we formally test the model's empirical implications. The main empirical challenge lies in finding high-quality data on consumers' brand loyalty and talent dependence that are measured in a consistent way across firms. We tackle this challenge by constructing a measure of the degree to which customer capital depends on talents that is based on a proprietary, granular brand perception survey database. The database, provided by the BAV Group, is regarded as the world's most comprehensive database of consumer brand perception.

The talent dependence of customer capital is reflected by the extent to which brand loyalty is associated with a firm's key talents. The BAV consumer survey data directly quantify a firm's general brand loyalty and its specific components. In particular, the BAV Group has developed two major brand metrics:

[3] Babina (2020) provides several pieces of evidence consistent with our model's predictions. First, employees' exit rates are higher in distressed firms. Second, employees exiting distressed firms earn higher wages prior to exit than employees exiting nondistressed firms. Third, the turnover rate of employees exiting distressed firms is greater in states with weaker enforcement of noncompete agreements.

brand stature and *brand strength*. Brand stature quantifies a firm's brand loyalty in general, whereas brand strength quantifies brand loyalty associated with key talents, mainly through product innovativeness and management efficiency. We use the ratio of brand stature and brand strength to capture the talent dependence of customer capital (i.e., the ICC). We emphasize that while the ICC can endogenously affect the extent to which a firm is financially constrained (i.e., the marginal value of internal funds), our survey-based ICC measure is not designed to be an empirical measure of financial constraints like those developed by Whited and Wu (2006) and Buehlmaier and Whited (2018), who aim to capture different underlying economic concepts.

To justify the connection between our survey-based ICC measure and its counterpart in the model, that is, the talent dependence of customer capital, we need to show that our empirical ICC measure can capture three major properties of its theoretical counterpart in our model: (i) firms whose talents play a more important role have a higher ICC, (ii) firms with a higher ICC tend to lose a larger fraction of customer capital upon talent turnover, and (iii) firms' customer capital becomes less talent-dependent (i.e., the ICC declines) upon talent turnover. We provide direct evidence that our survey-based ICC measure satisfies all three properties.

We present two main sets of empirical results to support our model. First, we show that firms with a higher ICC have higher average (risk-adjusted) excess returns. The ICC spread is persistent around the time of portfolio formation and is robust to controlling for various measures of customer capital, intangible assets, and industry classifications. Moreover, the ICC spread remains significantly positive even after controlling for research and development (R&D) measures using Fama-MacBeth regressions. We further show that the ICC spread is highly correlated with the financial constraints factor constructed based on the two financial constraint measures of Whited and Wu (2006) and Buehlmaier and Whited (2018), suggesting that the ICC spread largely captures the same financial constraints risk. The strong comovement between the ICC spread and the financial constraints factor convincingly supports the main channel of our theory—the interaction between the ICC and financial constraints. Second, we show that firms with a higher ICC are associated with a higher talent turnover rate, a finding that holds for both executives and innovators. Moreover, the positive relationship between the ICC and the talent turnover rate is more pronounced in periods of heightened financial constraints risk and in states with weaker enforcement of noncompete agreements.

Finally, we extend the model by incorporating three additional ingredients into the quantitative analyses: (i) an aggregate productivity shock, to allow for multiple asset pricing factors and in turn better data matching, (ii) a firm-specific shock to the ICC, to match a more realistic cross-sectional distribution of talent compensation in the data, and (iii) nonpecuniary private benefits to the key talents working for firms with prestigious brands. Our calibrated extended model can quantitatively explain the joint patterns in talent turnover and stock returns. The model also allows us to investigate the economic importance of each mechanism. The analyses indicate that the interaction between the ICC and financial constraints is crucial for generating the differential exposure to financial constraints risk. The absence of either one makes it impossible for the model and the data to reconcile.

Related Literature

Our paper is related to the large literature on cross-sectional stock returns (e.g., Cochrane (1991), Berk, Green, and Naik (1999), Gomes, Kogan, and Zhang (2003), Nagel (2005), Zhang (2005), Belo and Lin (2012), Eisfeldt and Papanikolaou (2013), Ai and Kiku (2013), Ai, Croce, and Li (2013), Belo, Lin, and Bazdresch (2014), Kogan and Papanikolaou (2014), Kumar and Li (2016), Belo et al. (2017), Dou, Ji, and Wu (2020b)), and in particular, on the cross-sectional asset pricing implications of financial distress (e.g., Campbell, Hilscher, and Szilagyi (2008), Garlappi, Shu, and Yan (2008), Gomes and Schmid (2010), Garlappi and Yan (2011), Chen et al. (2020)) and financial constraints (e.g., Gomes, Yaron, and Zhang (2006), Whited and Wu (2006), Li (2011), Ai et al. (2020), Buehlmaier and Whited (2018)). Unlike most papers in this literature, however, we study the asset pricing implications of financial constraints in a dynamic model in which corporate liquidity is a crucial state variable. Indeed, corporate finance research increasingly emphasizes the importance of corporate liquidity (or cash holdings) as a state variable in dynamic structural corporate models (e.g., Bolton, Chen, and Wang (2011, 2013), Bolton, Wang, and Yang (2019a, b)). This emphasis is motivated by empirical evidence showing that cash holdings are often large. But, a more important reason is that liquidity management is crucial for corporate entities. However, the importance of corporate liquidity (as a state variable) is not as well appreciated in the asset pricing literature as it perhaps should be. Exceptions include Livdan, Sapriza, and Zhang (2009) and Belo, Lin, and Yang (2019), who use retained earnings (negative debt) as a state variable and quantitatively study the asset pricing implications of financial constraints, but they do not examine the interaction between financial constraints and the ICC. Our paper aims to fill this gap. More precisely, we contribute to the literature by shedding light on firms' heterogeneous exposure to financial constraints shocks through their different levels of the ICC. Moreover, our model simultaneously generates asset pricing implications of financial constraints shocks for two different cross sections—the ICC and corporate liquidity (i.e., the marginal value of internal funds).

Our paper contributes to the emerging literature on the interaction between customer capital and finance. Titman (1984) and Titman and Wessels (1988) provide the first theoretical insights into and empirical evidence on the interaction between a firm's financial and product market characteristics. A large body of research examines how financial characteristics influence firm performance and decisions in the product market (e.g., Chevalier and Scharfstein (1996), Fresard (2010), Phillips and Sertsios (2013), Gourio and Rudanko (2014), Gilchrist et al. (2017), D'Acunto et al. (2018)), whereas only a few papers focus on the implications of product market characteristics for valuation and various corporate policies (e.g., Dumas (1989), Banerjee, Dasgupta, and Kim (2008), Larkin (2013), Belo, Lin, and Vitorino (2014), Gourio and Rudanko (2014), Vitorino (2014), Dou and Ji (2020), Dou, Ji, and Wu (2020a)). We depart from existing literature by investigating the financial implications of the ICC.

Our paper is related to the literature on inalienable human capital dating back to Hart and Moore (1994). Human capital is embodied in a firm's key talents, who have the option to walk away. Thus, shareholders are exposed to the risk inherent in the limited commitment of key talents. The talent-dependent customer capital that we investigate provides one of the most concrete and convincing examples of inalienable human capital. Lustig, Syverson, and Nieuwerburgh (2011) develop a model of optimal compensation to managers who are unable to commit to staying with a firm. Eisfeldt and Papanikolaou (2013) show that firms with more organization capital are riskier because of their greater exposure to frontier technology shocks. Berk, Stanton, and Zechner (2010) develop a model with entrenched employees under long-term optimal labor contracts to analyze the implications of these employees for the optimal capital structure. Their model focuses on entrenched workers who cannot be fired by firms and thus are overpaid. Our theory is related to the work of Bolton, Wang, and Yang (2019b), who analyze the implications of inalienable human capital on corporate credit limits, the idiosyncratic risk exposure of talents, and liquidity and risk management in a long-term optimal contracting framework. In the model of Bolton, Wang, and Yang (2019b), inalienable human capital endogenously creates financial constraints and makes the marginal value of internal funds increase nonlinearly as internal liquidity dries up. Similarly, in our model the ICC endogenously affects the extent to which a firm is financially constrained, though we do not endogenize financial constraints. Different from Bolton, Wang, and Yang (2019b), our model highlights the operating leverage effect imposed by the ICC in models with financial constraints and the resulting asset pricing implications.[4]

The inalienability of human capital essentially arises from limited commitment. Accordingly, our paper is also related to the optimal contracting problem with limited commitment (e.g., Alvarez and Jermann (2000, 2001), Albuquerque and Hopenhayn (2004), Rampini and Viswanathan (2013), Ai and Li (2015), Ai and Bhandari (2018), Bolton, Wang, and Yang (2019b)). Several papers in this literature study the asset pricing implications of limited commitment. For example, Alvarez and Jermann (2000, 2001) study its asset pricing implications in an incomplete market model with one-sided limited commitment. Recently, Ai and Bhandari (2018) provide a unified view of labor market

[4] Eisfeldt and Rampini (2008) propose a model of talent turnover that differs from ours in two ways. First, in their model, managers are compensated to overcome moral hazard. Second, they focus on aggregate turnover patterns over the business cycle instead of cross-sectional turnover patterns. Extending our model to a general equilibrium framework to analyze aggregate turnover is an interesting direction for future research.

risk and asset prices in a general equilibrium model with two-sided limited commitment and moral hazard. Our paper is related to theirs in that both papers emphasize that higher labor compensation effectively leads to higher operating leverage, which generates cross-sectional asset pricing implications. Our model adopts a different perspective, however, by emphasizing compensation to key talents due to the ICC. Moreover, we show that the presence of financial constraints risk amplifies the operating leverage channel, generating significant asset pricing implications in the cross section.

Because the ICC reflects firms' operating leverage due to their dependence on key talents, our paper is also related to the literature on operating leverage and stock returns (e.g., Hamada (1972), Rubinstein (1973), Lev (1974), Mandelker and Rhee (1984), Carlson, Fisher, and Giammarino (2004), Novy-Marx (2011), Favilukis and Lin (2016a, b), Donangelo et al. (2019), Favilukis, Lin, and Zhao (2020)). We find that our ICC measure is negatively correlated with six existing measures of operating leverage, which mainly capture labor costs for ordinary employees. The operating leverage imposed by the ICC mainly amplifies financial constraints shocks. By contrast, the operating leverage imposed by labor costs for ordinary employees mainly amplifies productivity or demand shocks (e.g., Carlson, Fisher, and Giammarino (2004), Favilukis and Lin (2016a, b), Donangelo et al. (2019), Favilukis, Lin, and Zhao (2020)), and the spreads of the long-short portfolios sorted on these operating leverage measures are not correlated with the financial constraints factor.

Finally, our paper is related to the growing literature on the intersection of marketing and finance. The BAV survey database is the standard data source for measuring brand value (e.g., Gerzema and Lebar (2008), Keller (2008), Mizik and Jacobson (2008), Aaker (2012), Lovett, Peres, and Shachar (2014), Tavassoli, Sorescu, and Chandy (2014)). Our study adds to this strand of literature by examining the channels for maintaining customer capital and providing new predictions on the effect of customer capital on asset prices and talent turnover.

The rest of the paper proceeds as follows. In Section I, we present the baseline model for the interaction between the ICC and financial constraints, and we develop the main intuition for the effect of the interaction on the joint patterns of stock returns and talent turnover in the cross section. In Section II, we use a comprehensive database of consumers' perception of brands to measure customer capital and the ICC. We further show that our survey-based ICC measure satisfies the key properties of its theoretical counterpart. In Section III, we empirically test the joint cross-sectional implications of the ICC on stock returns and talent turnover. In Section IV, we extend the baseline model by adding three additional ingredients and we conduct quantitative analyses. Finally, Section V concludes.

I. Model

In this section, we develop an asset pricing model of heterogeneous firms to explain the interaction between the ICC and financial constraints, as well as its role in determining the joint patterns of asset pricing and talent turnover. Importantly, we show that the heterogeneous exposure to aggregate financial constraints shocks is simultaneously reflected in the cross sections of the ICC and of the extent to which firms are financially constrained. Below, we first introduce the model ingredients in Sections I.A to I.C. We then describe the firm's optimization problem in detail in Section I.D. We discuss key model assumptions in Section I.E. We develop the model's basic mechanisms and main predictions in Section I.F.

A. Basic Environment

A.1. Firms and Agents

A continuum of firms and agents exists in the economy. Agents purchase goods as consumers and fund firms by holding equity as shareholders. Some agents also act as talents who manage firms. We assume that agents can trade a complete set of contingent claims on consumption, and that a representative agent owns the equity and consumes the goods of all firms. The representative agent is exposed only to aggregate shocks. We omit firm subscripts for simplicity.

A.2. Supply and Demand

All firms have the same AK production technology with productivity e^a, and produce a flow of goods over $[t, t + \mathrm{d}t]$ with intensity $Y_t = e^a K_t$. The goods are perishable, and thus firms cannot build up inventories.

Instantaneous demand capacity $B_t \mathrm{d}t$ over $[t, t + \mathrm{d}t]$ depends on the firm's customer capital B_t, which can be thought of as a measure of the firm's existing customer base at time t. The amount of goods sold by the firm is $S_t \mathrm{d}t$ over $[t, t + \mathrm{d}t]$. Naturally, $S_t \le Y_t$ and $S_t \le B_t$, which capture the fact that total sales cannot exceed production output Y_t or demand capacity B_t as in Gourio and Rudanko (2014). In equilibrium, sales are equal to

$$S_t = \min(Y_t, B_t). \tag{1}$$

This does not mean that customer capital B_t is a production input or that the production technology is Leontief. The production technology is still AK with physical capital K_t as the only input. Rather, equation (1) simply implies that sales cannot exceed the smaller value between consumer demand and the firm's production, and that firms sell as much as possible.

To keep the model manageable, we assume that firms rent physical capital K_t from a capital rental market at competitive rental rate $r + \delta_K$, where r is the risk-free rate and δ_K is the rate of physical capital depreciation. In other words, firms do not own physical capital K_t and hence K_t is a decision variable that is chosen freely by the firm at time t rather than a state variable. Under our benchmark calibration in which $(r + \delta_K)/p \le e^a$, it is optimal for the firm to produce and match demand capacity by employing physical capital $K_t = B_t/e^a$.

Thus, all firms produce and sell up to the short-run demand capacity $S_t = Y_t = B_t$, and firm size is determined essentially by the firm's customer capital B_t. As we show in Section I.D, by exploiting the homogeneity of B_t, we can reduce the dimensionality of the firm's optimization problem. This modeling approach is inspired by Bolton, Chen, and Wang (2011), who exploit the homogeneity of firm size, which is measured by physical capital K_t in their model.

A.3. Customer Capital Growth

In contrast to physical capital K_t, customer capital B_t is owned by the firm. The firm hires i_t sales representatives to build new customer capital at convex costs $\phi(i_t)B_t\mathrm{d}t$ over $[t, t + \mathrm{d}t]$, with the adjustment cost function being

$$\phi(i_t) = \alpha i_t^{\eta}, \quad \alpha > 0, \eta > 1. \tag{2}$$

The evolution of customer capital B_t is given by

$$\mathrm{d}B_t = (\psi i_t - \delta_B)B_t\mathrm{d}t, \tag{3}$$

where δ_B is the rate of depreciation of customer capital.[5] Equation (3) implies that the firm can grow customer capital faster by hiring more sales representatives. The coefficient ψ captures the effective search-matching efficiency in the product market.

A.4. Cash Flow Shock

The firm faces firm-level idiosyncratic operating cash flow shocks over the next instant $\mathrm{d}t$,

$$\mathrm{d}C_t = \underbrace{\sigma_c B_t \mathrm{d}Z_{c,t}}_{\text{Brownian shocks}} - \underbrace{f B_t \mathrm{d}M_t,}_{\text{jump shocks}} \tag{4}$$

where $Z_{c,t}$ is a standard Brownian motion capturing small idiosyncratic cash flow shocks, and M_t is a firm-specific Poisson process capturing idiosyncratic negative jump shocks with proportional jump size $f > 0$ and constant intensity ξ. These negative jump shocks are introduced to capture the firm-specific tail risk. We assume that idiosyncratic cash flow shocks are proportional to firm size (e.g., DeMarzo and Sannikov (2006), Bloom (2009), Bolton, Chen, and Wang (2011), DeMarzo et al. (2012)). This specification ensures that firms cannot grow out of the exposure to idiosyncratic risks, and is consistent with the

[5] In Internet Appendix Section I.A, we derive equation (3) as the equilibrium representation in a search-matching model. The Internet Appendix is available in the online version of this article on *The Journal of Finance* website.

empirical fact that the idiosyncratic component of changes in a firm's sales is roughly proportional to firm size.

A.5. Financial Constraints Shock

We assume that the firm has access to the equity market but not the corporate debt market.[6] The firm has the option to pay out dividends or issue equity to finance expenses. The financing cost includes a fixed cost γ_t that is proportional to firm size and a variable cost φ proportional to the amount of equity issued. Thus, the deadweight loss to shareholders of raising funds W for a firm of size B is

$$\Phi_t(W; B) \equiv \underbrace{\gamma_t B}_{\text{fixed cost}} + \underbrace{\varphi W.}_{\text{variable cost}} \tag{5}$$

The modeling of fixed and variable equity financing costs follows the literature (e.g., Gomes (2001), Riddick and Whited (2009), Gomes and Schmid (2010), Bolton, Chen, and Wang (2011), Eisfeldt and Muir (2016)). The idea is simple: external funds are not perfect substitutes for internal funds.

Financial constraints motivate the firm to hoard cash W_t on its balance sheet. However, holding cash incurs the cost arising from tax distortions as well as the agency cost associated with free cash in the firm.[7] We assume that the return from cash is the risk-free rate r minus carrying cost $\rho > 0$. The carrying cost of cash implies that the firm pays out dividends when cash holdings W_t are high. In our model, cash holdings capture all of the internal liquid funds held by the firm.

Following Bolton, Chen, and Wang (2013), we capture changes in economy-wide financial constraints risk using a time-varying fixed financing cost γ_t.[8] A higher marginal value of internal funds can result from a tightened supply of funding liquidity due to financial sector dysfunction (e.g., Gilchrist and Zakrajšek (2012), Jermann and Quadrini (2012), Bolton, Chen, and Wang (2013), Iyer et al. (2014), Gilchrist et al. (2017)). In particular, Schularick and Taylor (2012) and Baron and Xiong (2017) show that credit expansions can predict a subsequent banking crisis/equity value crash and financial system dysfunction. All else equal, a higher γ_t increases the marginal value of internal funds for all firms, albeit by different amounts depending on their ICC and liquidity

[6] This assumption is innocuous for our purposes because we focus on the endogenous time-varying marginal value of internal funds. This simplification captures the main idea while maintaining tractability.

[7] The interest earned by the firm on its cash holdings is taxed at the corporate tax rate, which is generally higher than the personal tax rate on interest income (e.g., Graham (2000), Faulkender and Wang (2006), Riddick and Whited (2009)).

[8] We keep the variable financing cost φ constant for simplicity, as making it move together with γ_t would amplify the quantitative implications. Gilchrist et al. (2017) model shocks only to the variable financing cost. Belo, Lin, and Yang (2019) model shocks to both the fixed and variable financing costs. Like our model, Bolton, Chen, and Wang (2013) and Alfaro, Bloom, and Lin (2018) model shocks only to the fixed financing cost.

condition.[9] In this paper, we refer to the aggregate shocks to financing cost γ_t as *financial constraints shocks*.

In particular, we assume that the financing cost γ_t follows a two-state Markov process on $\{\gamma_L, \gamma_H\}$, where $0 \leq \gamma_L < \gamma_H$. The transition intensity from γ_L to γ_H is q_L, and that from γ_H to γ_L is q_H. The aggregate transition processes are denoted by $N_{L,t}$ for the jump from γ_L to γ_H and $N_{H,t}$ for the jump from γ_H to γ_L. The law of motion for γ_t can be described as

$$\mathrm{d}\gamma_t = \sum_{x:\gamma_x=\gamma_t} (\gamma_{-x} - \gamma_x)\mathrm{d}N_{x,t}, \tag{6}$$

where the notation "$-x$ "represents the state different from "x" in $\{H, L\}$.

A.6. Pricing Kernel

Because the market is complete, only aggregate shocks are priced. In the baseline model, the only aggregate shocks are financial constraints shocks. We assume that financial constraints shocks carry a negative market price of risk because prior empirical findings suggest that financial constraints shocks are negatively priced by investors (e.g., Whited and Wu (2006), Buehlmaier and Whited (2018)). We therefore assume that the representative agent's state-price density Λ_t evolves according to

$$\frac{\mathrm{d}\Lambda_t}{\Lambda_t} = -r\mathrm{d}t + \sum_{x:\gamma_x=\gamma_t} \underbrace{(e^{-\kappa_x} - 1)}_{\text{market price of risk}} \underbrace{(\mathrm{d}N_{x,t} - q_x\mathrm{d}t)}_{\text{financial shock}}. \tag{7}$$

The market price of risk for financial constraints shocks is constant and specified exogenously, and is captured by κ_x, where $x \in \{H, L\}$. We assume that $\kappa_L < 0$ and $\kappa_H > 0$ which imply that an increase in financing costs raises the state-price density and thus financial constraints shocks are negatively priced.

B. Inalienability of Customer Capital

An essential feature of customer capital is its inalienability due to its dependence on the unique human capital of key talents, including their skills, knowledge, connections, reputation, and so on. Shareholders have the option to fire key talents, and key talents have the option to leave the firm and start their own business.[10] We assume that a fraction $\tau_t \in (0, 1)$ of a firm's customer capital B_t can be affected by talent turnover. That is, τ_t captures the degree

[9] Higher financing costs can also result from excessive demand for funding liquidity, when firms are eager to invest aggressively (e.g., Gomes, Yaron, and Zhang (2006), Riddick and Whited (2009)). The incentive for making such investments is especially large under the displacement risk imposed by peer innovations (e.g., Kogan et al. (2017)). In Internet Appendix Section I.B, we develop a simple framework to show that a higher marginal value of internal funds can also be driven by other primitive shocks such as investment shocks and uncertainty shocks.

[10] For simplicity, our contracting framework does not incorporate moral hazard (e.g., Holmstrom (1979), Holmstrom and Milgrom (1987)) or managerial short termism (e.g., Stein (1988),

to which customer capital depends on key talents. We refer to $\tau_t B_t$ as talent-dependent customer capital. By definition, τ_t is the firm's ICC at time t because it reflects the fragility of customer capital to key talent turnover.

More precisely, when key talents leave, they take away $m\tau_t B_t$ of a firm's customer capital, where the parameter $m \in (0, 1)$ captures the damage rate of talent-dependent customer capital due to turnover. If turnover occurs over the period $[t, t + \mathrm{d}t]$, the remaining customer capital is $(1 - m\tau_t)B_t = B_t - m\tau_t B_t$, where $(1 - m)\tau_t B_t = \tau_t B_t - m\tau_t B_t$ is maintained by a different group of key talents.[11] Thus, τ_t jumps to $(1 - m)\tau_t/(1 - m\tau_t)$ immediately after turnover. Assume that $\ln \tau_t$ is mean-reverting and follows

$$\mathrm{d}\ln \tau_t = \mu_\tau(\ln \tau_t - \ln \overline{\tau})\mathrm{d}t + \underbrace{\left[\ln(1 - m) - \ln(1 - m\tau_t)\right]\mathrm{d}J_t}_{\text{endogenous turnover } < 0}, \tag{8}$$

where $\mathrm{d}J_t$ represents the talent turnover event, which is firm-specific and determined endogenously in equilibrium, that is, the process J_t jumps up by one ($\mathrm{d}J_t = 1$) over $[t, t + \mathrm{d}t]$ if talent turnover occurs during this period. Because the endogenous jump is always negative, the evolution process ensures that $\ln \tau_t$ remains negative forever and that τ_t fluctuates within $(0, 1)$.

C. Liquidity-Driven Turnover

C.1. Long-Term Contracts

Shareholders compensate key talents according to long-term contracts. Key talents have the option to leave the firm and start a new firm, and shareholders have the option to replace key talents. Key talents are well diversified and do not bear idiosyncratic risks—they are diffused shareholders.[12]

Upon exiting a firm, key talents create a new firm with customer capital

$$B_t^{\text{new}} = (m + \ell)\tau_t B_t, \tag{9}$$

where $m\tau_t B_t$ is the customer capital taken away from the original firm and $\ell\tau_t B_t$ is the new customer capital created by the new firm.

Customer capital B_t^{new} alone cannot generate profits. The new firm needs cash to operate, and thus it issues equity to diffused shareholders. All atomistic

Stein (1989), Shleifer and Vishny (1990), Bolton, Scheinkman, and Xiong (2006)). Evaluating the asset pricing implications of their interactions with customer capital is an interesting topic for future research.

[11] One interpretation is that when key talents leave, the firm promotes or hires new talents to manage talent-based customer capital $\tau_t B_t$. However, only a fraction of the previous talent-based customer capital $(1 - m)\tau_t B_t$ is retained because the new talents are not as efficient as those who left for reasons including lack of synergy, experience, and/or recognition. Importantly, newly promoted talents are less costly to maintain.

[12] This assumption is different from what is typically assumed in existing models with human capital inalienability. For example, Bolton, Wang, and Yang (2019b) emphasize that talents (entrepreneurs) are underdiversified with respect to idiosyncratic risks because they are unable to trade securities on their own.

agents, including key talents, are shareholders. Key talents have no incentives to retain a nondiversified equity position in the new firm, so the new firm is sold to diffused shareholders in its entirety. Thus, the new firm's valuation, which determines the value of outside options for key talents, is based on the state-price density Λ_t of all diffused shareholders (or the representative agent).

Let $V(W_t, B_t, \tau_t, \gamma_t)$ denote a generic firm's value with firm-specific cash holdings W_t, customer capital B_t, and ICC τ_t in aggregate state γ_t. Immediately after key talents create a new firm, they and other diffused shareholders work together to raise funds with optimal financing W^* for the new firm to maximize its value,

$$V_{\text{new}}\left(B_t, \tau_t, \gamma_t\right) = \max_W \underbrace{\left[V\left(W, B_t^{\text{new}}, \bar{\tau}, \gamma_t\right) - W\right]}_{\text{enterprise value}} - \underbrace{\Phi_t\left(W; B_t^{\text{new}}\right)}_{\text{deadweight loss}}, \tag{10}$$

where $\overline{\tau}$ is the dependence of the new firm's customer capital on key talents (i.e., the ICC),[13] $B_t^{\text{new}} = (m+\ell)\tau_t B_t$ is the new firm's customer capital defined in equation (9), and $V_{\text{new}}(B_t, \tau_t, \gamma_t)$ is the market value of the firm newly created by key talents if they leave the existing firm whose customer capital is B_t. We assume that key talents do not bear financing costs and thus can gain the enterprise value of the optimally financed firm, $V(W^*, B_t^{\text{new}}, \overline{\tau}, \gamma_t) - W^*$, which according to equation (10) equals $V_{\text{new}}(B_t, \tau_t, \gamma_t) + \Phi_t(W^*; B_t^{\text{new}})$.[14]

The value of the outside option for key talents is

$$V^O(B_t, \tau_t, \gamma_t) = V(W^*, B_t^{\text{new}}, \overline{\tau}, \gamma_t) - W^*. \tag{11}$$

In equilibrium, the promised utility, denoted by $U(B_t, \tau_t, \gamma_t)$, equals the value of outside options for key talents $V^O(B_t, \tau_t, \gamma_t)$ in all states of the world as long as key talents stay in the existing firm. This is because shareholders have no reason to promise more in our model, given that key talents have no bargaining power. In other words, the participation constraint of key talents is

$$U\left(B_t, \tau_t, \gamma_t\right) = V^O\left(B_t, \tau_t, \gamma_t\right), \text{ for all } B_t, \tau_t, \gamma_t. \tag{12}$$

Shareholders can implement the promised utility of key talents by promising key talents a payment of $\Gamma_t \mathrm{d}t$ over $[t, t+\mathrm{d}t]$ as long as the latter continues to work for the firm. Hence, the promised utility of key talents equals the present value of compensation over the period for which key talents remain in the existing firm plus the option value of leaving the existing firm and starting a new one,

$$U(B_t, \tau_t, \gamma_t) = \underbrace{\mathbb{E}_t\left[\int_t^{\tilde{t}} \frac{\Lambda_s}{\Lambda_t} \Gamma_s \mathrm{d}s\right]}_{\text{present value of compensation}} + \underbrace{\mathbb{E}_t\left[\frac{\Lambda_{\tilde{t}}}{\Lambda_t} V^O(B_{\tilde{t}}, \tau_{\tilde{t}}, \gamma_{\tilde{t}})\right]}_{\text{option value of starting a new firm}}, \tag{13}$$

[13] We assume that the ICC of a new firm is the mean-reverting value $\overline{\tau}$.

[14] This assumption is also adopted explicitly or implicitly by other models with financial constraints (e.g., Bolton, Chen, and Wang (2011, 2013)).

where $\tilde{t}$ is the time when key talents depart.

Based on equations (12) and (13), we have $U(B_t, \tau_t, \gamma_t) = \mathbb{E}_t[\int_t^\infty \frac{\Lambda_s}{\Lambda_t}\Gamma_s \mathrm{d}s]$, so we can solve explicitly for the compensation to key talents Γ_t. Intuitively, the requirement that the promised utility of key talents equals their outside option in all states of the economy (see equation (12)) pins down $U(B_t, \tau_t, \gamma_t)$ and $U(B_{t+dt}, \tau_{t+dt}, \gamma_{t+dt})$. Shareholders then compensate key talents as follows to ensure that promises are kept:

$$U(B_t, \tau_t, \gamma_t) = \Gamma_t \mathrm{d}t + \mathbb{E}_t\left[\frac{\Lambda_{t+dt}}{\Lambda_t} U(B_{t+dt}, \tau_{t+dt}, \gamma_{t+dt})\right]. \tag{14}$$

The intuitive promise-keeping constraint (14) above can be formalized as

$$0 = \Lambda_t \Gamma_t \mathrm{d}t + \mathbb{E}_t\big[\mathrm{d}\big(\Lambda_t U(B_t, \tau_t, \gamma_t)\big)\big], \tag{15}$$

where the expectation is taken with respect to aggregate shock $\mathrm{d}\gamma_t$ conditioning on the information up to t. Essentially, the limited commitment of key talents, together with the ICC, generates higher compensation and maintenance costs for retaining key talents, which leads to greater operating leverage for the firm. According to equation (15), holding B_t constant, Γ_t increases with τ_t, implying that the firm with higher ICC has higher operating leverage.[15]

Similar optimal contracting problems with limited commitment have been studied in the literature (e.g., Alvarez and Jermann (2000, 2001), Albuquerque and Hopenhayn (2004), Rampini and Viswanathan (2013), Ai and Li (2015), Ai and Bhandari (2018), Bolton, Wang, and Yang (2019b)). In particular, Ai and Bhandari (2018) develop a general equilibrium model with two-sided limited commitment and moral hazard to provide a unified view of labor market risk and asset prices. One of their main results is that firms with a larger obligation to workers are associated with higher expected returns because labor compensation imposes a form of operating leverage at the firm level. Our model focuses on a similar operating leverage channel, owing to the ICC. We emphasize that in the presence of financial constraints risk, the cross-sectional asset pricing implications of the operating leverage channel are much more significant (see Section IV.C).

C.2. Talent Turnover and Financial Constraints

Shareholders can successfully fire key talents with intensity θ_t in the next instant $\mathrm{d}t$. Turnover intensity θ_t is a decision variable that takes one of two

[15] In principle, high-ICC firms could alleviate financial constraints by adjusting compensation contracts. For example, firms frequently adopt vesting schedules to increase pay duration for executives. Recognizing the importance of this feature of option programs, Sircar and Xiong (2007) develop a general framework for evaluating executive stock options. Our empirical results in Internet Appendix Section IV.K indicate that firms with higher ICC are indeed more likely to increase the pay duration for key talents to delay cash payments. However, the change in duration is economically small, suggesting that high-ICC firms are unlikely to be able to eliminate financial constraints simply by actively managing pay duration.

values, $\{\theta_l, \theta_h\}$, where $\theta_l \equiv 0$ and $\theta_h > 0$. More precisely,

$$\theta_t = \left(\begin{cases} \theta_l \equiv 0, & \text{if shareholders decide to keep key talents over}[t, t + \mathrm{d}t], \\ \theta_h > 0, & \text{if shareholders decide to replace key talents over}[t, t + \mathrm{d}t]. \end{cases} \right) \tag{16}$$

Even if shareholders want to replace key talents at time t (i.e., choose $\theta_t = \theta_h$), they can only do so successfully with intensity θ_h over $[t, t + \mathrm{d}t]$. The limited power of shareholders to replace key talents reflects the entrenchment of talents, which is considered the primary reason for the low turnover rate observed in the data (Taylor (2010)). In our model, shareholders' choice of replacement intensity $\theta_t \in \{\theta_l, \theta_h\}$ depends crucially on the firm's current marginal value of internal funds. Intuitively, the firm is more likely to replace key talents when it is financially constrained because the required compensation becomes more costly when the marginal value of the firm's internal funds is high (e.g., Brown and Matsa (2016), Babina (2020), Baghai et al. (2017)). Such endogenous separations due to heightened financial constraints risk play a crucial role in generating sizable impacts on firm value and the cross-sectional asset pricing patterns across firms with different levels of ICC.

Key talents can extract additional rents when firms are financially distressed and external financing/restructuring is needed (e.g., Bradley and Rosenzweig (1992), Henderson (2007), Goyal and Wang (2017)). For example, firms frequently offer pay retention and incentive bonuses to persuade key talents to stay with the firm throughout the restructuring process. To capture the rent extraction, we assume that key talents extract $\lambda U(B_t, \tau_t, \gamma_t)$ from shareholders when the firm runs out of cash. This represents the amount of funds misappropriated by key talents rather than a deadweight loss that shareholders have to bear. In particular, such extraction will never occur when firms are financially frictionless (i.e., $\gamma_H = \varphi = 0$).

D. Firm Optimality and Model Solutions

Given rented capital K_t and hired sales representative i_t, the firm's operating profit over the period $[t, t + \mathrm{d}t]$ is given by

$$\mathrm{d}O_t = \underbrace{\left[p \min\left(B_t, e^a K_t\right) - (r + \delta_K) K_t\right]\mathrm{d}t}_{\text{production profits}} - \underbrace{\left[\phi(i_t) B_t + \Gamma_t\right]\mathrm{d}t}_{\text{hiring costs}} + \underbrace{\mathrm{d}C_t,}_{\text{shocks}} \tag{17}$$

where $\min(B_t, e^a K_t)\mathrm{d}t$ is the amount of goods sold, which is capped by customer capital B_t (e.g., Gourio and Rudanko (2014)), p is the price of goods, $(r + \delta_K)K_t\mathrm{d}t$ captures the cost of renting the physical capital for production, $[\phi(i_t)B_t + \Gamma_t]\mathrm{d}t$ captures the total cost of hiring sales representatives and key talents, and $\mathrm{d}C_t$ captures firm-specific operating cash flow shocks, as described in (4).

The firm's cash holdings evolve according to:

$$\mathrm{d}W_t = \mathrm{d}O_t + (r - \rho)W_t\mathrm{d}t + \mathrm{d}E_t - \mathrm{d}D_t, \tag{18}$$

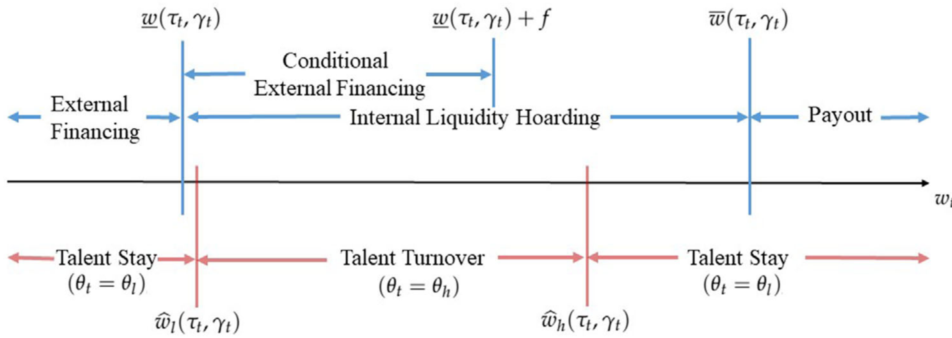

Figure 2. Decision boundaries and regions. (Color figure can be viewed at wileyonlinelibrary.com)

where $(r - \rho)W_t\mathrm{d}t$ is the interest income net of cash-carrying cost ρ, and E_t and D_t are cumulative equity issuance and cumulative payout up to t, respectively.

D.1. Optimization Problem

The firm rents physical capital K_t, hires i_t sales representatives, decides the turnover intensity θ_t, and chooses payout policy $\mathrm{d}D_t$ and external financing policy $\mathrm{d}E_t$ to maximize shareholder value defined as

$$V(W_t, B_t, \tau_t, \gamma_t) = \max_{K_s, i_s, \theta_s, \mathrm{d}D_s, \mathrm{d}E_s} \mathbb{E}_t\left[\int_t^\infty \frac{\Lambda_s}{\Lambda_t}(\mathrm{d}D_s - \mathrm{d}E_s - \mathrm{d}X_s)\right], \tag{19}$$

which is subject to the evolution of the ICC τ_t in (8), customer capital B_t in (9), cash holdings W_t in (18), and financing cost γ_t. The firm pays total financing cost $\mathrm{d}X_t = [\Phi_t(\mathrm{d}E_t; B_t) + \lambda U(B_t, \tau_t, \gamma_t)]\mathbb{1}_{\mathrm{d}E_t>0}$.

We emphasize that the dynamic constraint of cash holdings W_t in (18) depends in turn on the equilibrium firm value $V(\cdot)$ since the equilibrium compensation Γ_t (included in $\mathrm{d}O_t$) is endogenously determined by the value of outside options in equations (11) to (15). As a result, although we consider partial equilibrium, we must address a nontrivial fixed-point problem to solve the equilibrium.

D.2. Illustration of Model Solutions

A key simplification in our setup is that the firm's four-state optimization problem can be reduced to a three-state problem by exploiting homogeneity. We define the function $v(w_t, \tau_t, \gamma_t)$ on $D = \mathbb{R}^+ \times (0, 1) \times \{\gamma_L, \gamma_H\}$ such that

$$V\left(W_t, B_t, \tau_t, \gamma_t\right) \equiv v\left(w_t, \tau_t, \gamma_t\right)B_t, \text{ with } w_t = W_t/B_t. \tag{20}$$

The normalized value function $v(w_t, \tau_t, \gamma_t)$ can be solved based on a pair of coupled partial differential equations with free boundaries. Figure 2 illustrates the regions and boundaries intuitively.

The firm's financial decisions can be sufficiently characterized by decision boundaries, including the optimal external financing boundary $\underline{w}(\tau_t, \gamma_t)$ below which the firm issues equity ($dE_t > 0$) and the optimal payout boundary $\overline{w}(\tau_t, \gamma_t)$ above which the firm pays out dividends ($dD_t > 0$). The region between $\underline{w}(\tau_t, \gamma_t)$ and $\overline{w}(\tau_t, \gamma_t)$ is referred to as the internal liquidity-hoarding region. The internal liquidity-hoarding region contains a conditional external financing region $(\underline{w}(\tau_t, \gamma_t), \underline{w}(\tau_t, \gamma_t) + f)$ over which the firm issues equity conditional on the arrival of a negative lumpy cash flow shock. Intuitively, because holding cash is costly, the firm pays out cash when w_t reaches some high level $\overline{w}(\tau_t, \gamma_t)$. When w_t drops to some low level $\underline{w}(\tau_t, \gamma_t)$ such that the current financing costs are equal to the discounted future financing costs, the firm will issue equity. In the state γ_H, the firm issues equity only when it runs out of cash (i.e., $\underline{w}(\tau_t, \gamma_H) \equiv 0$).[16] In the state γ_L, the firm may exhibit "market-timing behavior" and tap the equity market with positive cash holdings (i.e., $\underline{w}(\tau_t, \gamma_L) \geq 0$) (Bolton, Chen, and Wang (2013)).

The firm's talent turnover decision can also be sufficiently characterized by two decision boundaries, $\widehat{w}_l(\tau_t, \gamma_t)$ and $\widehat{w}_h(\tau_t, \gamma_t)$, with $\widehat{w}_l(\tau_t, \gamma_t) \leq \widehat{w}_h(\tau_t, \gamma_t)$. The firm chooses to replace existing key talents ($\theta_t = \theta_h > 0$) when $w_t \in (\widehat{w}_l(\tau_t, \gamma_t), \widehat{w}_h(\tau_t, \gamma_t))$ and to keep key talents otherwise. The region between $\widehat{w}_l(\tau_t, \gamma_t)$ and $\widehat{w}_h(\tau_t, \gamma_t)$ is referred to as the talent-turnover region. Intuitively, the talent turnover decision depends on the trade-off between customer capital maintenance and liquidity management. When the cash ratio w_t falls between $\widehat{w}_l(\tau_t, \gamma_t)$ and $\widehat{w}_h(\tau_t, \gamma_t)$, the marginal value of internal funds is large enough that it dominates the marginal value of keeping key talents (and the talent-dependent customer capital). Thus, the firm will want to decrease key talents' compensation through turnover, resulting in a loss of customer capital. In the state γ_H, we have $\widehat{w}_l(\tau_t, \gamma_H) = \underline{w}(\tau_t, \gamma_H) \equiv 0$. Thus, the firm replaces key talents whenever w_t is lower than $\widehat{w}_h(\tau_t, \gamma_H)$. In the state γ_L, because of the market-timing behavior, the firm's marginal value of internal funds is low when w_t is around $\underline{w}(\tau_t, \gamma_L)$.[17] As a result, we have $\widehat{w}_l(\tau_t, \gamma_L) \geq \underline{w}(\tau_t, \gamma_L)$. The rigorous mathematical characterization of the equilibrium decision boundaries can be found in Internet Appendix Section II.A.

According to equation (20), three state variables (w_t, τ_t, γ_t) characterize the normalized value function and one scaling state variable B_t captures the size of the firm. The state variables w_t and τ_t are endogenous, while γ_t is exogenous. These three state variables are the bare minimum for delivering our key theoretical insights. First, the cash ratio w_t, as well as the financial friction, is necessary because our key mechanism relies on liquidity-driven turnover and financial constraints risk. Second, the ICC τ_t, as well as the dependence

[16] Financing costs always have smaller present values when they are paid later in the future, as long as the firm has positive liquidity hoarding for three reasons. First, cash within the firm earns a lower interest rate $r - \rho$ due to the holding cost. Second, the firm's expenses for customer capital growth are continuous. Third, the risk-free rate r is a positive constant.

[17] In particular, Bolton, Chen, and Wang (2013) show that the marginal value of internal funds is equal to 1 plus the variable financing cost φ when $w_t = \underline{w}(\tau_t, \gamma_L)$ if $\underline{w}(\tau_t, \gamma_L) > 0$.

of customer capital on key talents, is necessary because it represents the primary source of cross-sectional heterogeneity, and its interaction with financial constraints forms the main focus of this paper. Third, the level of financial constraints risk γ_t (i.e., financing costs) is necessary because we focus on the differential levels of exposure to aggregate shocks affecting the level of financing costs.

E. Discussion on the Model Assumptions

E.1. Model Summary

The partial-equilibrium investment-based asset pricing model makes six important assumptions: (i) AK technology with physical capital rental markets similar to Rampini and Viswanathan (2013), (ii) customer capital subject to convex adjustment costs similar to Gourio and Rudanko (2014), (iii) perishable goods leading to zero inventory similar to Gourio and Rudanko (2014), (iv) inalienability similar to the notion in Hart and Moore (1994) and Bolton, Wang, and Yang (2019b), which in our model leads to equilibrium turnover and retention with endogenous compensation design for talents, (v) costly equity financing and cash carrying costs, which create a dynamic cash management problem with time-varying financing costs driven by financial constraints shocks (e.g., Bolton, Chen, and Wang (2011, 2013)), and (vi) an exogenously specified stochastic discount factor that negatively prices financial constraints shocks.

Assumptions (i) to (iii) relate to customer capital and physical capital, while assumptions (iv) to (vi) relate inalienability and financial constraints. We discuss these two groups of assumptions next.

E.2. Customer Capital and Physical Capital

Customer capital B_t determines the demand capacity and rented physical capital K_t determines the supply $Y_t = e^a K_t$ over a short period of time. We assume that goods are perishable, and thus firms have no incentive to build inventory, which ensures tractability and makes our model more focused. As a result, equilibrium sales S_t are naturally the smaller of B_t and Y_t (Gourio and Rudanko (2014)). More precisely, given the demand capacity B_t, if $Y_t \geq B_t$, the equilibrium sales are $S_t = B_t$ since all output beyond demand perishes, whereas if $Y_t < B_t$, the equilibrium sales are $S_t = Y_t$ since firms cannot sell more than they produce.

We assume that no rental market exists for customer capital[18], but a rental market does exist for physical capital. As a result, firms must manage the stock of customer capital to maintain demand while they can continuously rent physical capital for production. Of course, in practice, most physical capital is not rented. Given that our focus is on customer capital, we adopt this simplifying assumption to keep the number of endogenous state variables manageable and

[18] This assumption is realistic because customer capital cannot be rented in practice.

guarantee numerical tractability. Under this assumption, customer capital is a state variable due to adjustment costs, while the stock of physical capital is not a state variable. Similar modeling approaches have been adopted in both the macroeconomics literature (e.g., Jorgenson (1963), Hall and Jorgenson (1969), Buera and Shin (2013), Moll (2014)) and the corporate theory literature (e.g., Rampini and Viswanathan (2013)).

Further, like cash holdings W_t, holding customer capital B_t can have a smoothing effect that mitigates the exposure to financial constraints shocks. This is not the case for physical capital: firms do not hold any physical capital, so they have no physical capital to divest when the marginal value of internal liquidity is high. However, the smoothing effect of B_t is limited because of the adjustment cost of B_t, similar to Gourio and Rudanko (2014), and the entrenchment of key talents (i.e., firms cannot freely divest talent-dependent customer capital by replacing key talents). The smoothing effect of W_t is also limited because of the cash carrying costs of W_t, similar to Bolton, Chen, and Wang (2011, 2013).

E.3. Inalienability and Financial Constraints

We emphasize that the interaction between the ICC and financial constraints is crucial for generating significant quantitative effects. The absence of either one of these features would prevent matching the model and the data (see Section IV.C).

The ICC is defined following the concept of inalienable human capital proposed by Hart and Moore (1994) and Bolton, Wang, and Yang (2019b). In their models, human capital is inalienable in the sense that, as a production input, it cannot be taken away from its possessors (i.e., key talents) because of limited legal enforcement. Also because of the limited commitment of key talents, human capital cannot be fully collateralized for external financing or fully capitalized for generating profits. Specifically, Hart and Moore (1994) assume that physical capital is operated most efficiently by the talents who originally develop it, with its productivity dropping when it is operated by other talents. There is no separation between the firm and its key talents in equilibrium because they focus on a deterministic contracting problem. In their deterministic model, the optimal debt contract can be achieved by restricting attention to "repudiation-proof" contracts. Their specification of inalienability is essentially similar to ours, but we consider a stochastic model. In the recent model of Bolton, Wang, and Yang (2019b), the human capital of key talents is a necessary input for operating a firm's physical capital. If talents leave, physical capital cannot generate any cash flow, and the firm is terminated. As a result, there is no separation in equilibrium, similar to Hart and Moore (1994). In our model, when key talents leave, a fraction of the firm's customer capital (which depends on the ICC) is taken away and thus stops generating cash flow for the firm. However, the remaining customer capital in the firm can still generate cash flow, albeit to a smaller degree, because the firm can immediately hire new talents to replace old talents without paying any upfront replacement costs. Therefore, the ICC is fundamentally linked to the inalienability of human capital. In a sense, our notion of inalienable human capital is weaker than that of Bolton, Wang, and Yang (2019b), which is the reason our model can allow for endogenous separation between key talents and firms in equilibrium.

Our model is different from Bolton, Wang, and Yang (2019b) in four additional important aspects. First, Bolton, Wang, and Yang (2019b) use an optimal long-term contracting framework to show that the inalienability of human capital gives rise to an endogenous debt limit that makes firms financially constrained. By contrast, we do not endogenize financial constraints from the inalienability of human capital. Instead, we use a dynamic contracting model that features customer capital and key talents to study the endogenous amplification effect of inalienable customer capital on financial constraints, which are exogenously specified as in Bolton, Chen, and Wang (2011, 2013). Second, different from their paper, our model assumes that firms do not have access to the corporate debt market. In our model, firms with different ICC have different exposure to financial constraints risk as a result of variation in operating leverage arising from the compensation of key talents, rather than debt limits. Incorporating (endogenous) debt limits as in Bolton, Wang, and Yang (2019b) would strengthen the implications of our model because firms with higher ICC would endogenously face tighter borrowing constraints due to lower pledgeability of their customer capital. Third, the focus of our model is on the asset pricing implications of the ICC and financial constraints (especially corporate liquidity). In certain respects, our paper develops a theoretical framework from the perspective of the ICC, which allows us to study important asset pricing implications of the corporate mechanism in Bolton, Wang, and Yang (2019b). We also provide extensive empirical evidence on the asset pricing implications. Fourth, in their model, idiosyncratic risks can be hedged, and the endogenous debt limit induced by inalienable human capital leads to intriguing implications for idiosyncratic risk management. By contrast, although key talents are well diversified in our model, the idiosyncratic shock to a firm's internal liquid funds cannot be hedged. This is a major factor driving equilibrium separation in our model.

F. Main Predictions

We illustrate the basic mechanism and main predictions of the model by numerically solving the model with the calibrated parameters presented in Table IX. To highlight the importance of financial constraints risk, we compare the numerical solutions from our model with those from a model without financial frictions (by setting $\gamma_H = \varphi = 0$).

F.1. Cash Holdings and Financial Decisions

Panel A of Figure 3 plots the firm's normalized enterprise value $v(w_t, \tau_t, \gamma_H) - w_t$, that is, the value of the firm's marketable claims minus the cash ratio,

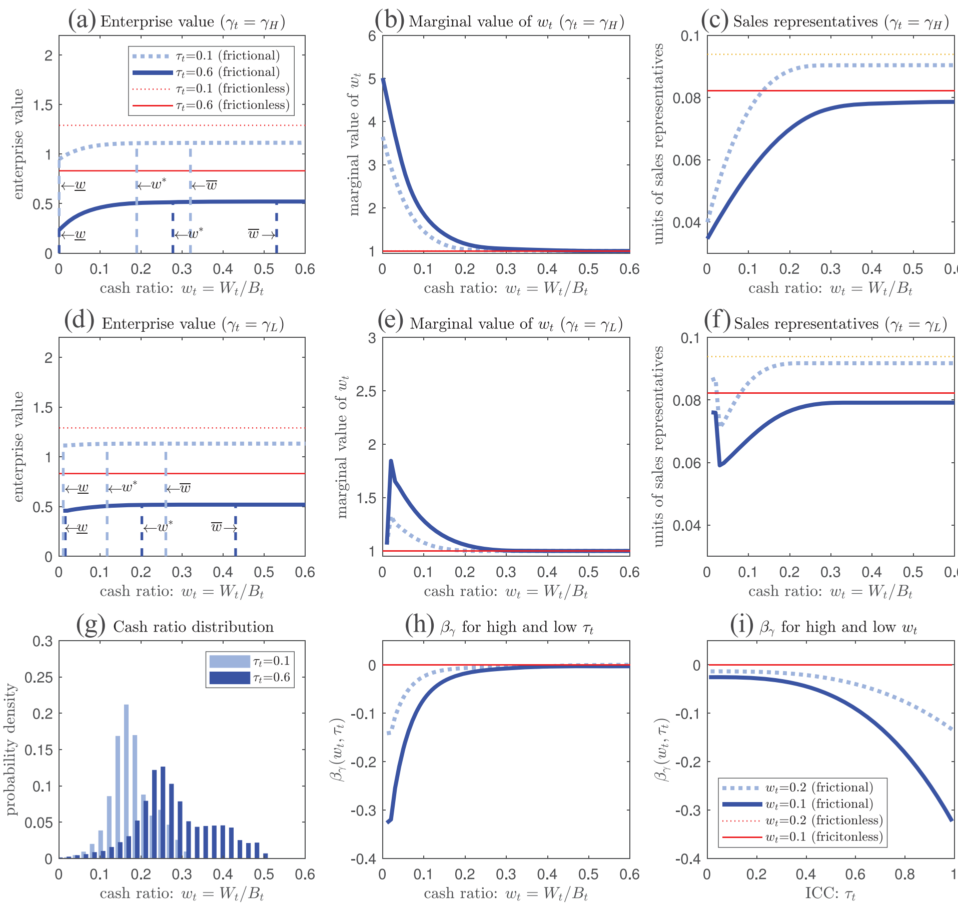

Figure 3. The model's basic mechanism and asset pricing implications. Panels A, B, and C plot the firm's enterprise value, marginal value of internal funds, and sales representatives with $\gamma_t = \gamma_H$. Panels D, E, and F plot the same quantities with $\gamma_t = \gamma_L$. The legends of Panels B to F and H are the same as the legend of Panel A. (Color figure can be viewed at wileyonlinelibrary.com)

as a function of the cash ratio in the regime of high financing costs. The panel shows that the low-ICC firm ($\tau_t = 0.1$) has a significantly higher enterprise value than the high-ICC firm ($\tau_t = 0.6$), primarily because talent-dependent customer capital is more costly for the high-ICC firm to maintain. The firm's enterprise value increases with the cash ratio because the financial constraints risk imposes a deadweight loss through costly equity financing and distorts the firm's decisions. By contrast, in the absence of financial frictions, both firms have a higher and flat enterprise value.

Our model predicts that the low-ICC firm tends to issue less equity (i.e., lower w^*) and pay out more dividends (i.e., lower $\overline{w}$). As a result, its endogenous steady-state distribution of cash ratios is concentrated at lower levels (see Panel G). We provide empirical evidence in Internet Appendix Section IV.I. The difference in financial policies can be explained by the difference in the marginal value of internal funds. Panel B shows that the high-ICC firm has a higher marginal value of internal funds because it is more exposed to financial constraints risk given its higher operating leverage. When the firm's cash ratio is high, operating leverage does not increase financial constraints risk much because internal funds cushion the firm from cash flow shocks. However, when the cash ratio is low, the compensation required to retain key talents significantly increases the financial constraints risk faced by the high-ICC firm. In the frictionless benchmark, the marginal value of internal funds for both firms is flat and equal to 1.

Panel C compares the hiring decisions of the two firms. The variation in the endogenous marginal value of internal funds suggests that both firms hire fewer sales representatives when cash ratios are low. On average, the low-ICC firm tends to hire more sales representatives. These implications suggest that financial constraints risk also distorts firm decisions in the product market. When a firm is financially constrained, it cuts investment in customer capital to boost short-term liquidity. In the frictionless benchmark, the hiring units are higher for both firms.

Panels D to F show that in the regime of low financing costs, both firms have a higher enterprise value and a lower marginal value of internal funds, and they also hire more sales representatives. The marginal value of internal funds is hump-shaped because of the market-timing behavior (Bolton, Chen, and Wang (2013)).

F.2. Asset Pricing Implications

Panels E and F of Figure 3 illustrate the asset pricing implications of our model by plotting firms' exposure to financial constraints shocks, as measured by the betas with respect to γ_t, that is, $\beta_\gamma(w_t, \tau_t) = v(w_t, \tau_t, \gamma_H)/v(w_t, \tau_t, \gamma_L) - 1$. Panel E shows that conditioning on the ICC, firms' exposure to financial constraints shocks increases when their cash ratio decreases. As a result, investors demand higher expected returns for firms with a lower cash ratio. Importantly, the difference in betas between high- and low-ICC firms decreases with the cash ratio.[19] Similar patterns are observed in Panel F, in which we compare betas of a high-cash firm ($w_t = 0.2$) and a low-cash

[19] The quantitatively different response to financial constraints shocks between low- and high-ICC firms also incorporates a countervailing force that dampens the relative response of the high-ICC firm because an increase in financial constraints risk reduces the compensation of key talents as the outside option of creating a new firm diminishes. From shareholders' perspective, the reduction in compensation provides insurance against the regime with high financial constraints risk, increasing the firm's value. This insurance effect is especially beneficial for the high-ICC firm, in which more customer capital is held by key talents. Our numerical solutions suggest that this countervailing force is dominated by the main force through greater operating leverage and larger decrease in customer capital when key talents leave.

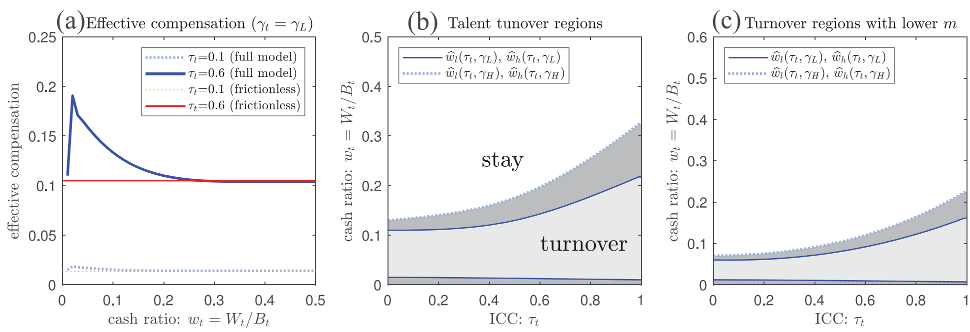

Figure 4. Model predictions on effective compensation and talent turnover. (Color figure can be viewed at wileyonlinelibrary.com)

firm ($w_t = 0.1$). Conditioning on the cash ratio, firms' exposure to financial constraints shocks becomes more negative as their customer capital becomes more talent-dependent. Importantly, the difference in betas and expected excess returns between high- and low-cash firms increases with the ICC. By contrast, in the frictionless benchmark, betas are almost zero, regardless of the cash ratio and the ICC.

Our model shows that the interaction between the firm's ICC and cash ratio has important implications for asset prices. Thus, firms' heterogeneous exposure to financial constraints shocks is simultaneously reflected in two distinctive cross sections: the ICC and the extent to which firms are financially constrained. In other words, the model implies that financial constraints shocks can be jointly identified by two cross-sectional return spreads.

F.3. Talent Turnover Implications

Our model's asset pricing implications depend tightly on talent turnover and the resulting decrease in customer capital. Panel A of Figure 4 compares the effective compensation of high- and low-ICC firms, defined as the monetary compensation to key talents multiplied by the marginal value of internal funds, in the regime of low financing costs. Relative to the frictionless benchmark, the effective compensation to key talents of both low- and high-ICC firms increases nonlinearly as the cash ratio decreases, up to the point where the market-timing effect starts to dominate (see Panel E of Figure 3 and the related discussion), with the increase in effective compensation more dramatic and nonlinear for the high-ICC firm.

The high effective costs of retaining key talents imply that the firm tends to replace key talents when their cash ratio is low. As Panel B of Figure 4 shows, firms with higher ICC and a lower cash ratio are more likely to replace key talents. The turnover boundary $\widehat{w}_h(\tau_t, \gamma_t)$ shifts upward when aggregate financial constraints risk increases. The difference in turnover boundaries

$\widehat{w}_h(\tau_t, \gamma_H) - \widehat{w}_h(\tau_t, \gamma_L)$ increases with τ_t. Therefore, our model suggests that the high-ICC firm tends to be associated with a greater increase in turnover when financial constraints risk increases. In other words, the high-ICC firm's customer capital is more fragile to financial constraints risk than that of the low-ICC firm.

Intuitively, retaining key talents is beneficial to the firm because customer capital normally generates positive net cash inflows. However, when the firm is financially constrained, the cost of increased exposure to financial constraints risk due to operating leverage outweighs the benefit of higher demand, motivating the firm to replace key talents and downsize the dependence of customer capital on key talents. An increase in financial constraints risk (from γ_L to γ_H) leads to a larger turnover region (i.e., higher likelihood of talent turnover) in Panel B. The high-ICC firm is more financially constrained, and therefore responds more strongly to the increase in financial constraints risk by expanding the turnover region to a greater extent. By contrast, no turnover occurs in the frictionless benchmark regardless of the financial constraints risk. This pattern differentiates our mechanism from that of Eisfeldt and Papanikolaou (2013), in whose model the firm operates in a perfect financial market. Both talent turnover decisions and asset pricing implications are driven by aggregate frontier technology shocks to the outside options of key talents.

Panel C of Figure 4 plots the turnover boundaries with a lower value of m. Because the parameter m reflects the customer capital that key talents take with them when they leave, a lower m reduces the value of their outside options. The panel shows that when the outside options of key talents decrease, turnover boundaries shift downward, indicating that firms can keep key talents more easily. Reduced compensation benefits high-ICC firms more extensively because these firms are endogenously more financially constrained. Thus, the positive relationship between the ICC and talent turnover weakens with a lower m, as reflected by flatter turnover boundaries as the ICC increases.

II. Measuring the ICC

In this section, we exploit a comprehensive database of consumers' perception of brands to measure customer capital as well as the ICC (i.e., τ_t in our model). We first introduce the data and construct our ICC measure. Then, similar to Bloom and Reenen (2007), we conduct external validation tests to show that our survey-based ICC measure satisfies the key theoretical properties of τ_t.

A. Data

Our brand metrics data come from the BAV Group. This database is regarded as the world's most comprehensive database of consumers' perception of brands. The BAV Group is one of the largest, and leading, consulting firms that conduct brand valuation surveys and provide brand development strategies for clients. The BAV brand perception survey contains more than 870,000 respondents; it is constructed in such a way as to be representative of the U.S. population according to gender, ethnicity, age, income group, and geographic location. Details on the survey are available in a number of finance and marketing academic papers (e.g., Larkin (2013), Tavassoli, Sorescu, and Chandy (2014)). The BAV surveys are conducted at the brand level. Survey respondents are asked to complete a 45-minute survey that yields measures of brand value. The first survey was conducted in 1993, and since 2001, the surveys have been conducted quarterly. The surveys cover more than 3,000 brands and are not biased toward the BAV Group's clients. The BAV Group updates the list of brands regularly to include new brands and exclude those that have exited the market, and it does not backfill the survey data. To make the surveys manageable, each questionnaire contains fewer than 120 brands that are randomly selected from the list of brands.

We identify the firms that own the brands over time, and link the BAV survey data with Compustat and CRSP. We pay particular attention to the brands involved in mergers and acquisitions to ensure that they are correctly assigned to firms. For each firm-year, we calculate the average scores of various brand metrics over all of the brands owned by the firm.[20] Our merged BAV-Compustat-CRSP data span the period from 1993 to 2016 and include firms listed on the NYSE, Amex, and NASDAQ exchanges with share code 10 or 11. We exclude financial firms and utility firms. Our sample spans 1,004 unique firms in total, and on average, about 400 firms in the yearly cross section. The firms in the merged sample collectively own 4,745 unique brands covered by the BAV surveys. The entry and exit rates of the firms in the merged sample are approximately 7%, which is comparable to the corresponding rates in the Compustat data. Firms in the merged sample and in the Compustat/CRSP sample have comparable book-to-market ratios and debt-to-asset ratios. The merged sample is biased toward large firms.[21] Because the merged sample is not a random sample of U.S. public firms, in Internet Appendix Section IV.D we replicate our asset pricing tests in an extended sample that covers the cross section of all U.S. public firms. We further link the merged BAV-Compustat-CRSP data with Execucomp, BoardEx, and the Harvard Business School patent and innovator database (Li et al. (2014)). Internet Appendix Table IA.V presents the summary statistics for the main variables.

[20] In our sample, 58% of firm-year observations have only one brand. For the firms that own more than one brand, we compute the firm-level brand metrics from the brand-level data using several alternative methods. We provide details on the construction of firm-level brand metrics in Internet Appendix Section IV.A. Our results are robust to the choice of method.

[21] In the merged sample, the median book-to-market ratio, debt-to-asset ratio, market capitalization, and sales are 0.37, 0.55, \$4,915 million, and \$5,115 million, respectively, whereas they are 0.49, 0.44, \$420 million, and \$424 million in the Compustat/CRSP sample. We provide more details on the merged sample, including its distribution across industries, in Internet Appendix Section IV.B.

B. The ICC Measure

Based on the brand perception survey data, the BAV Group has developed two major brand metrics to assess the value of customer capital to a firm, namely, brand stature and brand strength.

B.1. Brand Stature

The BAV Group constructed the brand stature measure to capture customer capital (i.e., brand loyalty of existing and potential customers) (e.g., Gerzema and Lebar, 2008). Brand stature is the product of esteem and knowledge. Esteem assesses consumers' respect and admiration for a brand. In particular, it comprises (i) the brand score on "regard" ("How highly do you think of this brand?" on a seven-point scale) and (ii) the fraction of respondents who consider the brand to be of "high quality," "reliable," and a "leader." Esteem reflects brand loyalty because consumers are proud to be associated with brands that they hold in high regard. To augment precision and thus credibility of the esteem measure, BAV uses the knowledge measure to capture the degree of personal familiarity ("How familiar are you with this brand?" on a seven-point scale). BAV shows that past, current, and potential users of a brand tend to rate themselves as significantly more knowledgeable about the brand. Thus, the knowledge measure is an adjustment factor for the esteem measure in quantifying brand stature (i.e., customer capital defined by brand loyalty of existing and potential customers).

B.2. Brand Strength

The BAV Group constructed the brand strength measure to capture the extent to which a brand is perceived to be innovative, distinctive, and managed by a dynamic team. Brand strength is the product of energized differentiation and relevance. Energized differentiation is the average fraction of respondents who consider a brand to be "innovative," "distinctive," "unique," "different," and "dynamic," where "innovative" captures brand innovativeness, "distinctive," "unique," and "different" capture the brand differentiation, and "dynamic" captures the vibrancy of the management team. Energized differentiation is clearly related to the unique contribution of key talents. The relevance measure captures the degree of personal appropriateness ("How relevant do you feel the brand is for you?" on a seven-point scale). Thus it is an adjustment factor for the energized differentiation measure in quantifying brand strength (i.e., talent-dependent customer capital defined by brand loyalty of existing and potential customers attributed to the unique contribution of key talents). Consumers' perception of a brand's energized differentiation can better reflect the firm's talent-dependent customer capital when they are more likely to purchase the firm's goods.

B.3. The ICC Measure

An ICC measure should reflect the degree to which customer capital depends on talents. Accordingly, for each firm i and year t, we capture the ICC as follows:

$$\mathrm{ICC}_{i,t} \equiv \frac{\text{brand strength}_{i,t}}{\text{brand stature}_{i,t}}. \tag{21}$$

The distribution of our ICC measure is skewed, and thus we use the log transformation of the ICC measure, ln(ICC). Internet Appendix Section IV.B shows that ln(ICC) exhibits a fair amount of variation, with an approximately normal distribution. Moreover, logged brand stature and logged brand strength have a similar range and standard deviation, and thus the variation in ln(ICC) does not come predominantly from either brand stature or brand strength. To ease interpretation of the regression coefficients in our empirical analyses, we standardize ln(ICC) by its unconditional mean and standard deviation across all firms over the entire sample period. We sort our sample firms into five quintiles based on the ICC measure. Summary statistics are reported in Internet Appendix Table IA.VI.

Because our ICC measure is constructed from consumer surveys of brand loyalty, it directly captures the perceptions of existing and potential customers. The ICC measure is distinct from brand metrics derived from firms' financial and accounting variables, which are subject to at least two major concerns: (i) they could suffer from estimation error introduced by indirectly inferring unobservable characteristics from noisy accounting information, and (ii) they could be mechanically linked to the outcome financial variables we study. The BAV survey-based measures are designed to tackle these issues.

To illustrate, we provide a few concrete examples. In the automobile industry, Toyota is a typical low-ICC firm that enjoys strong brand recognition all over the world, whereas Tesla is a typical high-ICC firm whose customer capital depends crucially on its R&D team. In the beverage industry, Coca-Cola is a typical low-ICC firm whose customer loyalty depends less on the firm's current executives or innovators and more on customers' own habits and tastes. By contrast, Teavana—an innovative tea company that combines innovative brewing methods with high-quality teas and "imaginative flavors from around the world"—is a typical high-ICC firm. In the information technology and apparel industries, respectively, Microsoft and Gap are examples of low-ICC firms, while Facebook and Ralph Lauren are examples of high-ICC firms.

C. External Validation of the ICC Measure

We conduct several external validation tests of our ICC measure. According to our model, if the ICC measure captures the ICC (i.e., τ_t in our model), we would expect: (i) firms whose talents play more important roles are associated with higher ICC, (ii) firms with higher ICC tend to lose a larger fraction of customer capital upon talent turnover, and (iii) firms' customer capital becomes less talent-dependent (i.e., the ICC decreases) upon talent turnover.

To test property (i), we examine the relationship between our ICC measure and measures of various intangible assets. Conceptually, customer capital is not a new type of intangible asset. Instead, it is a synthesis of other intangible assets such as innovation and product differentiation, dynamic management, and pure brand recognition. If our ICC measure is a valid proxy for the ICC, we would expect firms whose talents play a more important role to be associated with a higher ICC value. Accordingly, we examine the relationship between our ICC measure and R&D expenditures (a measure of innovation and product differentiation), administrative expenses and executive compensation (a measure of dynamic management), and advertising expenditures (a measure of pure brand recognition). Using panel regressions (see Table I), we find that the firms with a higher ICC value are indeed associated with higher R&D expenditures, administrative expenses, and executive compensation, while they are associated with lower advertising expenditures, suggesting that their customer capital depends more on talents than on pure brand recognition.

We emphasize that customer capital cannot be fully captured by any single type of intangible asset because a firm's investment in one type of intangible asset such as R&D may not necessarily increase its customer capital. For example, when a firm increases its R&D expenditures or administrative expenses, its products or services may not necessarily improve or they may even become less relevant to consumers, in which case these expenses will not lead to higher brand loyalty. In other words, consumers may not appreciate the changes (if any) brought about by increased R&D expenditures, administrative expenses, or executive compensation. By contrast, our survey-based measure from the demand side directly reflects consumers' brand perceptions, and thus it captures customer capital in a more direct manner. In Internet Appendix Section IV.G, we show that the asset pricing implications of our ICC measure cannot be fully explained by any single intangible-asset measure.

We also examine the relationship between the ICC and organization capital (Eisfeldt and Papanikolaou (2013)). We find a weak association between these two measures (see column (5)), likely because organization capital is constructed from selling, general, and administrative expenses (SG&A), which contains both advertising expenditures and administrative expenses. Advertising expenditures boost pure brand recognition and are negatively related to our ICC measure (see column (4) of Table I), whereas administrative expenses mainly reflect the contribution of talents and thus are positively related to our ICC measure (see column (1) of Table I). The weak correlation between our ICC measure and organization capital suggests that the two measures capture different firm characteristics.

To test theoretical properties (ii) and (iii) of our ICC measure, we examine the growth rate of brand stature—a measure of customer capital—following the nonretirement turnover of CEOs. As shown in columns (1) and (2) of Table II, the customer capital of high-ICC firms is more negatively affected by CEO turnover than that of low-ICC firms. In addition, the sales growth and

Table I

The ICC Measure and Measures of Intangible Assets

This table shows the relationship between the ICC measure and measures of intangible assets. The dependent variable ln(ICC) is the natural log of the ICC. The independent variables are the natural log of the administrative expenses-to-sales ratio, the natural log of the R&D-to-sales ratio, the natural log of the executive compensation-to-sales ratio, the natural log of the advertisement-to-assets ratio, and the natural log of the organization-capital-to-assets ratio, all computed using the average values over the previous three years. Our results are robust to using the average values over other time periods (one to six years). Administrative expenses are SG&A net of advertising costs, R&D expenses, commissions, and foreign currency adjustments. Executive compensation is the total compensation of the top five executives of firms in the Execucomp data. We construct organization capital (OC) from SG&A expenditures using the perpetual inventory method and we replace missing values with zero. In column (2), we exclude firms with missing R&D because these firms do not necessarily lack innovation activities (e.g., Koh and Reeb (2015)), unlike zero-R&D firms. In column (4), we exclude firms with missing advertising expenditures following Grullon, Kanatas, and Weston (2004) and Belo, Lin, and Vitorino (2014). Our results hold if we replace missing values for R&D and advertising expenditures with zeros. Firm controls include the natural log of market capitalization and the natural log of the book-to-market ratio. The sample period is 1993 to 2016. We include t-statistics in brackets. Standard errors are clustered by firm and year. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	$\ln(\text{ICC})_t$				
	(1)	(2)	(3)	(4)	(5)
$\ln(\text{administrative expenses/sales})_{t-3:t-1}$	0.13^{***}				
	[2.97]				
$\ln(\text{R\&D/sales})_{t-3:t-1}$		0.26^{***}			
		[5.76]			
$\ln(\text{executive compensation/sales})_{t-3:t-1}$			0.25^{***}		
			[6.47]		
$\ln(\text{advertising expenditures/asset})_{t-3:t-1}$				-0.09^{**}	
				[−2.48]	
$\ln(\text{OC/asset})_{t-3:t-1}$					−0.04
					[−1.31]
Firm controls	Yes	Yes	Yes	Yes	Yes
Industry FEs and year FEs	Yes	Yes	Yes	Yes	Yes
Observations	5,300	2,695	5,086	4,329	5,594
R^2	0.386	0.468	0.411	0.413	0.382

asset growth of high-ICC firms react more negatively to CEO turnover (see columns (3) to (6) of Table II). Finally, we examine the changes in ICC after CEO turnover in columns (7) and (8). We find that the ICC decreases following CEO turnover, suggesting that a firm's customer capital depends less on talents after their departure.

III. Empirical Results

In this section, we test the joint cross-sectional implications of the ICC on stock returns and talent turnover. We first examine the asset pricing implications of the ICC in Section III.A. We show that firms with higher ICC have

Table II

The ICC Measure and Changes in Customer Capital Following Talent Turnover

This table shows the relationship between the ICC measure and changes in customer capital following talent turnover. The dependent variables are the two-year growth rate of brand stature ($\text{Stature\_gr}_{t:t+2}$), the two-year growth rate of sales ($\text{Sales\_gr}_{t:t+2}$), the two-year growth rate of assets ($\text{Asset\_gr}_{t:t+2}$), and the two-year change in the ICC ($\Delta\text{ICC}_{t:t+2}$). CEO turnover_t is an indicator variable that equals 1 if a CEO leaves the firm at age 59 or younger. The main independent variables are lagged standardized $\ln(\text{ICC})_{t-1}$, the turnover indicator, and their interaction. Firm controls include the natural log of firm market capitalization, the natural log of the book-to-market ratio, the natural log of the debt-to-equity ratio, and the natural log of organization capital normalized by assets. We control for year fixed effects and SIC industry fixed effects. The sample period is 1993 to 2016. We include t-statistics in brackets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	$\text{Stature\_gr}_{t:t+2}$		$\text{Sales\_gr}_{t:t+2}$		$\text{Asset\_gr}_{t:t+2}$		$\Delta\text{ICC}_{t:t+2}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\ln(\text{ICC})_{t-1}$ $\times\text{Turnover}_t$	-0.04^{*}	-0.05^{**}	-0.04^{**}	-0.03^{*}	-0.07^{**}	-0.06^{**}		
	[−1.80]	[−1.98]	[−2.40]	[−1.79]	[−2.32]	[−2.30]		
Turnover_t	−0.01	−0.02	-0.07^{***}	-0.06^{***}	-0.11^{***}	-0.10^{***}	-0.18^{***}	-0.16^{**}
	[−0.63]	[−1.01]	[−3.65]	[−3.30]	[−4.51]	[−3.68]	[−2.70]	[−2.40]
$\ln(\text{ICC})_{t-1}$	0.14^{***}	0.15^{***}	0.07^{***}	0.03^{***}	0.07^{***}	0.03^{*}		
	[17.60]	[17.02]	[5.92]	[3.01]	[3.89]	[1.75]		
Firm controls	No	Yes	No	Yes	No	Yes	No	Yes
Industry FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,709	3,525	4,523	4,285	4,523	4,285	4,059	3,855
R^2	0.440	0.443	0.170	0.233	0.135	0.211	0.099	0.108

higher average and risk-adjusted returns. Moreover, we find that the spread of the long-short portfolio sorted on the ICC comoves with the financial constraints factor. We then test the model's joint predictions on turnover in Section III.B. We show that the ICC is positively related to the turnover rates of executives and innovators. Moreover, the positive relationship is more pronounced during periods of heightened financial constraints risk and for firms located in states with weaker enforcement of noncompete agreements.

A. Asset Pricing Tests

A.1. Portfolios Sorted on the ICC

In this subsection, we document the returns of stock portfolios sorted on the ICC. In June of year t, we sort firms into five quintiles based on their ICC in year $t-1$. After the portfolios are formed, we track their monthly returns from July of year t to June of year $t+1$. Table III shows that the equal-weighted (value-weighted) low-ICC portfolio (Q1) has an annualized average excess return of 10.20% (4.94%). By contrast, the equal-weighted (value-weighted) high-ICC portfolio (Q5) has an annualized average excess return of 16.18% (11.62%).

Table III

Excess Returns and Alphas of Portfolios Sorted on the ICC

This table shows the equal-weighted and value-weighted average excess returns and alphas for portfolios sorted on the ICC. The sample period is 1993 to 2016. We include t-statistics in brackets. Standard errors are computed using the Newey-West estimator to adjust for serial correlation in returns. We annualize the average excess returns and alphas by multiplying them by 12. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Equal Weighted			Value Weighted		
ICC Quintile	1 (Low)	5 (High)	5 − 1	1 (Low)	5 (High)	5 − 1
Average excess returns (%)	10.20**	16.18***	5.98**	4.94	11.62***	6.68*
	[2.53]	[3.46]	[2.14]	[1.56]	[2.65]	[1.94]
CAPM α (%)	1.87	6.02**	4.15**	−1.66*	2.47	4.13**
	[1.41]	[2.45]	[1.99]	[−1.65]	[1.09]	[2.01]
Fama-French three-factor α (%)	−0.42	5.50**	5.92**	−2.53*	4.25*	6.77**
(Fama and French (1993))	[−0.23]	[2.44]	[2.44]	[−1.71]	[1.92]	[2.35]
Carhart four-factor α (%)	1.81	8.00***	6.19**	−2.09	4.83**	6.92**
(Carhart (1997))	[1.08]	[3.89]	[2.51]	[−1.41]	[2.17]	[2.37]

The equal-weighted (value-weighted) portfolio that longs Q5 and shorts Q1 has a positive and statistically significant annualized return of 5.98% (6.68%). The magnitude of this return spread (i.e., the ICC spread) is economically significant, as it is close to the level of the equity premium and value premium.

Because high- and low-ICC firms may have different exposures to the priced risk factors, we also estimate the alphas (i.e., the risk-adjusted excess returns) using the capital asset pricing model (CAPM) model, the Fama-French three-factor model (Fama and French (1993)) and the Carhart four-factor model (Carhart (1997)). We find that the long-short portfolio sorted on the ICC has positive and statistically significant alphas using all three models.[22]

We further examine the persistence of the return spread around the portfolio sorting period. We find that the positive relationship between portfolio alphas and the ICC exists three years before and continues to exist three years after portfolio formation (see Internet Appendix Figures IA.6 and IA.7). This result reinforces the findings in Table III, as it indicates that the ICC is a persistent firm characteristic that is priced in the cross section with respect to certain asset pricing factors.[23] The finding of persistent ICC spreads supports our prediction of heterogeneous persistent risk exposure due to persistent firm characteristics, rather than time-varying betas (e.g., Daniel and Moskowitz (2016)).

[22] In Internet Appendix Table IA.VII, we tabulate the excess returns and alphas for all ICC quintiles. We also show that the ICC continues to have positive and statistically significant alphas using the q-factor model (Hou, Xue, and Zhang (2015)), the Fama-French five-factor model (Fama and French (2015)), and the Pástor-Stambaugh five-factor model, the latter of which contains the Fama-French three factors, the momentum factor, and the Pástor-Stambaugh liquidity factor (Pástor and Stambaugh (2003)).

[23] The autocorrelation of ln(ICC) is 0.96 between years t and $t-1$ and 0.80 between years t and $t-5$.

Since our BAV sample covers only a subset of public firms, we next extend our analysis and show that the ICC spread is priced in the cross section of all public firms. Specifically, we sort all U.S. public firms based on their betas with respect to the ICC spread, denoted by β_{ICC}, which is estimated using a rolling window.[24] We then sort firms into quintiles based on β_{ICC} and compute the average excess returns and alphas of each quintile. We find that firms with higher β_{ICC} have significantly higher average excess returns and alphas (see Internet Appendix Table IA.X), which suggests that the ICC spread is positively priced in the cross section of all U.S. public firms.

A.2. Economic Force Captured by the ICC Spread

Our model implies that firms with higher ICC have greater exposure to financial constraints risk and therefore must compensate investors with higher expected returns. In this subsection, we provide empirical evidence to support the linkage between the ICC and exposure to financial constraints risk.

Specifically, we examine the relationship between the ICC spread and the return spread of two financial constraints measures: (i) the WW index (Whited and Wu (2006)), which is structurally estimated to capture the marginal value of internal funds,[25] and (ii) the BW index constructed by Buehlmaier and Whited (2018), which is based on textual analysis to provide a direct measure of financial constraints. Figure 5 displays the time series and scatter plots of the ICC spread, the WW factor, and the BW factor.[26]. As can be seen, the ICC spread is highly correlated with both the WW factor and the BW factor, with the quarterly correlation equal to 0.59 and 0.68, respectively.

The high correlation between our theoretically motivated ICC spread and the two financial constraints factors has two important implications. First, it provides empirical support for our theory because it suggests that, to a large extent, the ICC spread also captures the financial constraints factor. In other words, firms with higher ICC are more exposed to financial constraints risk.

[24] Because the ICC spread is exposed to the risk of traditional asset pricing factors, we control for these factors when estimating β_{ICC}. Pástor and Stambaugh (2003) use the same approach to study the asset pricing implications of their market liquidity factor. They estimate the market liquidity beta in regressions that control for the Fama-French three factors. We use the equal-weighted ICC spread to estimate β_{ICC} because our sample contains a relatively small number of firms and thus the value-weighted ICC spread suffers from small-sample bias.

[25] Similar financial constraints factors are structurally estimated by Eisfeldt and Muir (2016) and Belo, Lin, and Yang (2019) using different approaches. We use the WW factor because it is available at a monthly frequency and our model fits into the estimation setup of Whited and Wu (2006). Several other financial constraints measures are constructed using a reduced-form approach (e.g., Kaplan and Zingales (1997), Hadlock and Pierce (2010)), but these estimates do not directly reflect the marginal value of internal funds.

[26] We construct the WW factor following Whited and Wu (2006). We obtained the BW factor from Buehlmaier and Whited (2018) for the period 1994 to 2010. This factor is calculated as the value-weighted long-short portfolio spreads sorted on the BW index. The BW index captures general financial constraints and is constructed using the Dow Jones Factiva database as the training sample.

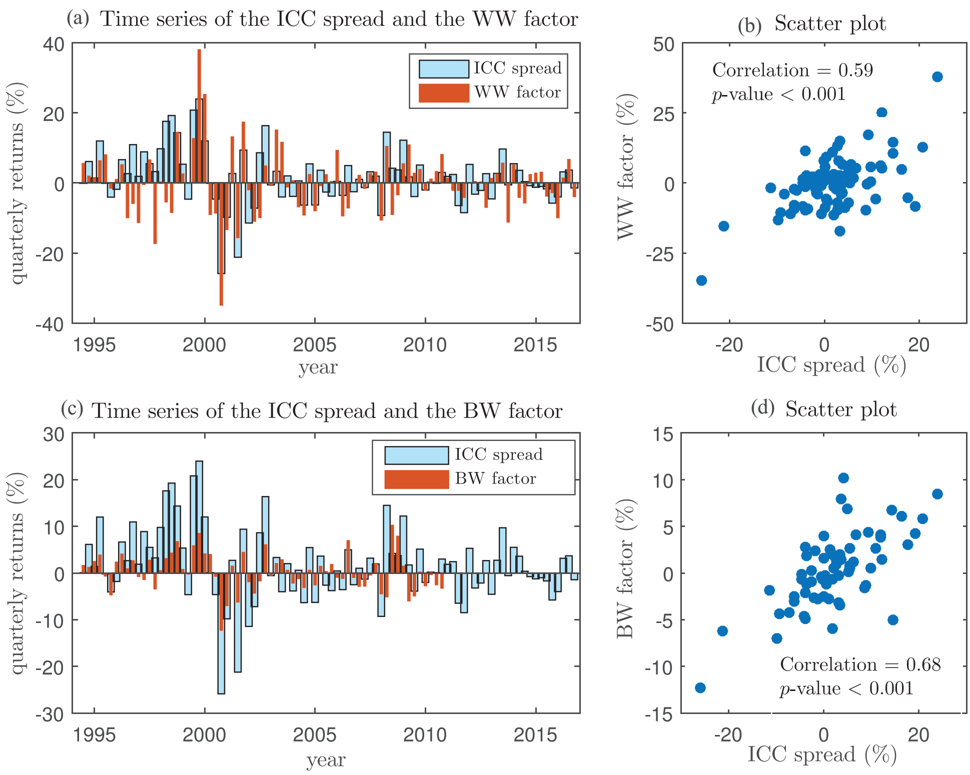

Figure 5. Correlation between the ICC spread and the financial constraints factors. Panels A and B illustrate the relationship between the ICC spread and the WW factor. Panels C and D illustrate the relationship between the ICC spread and the BW factor. (Color figure can be viewed at wileyonlinelibrary.com)

Second, by connecting our theoretically motivated ICC spread to the financial constraints factor, we shed new light on how financial constraints can be priced. Specifically, our theory suggests that one major channel through which the financial constraints factor affects stock returns is the ICC, in addition to the channel of corporate liquidity condition.

In Table IV, we further examine whether the ICC spread can explain the return spreads of the BW index. Consistent with Buehlmaier and Whited (2018), we find that the alphas of the long-short portfolio sorted on the BW index are positive and statistically significant using the Pástor-Stambaugh five-factor model, the Hou-Xue-Zhang q-factor model, and the Fama-French five-factor model. However, the average excess returns and alphas decrease significantly and become statistically insignificant after controlling for the ICC spread.

Last but not least, we emphasize that financial constraints measures and our ICC measure capture different economic concepts. The ICC measure is not an alternative empirical measure for financial constraints. As we show in Section I.F, the ICC and the marginal value of internal funds are

Table IV

A Common Financial Constraints Factor for Two Cross Sections

This table shows the value-weighted spreads and alphas of the long-short portfolio sorted on the BW index, where the first (second) row does not (does) control for the ICC spread. The sample period is 1994 to 2010, the period over which the BW index is available. We include t-statistics in brackets. Standard errors are computed using the Newey-West estimator to adjust for serial correlation in returns. We annualize the average excess returns and the alphas by multiplying them by 12. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Factor Model	Spread	CAPM	FF3F	FF4F	PS5F	q-Factor	FF5F
Spreads and α (%)	1.05	0.59	2.33	2.23	3.39*	5.02**	4.60**
	[0.47]	[0.26]	[1.19]	[1.12]	[1.66]	[2.11]	[2.03]
Spreads and α controlling	−1.85	−1.68	−0.37	−0.45	0.71	0.33	0.62
for the ICC spread (%)	[−1.12]	[−1.01]	[−0.22]	[−0.27]	[0.42]	[0.16]	[0.32]

endogenously linked. However, the marginal value of internal funds is not determined solely by the ICC; it is also determined (largely) by other factors such as cash holdings. Given the same marginal value of internal funds, the exposure to financial constraints shocks still varies with a firm's ICC. Thus, even a perfect empirical measure of the marginal value of internal funds should not be considered a "sufficient statistic" for a firm's exposure to financial constraints shocks. The primary goal of our paper is to show that a firm's ICC is informative and has first-order importance as an additional complementary statistic for summarizing a firm's exposure to financial constraints shocks.

A.3. ICC and Operating Leverage

Our model suggests that firms with higher ICC are more exposed to financial constraints shocks and thus are riskier. This is because retaining key talents imposes operating leverage on firms.[27] As shown in Internet Appendix Tables IA.VI and IA.XXVI, firms with higher ICC do indeed have higher cash flow volatility.

In this subsection, we contrast our ICC measure with existing measures of operating leverage that mainly reflect a firm's labor cost for ordinary employees. We show that our ICC measure is negatively related to these measures of operating leverage, suggesting that it captures an aspect of operating leverage that is not emphasized in existing literature on operating leverage. Unlike our ICC measure, the long-short portfolio spreads sorted on the existing measures of operating leverage do not comove with the financial constraints factor.

We consider six existing measures of operating leverage, denoted by OL, OL_reg, LS, LS_ebitda, ELS, and $-\Delta$XLR. All of them are constructed based on Compustat accounting data. OL is developed by Novy-Marx (2011) and is

[27] Operating leverage refers to the fact that a firm's fixed operating costs represent a rigid stream of cash outflow and therefore behave much like financial leverage in magnifying shocks and affecting expected returns (e.g., Hamada (1972), Rubinstein (1973), Lev (1974), Carlson, Fisher, and Giammarino (2004)).

Table V

The ICC Measure and Existing Measures of Operating Leverage

This table shows the relationship between the ICC measure and existing measures of operating leverage. The dependent variable is the natural log of the ICC. The independent variables are six measures of operating leverage. Firm controls include the natural log of market capitalization and the natural log of the book-to-market ratio. The sample period is 1993 to 2016. We include t-statistics in brackets. Standard errors are clustered by firm and year. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	$\ln(\text{ICC})_t$					
Operating Leverage Measures (Regressor on the RHS)	ln(OL) (1)	ln(OL_reg) (2)	LS (3)	LS_ebitda (4)	ELS (5)	$-\Delta$XLR (6)
Operating leverage$_t$	-0.23^{***}	-0.04	-0.87^{*}	-0.88^{*}	-0.86^{***}	-1.19^{***}
	[−3.34]	[−1.63]	[−1.77]	[−1.79]	[−5.17]	[−3.80]
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry FEs and year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,682	5,412	697	698	5,664	693
R^2	0.354	0.364	0.546	0.546	0.384	0.559

given as the sum of the cost of goods sold (COGS) and SG&A divided by assets. OL_reg is estimated from a time-series regression of earnings before interest and taxes (EBIT) on revenue (e.g., Mandelker and Rhee (1984)). LS and LS_ebitda are labor share measures that capture the ratio between a firm's labor expenses and its added value (Donangelo et al. (2019), Favilukis, Lin, and Zhao (2020)). In particular, LS is the labor share measure of Donangelo et al. (2019), and is defined as XLR/(OIBDP+ ΔINVFG + XLR), where XLR is total staff expenses, OIBDP is operating income before depreciation, and ΔINVFG is the change in finished inventory goods, while LS_ebitda is the labor share measure of Favilukis, Lin, and Zhao (2020), and is defined as XLR/(EBITDA + XLR), where EBITDA is earnings before interest, taxes, depreciation, and amortization. ELS is the extended labor share measure of Donangelo et al. (2019), defined as LABEX/(OIBDP+ ΔINVFG + LABEX), where LABEX is an imputed measure of labor expenses. ELS extends the coverage of the LS measure, which is limited by the fact that XLR is available only for about 10% of the firm-year observations in the Compustat data (Donangelo et al. (2019)). ΔXLR is the labor expense growth rate. Low labor expense growth implies smooth wages that act like operating leverage (e.g., Favilukis and Lin (2016a), Favilukis and Lin (2016b), Favilukis, Lin, and Zhao (2020)). Of these six existing measures, OL and OL_reg reflect a firm's total fixed costs, a major component of which is the labor cost for ordinary employees, while the four other measures focus on a firm's total labor costs for ordinary employees.

We first examine the relationship between the ICC and these existing measures of operating leverage. As shown in Table V, the ICC is negatively correlated with all existing measures, suggesting that the ICC captures a different aspect of operating leverage. In particular, we find that the existing operating leverage measures do not capture a firm's talent dependence. These measures

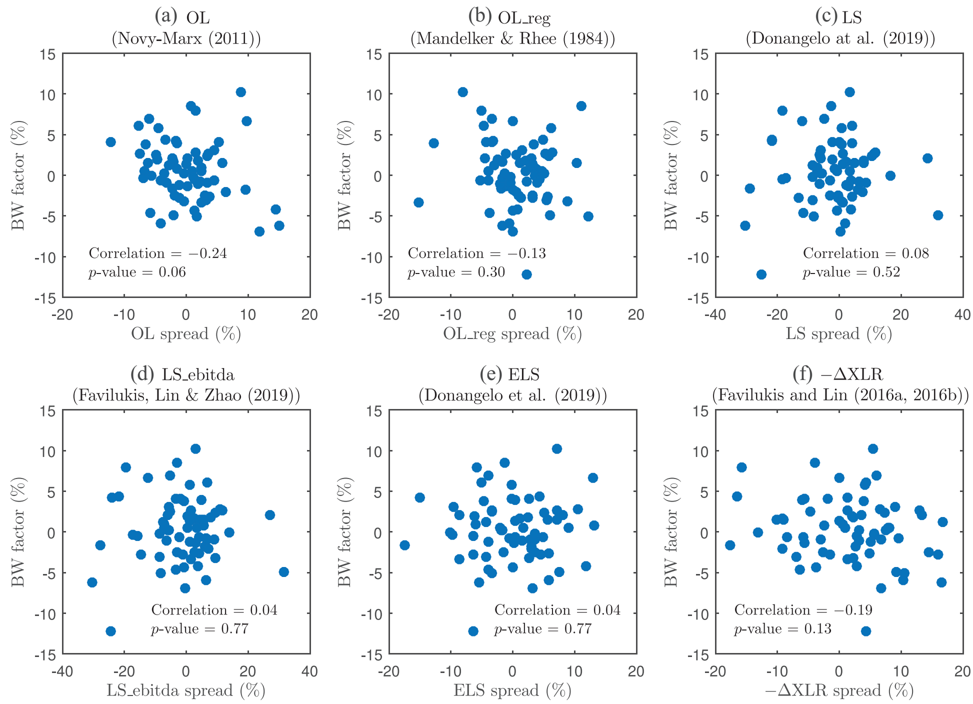

Figure 6. Correlation between the spreads of long-short portfolios sorted on the six existing measures of operating leverage and the financial constraints factor. (Color figure can be viewed at wileyonlinelibrary.com)

are, in fact, negatively related to both administrative expenses and executive compensation (see Internet Appendix Table IA.XII), which is in stark contrast with our ICC measure (see Table I). Intuitively, high-operating-leverage firms, according to the existing measures, are likely to be mature, low-growth firms, while high-ICC firms tend to be young, high-growth firms. Further, the operating leverage imposed by the ICC is driven mainly by administrative expenses, executive compensation, and innovation expenses, and mainly amplifies financial constraints shocks (see Figure 5). By contrast, the operating leverage imposed by labor costs for ordinary employees mainly amplifies productivity or demand shocks (e.g., Carlson, Fisher, and Giammarino (2004), Favilukis and Lin (2016a, b), Donangelo et al. (2019), Favilukis, Lin, and Zhao (2020)).

To further confirm that the ICC and existing measures of operating leverage capture different economic mechanisms, we show that the existing measures of operating leverage are not significantly correlated with measures of financial constraints. In Figure 6, we plot the spreads of the long-short portfolios sorted on each existing operating leverage measure against the financial constraints factor. There is virtually no correlation between the two time series, suggesting that the existing operating leverage measures have no clear association with the financial constraints channel, unlike our ICC measure (see Figure 5).

Moreover, in Internet Appendix Table IA.XIII, we show that the ICC spreads continue to hold after controlling for the existing measures of operating leverage.

A.4. Robustness

We also perform various double-sort analyses and show that the asset pricing implications of the ICC are robust and not explained by other firm characteristics, especially R&D activities (e.g., Li (2011), Hirshleifer, Hsu, and Li (2013, 2017)). We further verify the robustness of our results using the Fama-MacBeth regression method (Fama and MacBeth (1973)). See Internet Appendix Section IV.G for detailed results.

B. Turnover

B.1. The ICC and Talent Turnover

We first study the relationship between the ICC and executive turnover. We focus on the executives in the Execucomp database, which covers the top five executives of each S&P 1500 firm in terms of compensation.[28] We find that executive turnover rates are significantly higher in the firms with higher ICC (see columns (1) and (2) of Table VI). According to the specification with both year and industry fixed effects, a one-standard-deviation increase in ln(ICC) is associated with a 1.546-percentage-point increase in the probability of executive turnover each year, which is roughly one-eighth of the average turnover rate in the data.

Next, we study the relationship between the ICC and innovator turnover. We track the employment history of innovators based on the Harvard Business School patent and innovator database, which provides innovators' names and affiliations from 1975 to 2010. We find that the firms with higher ICC are associated with significantly higher innovator turnover rates (see columns (3) to (6) of Table VI). According to the specifications with both year and industry fixed effects, a one-standard-deviation increase in ln(ICC) is associated with an approximate 17.0% increase in leavers and an approximate 15.8% increase in new hires.

[28] Because Execucomp provides only limited information on the turnover of executives (especially for non-CEOs), we further merge Execucomp with BoardEx and use the employment history data in BoardEx to identify executive turnover. We focus on executive turnovers not caused by retirement because (i) retirement is mostly related to executive age, health, and lifestyle, none of which reflects a firm's decisions, and (ii) nonretirement turnover is more likely to hurt customer capital and thus is more relevant to the mechanism proposed in our paper. We follow the literature (e.g., Parrino (1997), Jenter and Kanaan (2015)) and use 60 as the retirement cutoff age. Our results are robust to using other age cutoffs such as 65. In Internet Appendix Section IV.H, we replicate the turnover analyses on two different samples: (i) CEOs only and (ii) all managers in the BoardEx data set. The relationship between the ICC and turnover continues to hold.

Table VI

The ICC and Talent Turnover

This table shows the relationship between the ICC and the turnover of executives and innovators. In columns (1) and (2), we study executive turnover. Turnover_t is an indicator variable equal to 1 for a given executive-year observation if the executive leaves the firm at age 59 or below, and 0 otherwise. In columns (3) to (6), we study innovator turnover. We classify an innovator as having a turnover in a given year if the innovator generates at least one patent in one firm and at least one patent in another firm later in the same year. If innovators leave their firms in a given year, they are classified as leavers of their former employers in that year. If innovators join new firms in a given year, they are classified as new hires of their new employers in that year. The dependent variables are the natural log of one plus the number of leavers (LnLeavers_t) and the natural log of one plus the number of new hires (LnNewHires_t). The main independent variable is lagged standardized ln(ICC). Firm controls include the natural log of firm market capitalization, the natural log of the book-to-market ratio, the natural log of the debt-to-equity ratio, the natural log of organization capital normalized by assets, and the stock return in the previous year. Executive controls include gender. We control for year fixed effects with and without SIC industry fixed effects. The executive turnover sample period is 1993 to 2016, whereas the innovator turnover sample period is 1993 to 2010. We include t-statistics in brackets. Standard errors are clustered by firm and year. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Executives		Innovators			
	$\text{Turnover}_t \times 100$		LnLeavers_t		LnNewHires_t	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(\text{ICC})_{t-1}$	1.653***	1.546***	0.163**	0.170**	0.156**	0.158**
	[3.621]	[3.232]	[2.198]	[2.299]	[2.097]	[2.113]
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Executive controls	Yes	Yes	n/a	n/a	n/a	n/a
Industry FEs	No	Yes	No	Yes	No	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,329	24,329	1,780	1,774	1,780	1,774
R^2	0.023	0.032	0.381	0.596	0.385	0.601

B.2. Interaction with Financial Constraints Risk

Our model implies that the positive relationship between the ICC and the turnover rate is stronger during periods of heightened financial constraints risk. Results in Section III.A above suggest that a low ICC spread is associated with heightened financial constraints risk. In this section, we thus include the interaction between ln(ICC) and the yearly ICC spread as the main independent variable.

Table VII shows that the coefficients on the interaction term are significantly negative, suggesting that the positive relationship between the ICC and talent turnover is indeed more pronounced during periods of heightened financial constraints risk. This interaction effect is economically significant. For example, according to the specification with year fixed effects (column (1)), when the ICC spread drops from its mean value (5.8%) to two standard deviations below

Table VII

The ICC and Talent Turnover: Interaction with Financial Constraints Risk

This table shows the relationship between talent turnover and the interaction between the ICC and the yearly ICC spread. The dependent variables, firm controls, executive controls, and fixed effects are defined in Table VI. The main independent variables are lagged standardized ln(ICC) and the product of lagged standardized ln(ICC) and lagged ICC spread. We omit the term ICC spread$_t$ in the regressions because it is absorbed by year fixed effects. The executive turnover sample spans the period from 1993 to 2016, whereas the innovator turnover sample spans the period from 1993 to 2010. We include t-statistics in brackets. Standard errors are clustered by firm and year. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Executives		Innovators			
	Turnover$_t$ × 100		LnLeavers$_t$		LnNewHires$_t$	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(ICC)$_{t-1}$	1.881***	1.758***	0.208***	0.209***	0.195**	0.194**
	[3.749]	[3.449]	[2.715]	[2.703]	[2.557]	[2.494]
ln(ICC)$_{t-1}$	−3.915**	−4.263**	−0.410***	−0.415**	−0.372***	−0.379*
× ICC spread$_t$	[−2.344]	[−2.533]	[−3.970]	[−2.672]	[−3.337]	[−2.052]
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Executive controls	Yes	Yes	n/a	n/a	n/a	n/a
Industry FEs	No	Yes	No	Yes	No	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,107	24,107	1,688	1,682	1,688	1,682
R^2	0.024	0.032	0.385	0.603	0.390	0.606

the mean (−27.5%), the sensitivity between ln(ICC) and executive turnover increases significantly (the coefficient changes from 1.654 to 2.958).

B.3. Interaction with Noncompete Enforceability

Our model implies that the positive relationship between the ICC and talent turnover is weaker for firms in which the value of outside options is lower for key talents (see Panel C of Figure 4). We therefore expect to see a weaker relationship for firms located in states with stronger enforceability of noncompete agreements because strictly enforced noncompete agreements decrease the value of outside options for key talents. To test this prediction, we exploit cross-state variation in the enforceability of noncompete agreements by including the interaction between the ICC and the noncompete enforceability index from Garmaise (2011) as the main independent variable.

As Table VIII shows, the coefficients on the interaction term are significantly negative, suggesting that the positive relationship between the ICC and talent turnover is indeed weaker when noncompete agreements are more strictly enforced. Consider column (4) as an example. Conditional on the weakest enforceability (index value = 0), a one-standard-deviation increase in ln(ICC) is associated with a 31.8% increase in the number of leavers. Conditional on the strongest enforceability (index value = 9), a one-standard-deviation increase

Table VIII

The ICC and Talent Turnover: Interaction with Noncompete Enforceability

This table shows the relationship between talent turnover and the interaction between the ICC and the noncompete enforceability index. The state-level noncompete enforceability index comes from Garmaise (2011). Higher values of the index represent stronger enforceability of noncompete agreements. The index is available from 1992 to 2004. The minimum, maximum, median, and mean of the index is 0, 9, 5, and 4.08, respectively. The standard deviation of the index is 1.83. Following Garmaise (2011), we map firms to the noncompete enforceability index based on the states in which firms' historical headquarters are located, which we obtain from García and Norli (2012). The dependent variables, firm controls, executive controls, and fixed effects are defined in Table VI. The main independent variables are lagged standardized ln(ICC), the lagged noncompete enforceability index, and their interaction. The sample period is 1993 to 2004. We include t-statistics in brackets. Standard errors are clustered by state. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Executives		Innovators			
	$\text{Turnover}_t \times 100$		LnLeavers_t		LnNewHires_t	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(\text{ICC})_{t-1}$	2.049***	2.360**	0.251**	0.318***	0.206**	0.255**
	[3.658]	[2.246]	[2.433]	[3.764]	[2.103]	[2.665]
$\ln(\text{ICC})_{t-1}$	−0.206*	−0.315**	−0.031**	−0.035**	−0.020**	−0.021**
$\times\ \text{Enforceability}_{s,t-1}$	[−1.875]	[−2.126]	[−2.361]	[−2.318]	[−2.714]	[−2.190]
$\text{Enforceability}_{s,t-1}$	−0.189**	−0.161*	−0.078**	−0.028**	−0.090**	−0.029**
	[−2.512]	[−1.997]	[−2.286]	[−2.064]	[−2.707]	[−2.433]
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Executive controls	Yes	Yes	N/a	N/a	N/a	N/a
Industry FEs	No	Yes	No	Yes	No	Yes
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,754	8,754	1,248	1,244	1,248	1,244
R^2	0.010	0.018	0.384	0.628	0.395	0.636

in ln(ICC) is associated with a 0.3% (insignificant) increase in the number of leavers.

IV. Quantitative Analyses

In this section, we conduct quantitative analyses. We first extend the baseline model with three additional ingredients in Section IV.A. Next, in Section IV.B, we calibrate the model's parameters and examine whether the model can replicate the main asset pricing and talent turnover findings from the data. Finally, we discuss the quantitative importance of different channels in Section IV.C.

A. Extended Quantitative Model

We extend our baseline model by incorporating the following three components as follows.

(i) Aggregate productivity shocks: We introduce aggregate productivity shocks as an additional risk to better match the data. The firm's output is affected by an aggregate productivity shock a_t that evolves according to

$$\mathrm{d}a_t = -\mu_a(a_t - \overline{a})\mathrm{d}t + \sigma_a\sqrt{a_t - \underline{a}}\mathrm{d}Z_{a,t}, \text{with } \mu_a > 0 \quad \text{and} \quad \overline{a} > \underline{a}, \tag{22}$$

where $Z_{a,t}$ is a standard Brownian motion independent of $Z_{c,t}$. We assume that $2\mu_a(\overline{a} - \underline{a}) > \sigma_a^2$ to guarantee $a_t > \underline{a}$. The pricing kernel (equation (7)) thus becomes

$$\frac{\mathrm{d}\Lambda_t}{\Lambda_t} = -r\mathrm{d}t + \sum_{x:\gamma_x=\gamma_t}\left[e^{-\kappa_x} - 1\right](\mathrm{d}N_{x,t} - q_x\mathrm{d}t) \underbrace{-\kappa_a\mathrm{d}Z_{a,t}}_{\text{productivity shock}}, \tag{23}$$

where $\kappa_a > 0$ is the market price of risk for aggregate productivity shocks. The extended model has four state variables (w_t, τ_t, γ_t, and a_t).

(ii) Exogenous firm-specific variation in the ICC: To better match the cross-sectional distribution of talent compensation, we introduce an exogenous firm-specific idiosyncratic shock $\mathrm{d}Z_{\omega,t}$ to firms' ICC. Thus, equation (8) becomes

$$\mathrm{d}\ln\tau_t = \underbrace{\mu_\tau(\ln\tau_t - \ln\overline{\tau})\mathrm{d}t + \left[\ln(1-m) - \ln(1-m\tau_t)\right]\mathrm{d}J_t}_{\text{baseline endogenous turnover}} + \underbrace{\sigma_\tau\sqrt{-\ln\tau_t}\mathrm{d}Z_{\tau,t}}_{\text{exogenous shock}}. \tag{24}$$

We assume that $-2\mu_\tau\ln\overline{\tau} > \sigma_\tau^2$. The process $Z_{\tau,t}$ is an idiosyncratic standard Brownian motion that is independent of $Z_{a,t}$ and $Z_{c,t}$.

(iii) Nonpecuniary private benefits: In addition to inalienability, we introduce another unique feature of customer capital—nonpecuniary private benefits. When managing a firm with customer capital B_t, key talents enjoy nonpecuniary private benefits hB_t with positive constant h.[29] The promise-keeping constraint equation (15) thus becomes

$$0 = \Lambda_t(\Gamma_t + hB_t)\mathrm{d}t + \mathbb{E}_t\left[\mathrm{d}\left(\Lambda_t U(B_t, \tau_t, a_t, \gamma_t)\right)\right]. \tag{25}$$

With the introduction of private benefits, all else equal, Γ_t decreases with B_t, which suggests that the firm with a weaker brand (smaller B_t) needs to offer a higher compensating wage differential to keep key talents, due to the smaller

[29] The assumption that nonpecuniary private benefits are proportional to customer capital B_t is motivated by findings and discussions in existing literature. For example, key talents can receive identity-based benefits (Akerlof and Kranton (2005)) from working at firms with strong brand value because firms with stronger brands offer key talents more opportunities for self-enhancement, greater visibility among their peers, and a higher probability of being seen as successful (Tavassoli, Sorescu, and Chandy (2014)). Moreover, future employers may rely on brand affiliation as a credible indicator of human capital quality. Thus, working for high brand value firms benefits key talents by signaling their unobserved ability (Weiss (1995)). Proportional nonpecuniary private benefits for key talents, hB_t, are commonly adopted in the literature for parsimony (e.g., Eisfeldt and Rampini (2008)).

Table IX
Calibration

Panel A: Externally Determined Parameters					
Risk-free rate	r	5%	Effective matching efficiency	ψ	0.75
Physical capital depreciation	δ_K	0.1	Sales hiring costs	η	2
Variable financing costs	φ	0.06	Customer capital depreciation	δ_B	0.15
Cash-carrying costs	ρ	1.5%	Customer capital damage rate	m	0.35
Fixed financing costs (L)	γ_L	0.005	Mean reversion of productivity	μ_a	0.275
Fixed financing costs (H)	γ_H	0.15	Price of productivity risk	κ_a	0.4
Transition rate (H to L)	q_H	0.2	Price of fin. risk (H to L)	κ_H	ln(3)
Transition rate (L to H)	q_L	0.16	Price of fin. risk (L to H)	κ_L	$-\ln(3)$
Panel B: Internally Calibrated Parameters					
Price of goods	p	0.59	Mean-reverting value (ICC)	$\overline{\tau}$	$e^{-0.9}$
Volatility of productivity	σ_a	0.15	Volatility of the ICC	σ_τ	0.19
Long-run average productivity	$\overline{a}$	0.8	Mean reversion of the ICC	μ_τ	0.038
Lower bound of productivity	$\underline{a}$	−1.37	Private benefits	h	0.009
Rent extraction rate	λ	0.06	Idiosyncratic cash flow shocks	σ_c	0.15
Sales hiring costs	α	5.0	Jump shocks (size)	f	0.3
Customer capital created	ℓ	0.3	Jump shocks (intensity)	ξ	0.12
Replacement intensity	θ_h	0.4			

nonpecuniary private benefits it offers. We provide supporting evidence in Internet Appendix Section IV.J.

B. Calibration and Parameter Choice

We discipline parameters based on both existing estimates and micro data. Table IX summarizes the values we use for the different parameters.

B.1. Externally Determined Parameters

The annual interest rate is $r = 5\%$. The depreciation rate of physical capital is $\delta_K = 10\%$ per year. We choose the variable financing cost $\varphi = 6\%$ based on the estimates of Altinkilic and Hansen (2000). Following Bolton, Chen, and Wang (2011, 2013), we set the carrying cost of cash to $\rho = 1.5\%$ and the fixed financing cost in the regime of low financial constraints risk to $\gamma_L = 0.5\%$. We set $\gamma_H = 15\%$.[30] The transition intensities, $q_L = 0.16$ and $q_H = 0.20$, are estimated using the regime-switching dynamics of the ICC spread. The estimates are consistent with the average length of business cycles, which is about 10 years.

[30] Our choice of γ_H is smaller than calibrations in existing literature. In a model without the ICC, Bolton, Chen, and Wang (2013) set $\gamma_H = 50\%$ and show that firms that run out of cash still prefer raising equity to liquidation. Gilchrist et al. (2017) choose a dilution cost of 50%, which is equivalent to setting our variable financing cost φ to 50%. Choosing a larger value of γ_H will strengthen the asset pricing implications of the ICC.

We set the effective matching efficiency to $\psi = 0.75$.[31] We consider a quadratic cost function of hiring sales representatives, that is, $\eta = 2$. We set $\delta_B = 15\%$, which is within the typical range of the annual customer turnover rate from 10% to 25% (Gourio and Rudanko (2014)). We set $m = 0.35$ so that, in our model, key talents leave with 35% of talent-dependent customer capital.[32]

We set the mean-reversion of productivity shocks to $\mu_a = 0.275$ following Gomes, Kogan, and Zhang (2003). We set the price of risk of productivity shocks to $\kappa_a = 0.4$, similar to Eisfeldt and Papanikolaou (2013), and the price of risk of financial constraints shocks to $\kappa_L = -\ln(3)$ and $\kappa_H = \ln(3)$, similar to Bolton, Chen, and Wang (2013).

B.2. Internally Calibrated Parameters

The remaining parameters are calibrated by matching relevant moments. We run 2,000 independent parallel simulations. In each simulation, we generate a sample of 1,000 firms for 55 years according to the solved policy functions; the first 30 years are dropped as burn-in, and thus we keep a 25-year simulated panel, putting our sample within the ballpark range. We then compute the model-implied moments and adjust parameters until these moments are in line with their values in the data. Table X reports the average value of these moments across 2,000 simulations.

We set the price of goods to $p = 0.59$ to get the average cash-to-asset ratio in line with the data. We set $\sigma_a = 0.15$ to match the volatility of the market portfolio's returns. We set the long-run average aggregate productivity to $\overline{a} = 0.8$ to match the average asset-to-sales ratio. The lower bound of aggregate productivity $\underline{a}$ is determined to ensure that production profits are always nonnegative, that is, $\underline{a} = -1.37$ so that $p = (r + \delta_K)/e^{\underline{a}}$.

We set the rent extraction rate to $\lambda = 0.06$ so that the retention bonuses lie between 30% and 70% of the compensation of key talents (Goyal and Wang (2017)). We set the hiring cost coefficient to $\alpha = 5.0$ to target the average advertising expenditures-to-sales ratio. We set $\ell = 0.3$ to match the average compensation of key talents as a percentage of sales. We set the talent replacement intensity to $\theta_h = 0.4$ to match the average executive turnover rate. We set cash

[31] In Internet Appendix Section I.A, we show that $\psi = \overline{\psi}\overline{n}^{\chi-1}$ in a model with micro-founded customer capital accumulation based on competitive search. The effective matching efficiency parameter ψ is calibrated as follows. We normalize the matching efficiency $\overline{\psi}$ and the disutility of search to one. We set $\chi = 1.12$, which implies that the elasticity parameter in the Cobb-Douglas matching function is $\frac{\chi-1}{\chi} = 0.11$, consistent with the estimate of Gourio and Rudanko (2014) based on the share of the labor force in sales-related occupations and the amount of time that consumers spend shopping. Finally, we set the maximum discount $\overline{n}$ to 0.10 to ensure that the firm makes profits from new customers even if the highest initial discounts are offered.

[32] Several papers develop models with this feature. For example, Lustig, Syverson, and Nieuwerburgh (2011) match the increase in intra-industry wage inequality by assuming that 50% of organization capital is transferred when the manager switches to a new firm. Eisfeldt and Papanikolaou (2013) assume that key talents can leave with all intangible capital. The benchmark calibration of Bolton, Wang, and Yang (2019b) assumes that the entrepreneur would be 20% less efficient if he or she walks away from the firm.

Table X
Moments in the Data and Model

Panel A: Aggregate Moments

	Data	Model		Data	Model
Cash/asset (%)	17.8	18.2	Talent turnover rate (%)	11.8	10.0
Vol. of market returns (%)	16.5	11.3	Vol. of net income/sales (%)	16.8	12.2
Asset/sales	2.9	2.8	Jump shock intensity	0.12	0.12
Retention bonuses (%)	30 to 70	46	Size of lumpy shocks	−0.16	−0.16
Advertising/sales (%)	5.1	4.4	Autocorrelation in ln(ICC)	0.96	0.95
Talent compens./sales (%)	14.9	13.3	Compens. reduction (%)	22.3	24.2

Panel B: Talent Compensation across Firm Groups Sorted on the ICC (i.e., τ_t in Model)

		1 (Low)	2	3	4	5 (High)
Talent compens./sales (%)	Data	9.6	10.7	12.4	17.2	24.9
	Model	3.4	8.5	13.0	17.6	23.8

Panel C: Nontargeted Moments across Firm Groups Sorted on the ICC (i.e., τ_t in Model)

		1 (Low)	2	3	4	5 (High)
Cash/asset (%)	Data	9.1	9.9	14.3	18.7	25.7
	Model	14.6	16.8	18.4	19.9	21.3
Talent turnover rate (%)	Data	10.9	11.9	11.5	11.6	13.3
	Model	9.0	9.7	10.1	10.3	10.8
Equity issuance/asset (%)	Data	0.9	1.0	1.2	2.3	3.4
	Model	1.1	1.2	1.3	1.4	1.7

flow shocks to $\sigma_c = 0.15$ to target the average volatility of the net income-to-sales ratio across firms. We calibrate the size of the lumpy negative cash flow shocks to $f = 0.3$ so that when these shocks arrive, the decrease in net income is about 16% of the firm's assets. The net income-to-asset ratio of -16% corresponds to the threshold that is 2.5 standard deviations below the median value in our sample.[33] Our choice of the size of lumpy negative cash flow shocks is conservative since we fix the jump size at the threshold level. In our Compustat sample, about 12% of the firm-year observations are below the threshold, and thus we set $\xi = 0.12$, which implies that lumpy cash flow shocks arrive every eight years on average for each firm.

Because our empirical ICC measure does not have the same units as τ_t in our model, we infer $\overline{\tau} = e^{-0.9}$ and $\sigma_\tau = 0.19$ by matching the cross-sectional distribution of the compensation of key talents.[34] The parameter $\mu_\tau = 0.038$

[33] Figure IA.5 in Internet Appendix Section IV.B plots a histogram of the net income-to-asset ratio in our Compustat sample. The distribution exhibits fat tails and is left skewed.

[34] Because key talents mainly include executives and innovators, we approximate the compensation of key talents using the sum of 50% of R&D expenses and administrative expenses. Many papers suggest that more than 50% of R&D expenses are wage payments to scientists, engineers, and other skilled technology workers (e.g., Lach and Schankerman (1989), Hall and Lerner (2010), Brown and Petersen (2011), Brown, Martinsson, and Petersen (2012)).

is calibrated to match the autocorrelation in ln(ICC). We calibrate the private benefit parameter $h = 0.009$ to match the decrease in compensation when executives move from the highest-ICC quintile to the lowest-ICC quintile.

B.3. Nontargeted Moments

We also check whether the model can match several nontargeted moments in the cross section. As shown in Panel C of Table X, the model implies that the high-ICC quintile holds more cash than the low-ICC quintile. Consistent with the data, the high-ICC quintile is also associated with a higher turnover rate of key talents and a greater amount of equity issuance. Overall, the model's quantitative implications on the relevant nontargeted moments are in line with the data.

C. Quantitative Results on Asset Pricing and Turnover

C.1. Asset Pricing

We now check whether our model can replicate the main asset pricing patterns quantitatively. Panel A of Table XI shows that the model-implied difference in portfolio alphas between Q1 and Q5 is about 4.78%, consistent with the difference in portfolio alphas in our data (4.13%) based on the CAPM.

In Panel B, we investigate the effect of financial constraints (FC) by conducting split-sample analysis. The difference in portfolio alphas between Q1 and Q5 is about 7.74% among the most financially constrained firms and 0.09% among the least financially constrained firms in our model. These spreads are fairly consistent with those in our data using the BW index to estimate the degree to which firms are financially constrained.

In Panel C, we examine whether the ICC spread can be explained by the financial constraints factor. In the data, the α for the ICC spread is 6.93% based on the CAPM, and it decreases to 5.45% after adding the financial constraints factor.[35] The difference is statistically significant, and the loading on the financial constraints factor is also positive and statistically significant. The α for the ICC spread, 5.45%, remains statistically significant after controlling for the market and financial constraints factors, suggesting that the ICC spread can be priced by other factors. In the model, the α for the ICC spread decreases from 4.78% to 0.97% after adding the financial constraints factor to the CAPM; the loading on this factor is 1.41 and statistically significant.

C.2. Turnover

The model's prediction on turnover is qualitatively consistent with the data. We first normalize our model's ICC τ_t by its unconditional mean and

[35] The α for the ICC spread based on the CAPM is different from the value reported in Panel A because the sample period in Panel C is different (1994 to 2010) given the availability of text-based financial constraints measures.

Table XI

Asset Pricing and Turnover Implications in the Model and Data

Panel A compares the value-weighted alphas of portfolios sorted on the ICC between the model and the data based on the CAPM. In the model, in each year t we sort the simulated firms into five quintiles based on their τ_t at the beginning of the year. We then compute the portfolio alphas of each quintile by regressing excess portfolio returns on the excess returns of the market portfolio, constructed using simulated data. Panel B reports the value-weighted CAPM α from split-sample analysis. We first sort firms into three groups based on their financial constraints (the BW index in the data and the marginal value of internal funds in the model). In each group, we further sort firms into five quintiles based on their ICC and construct the group-specific ICC spread using the returns of Q5 minus the returns of Q1. We run the CAPM for each group separately to obtain alphas. In Panel C, we focus on the long-short portfolio sorted on the ICC. In the data, the financial constraints factor is constructed based on the spreads of the long-short portfolio sorted on the financial constraints measures obtained from textual analysis (Buehlmaier and Whited (2018)). In the model, we construct the financial constraints factor using the spreads of the long-short portfolio sorted on a firm's marginal value of internal funds. Panel D tabulates the regression coefficients of talent turnover on $\ln(\text{ICC})_{t-1}$ and its interaction with the ICC spread$_{t-1}$ in the model and data (values come from Tables VI and VII). Equal-weighted results are similar in both the data and the model. All numbers from the model are based on the average value across 2,000 simulations, and p-values are computed accordingly.

Panel A: Portfolios Sorted on the ICC

	Data			Model		
Portfolio	ICC Q1	ICC Q5	Q5–Q1	ICC Q1	ICC Q5	Q5–Q1
CAPM α (%)	−1.66	2.47	4.13	−1.04	3.74	4.78
p-Value	0.100	0.277	0.048	0.131	0.060	0.025

Panel B: Long-Short Portfolios Sorted on the ICC (Q5–Q1) in Split Samples by FC

	Data			Model		
Split sample	Low FC	Mid FC	High FC	Low FC	Mid FC	High FC
CAPM α (%)	0.62	0.09	8.08	0.09	2.11	7.74
p-Value	0.451	0.488	0.022	0.634	0.078	0.017

Panel C: Long-Short Portfolio Sorted on the ICC (Q5–Q1)

	Data	Model
CAPM α for ICC spread (%)	6.93	4.78
Two-factor model (market + financial constraints) α for ICC spread (%)	5.45	0.97
p-Value for the difference in α	0.044	0.019
Loadings on the financial constraints factor in the two-factor model	0.94	1.41
p-Value for the loadings on the financial constraints factor	<0.001	<0.001

Panel D: Regressing Turnover on

	Data		Model	
ln(ICC)	1.546	1.758	2.076	2.191
ln(ICC) × ICC spread		−4.158		−8.657

Table XII

Inspecting the Model Mechanisms

All the numbers from the model are based on the average value across 2,000 simulations.

(All Numbers Are %)	Data (1)	Model (2)	$m = 0$ (3)	$\gamma_H, \varphi = 0$ (4)	$h = 0$ (5)	$\theta_h = \infty$ (6)	$\xi = 0$ (7)
CAPM α: Q5–Q1 (ICC)	5.98	4.78	1.45	0.62	3.45	1.33	4.58
Q5–Q1 (cash ratio)	N/a	3.74	1.69	0	2.75	1.12	3.17
Cash/asset: mean	15.6	18.2	16.8	0	21.1	14.1	15.8
Q5–Q1 (ICC)	16.6	6.7	5.2	0	7.4	3.0	3.4
Compens./sales: mean	14.9	13.3	5.7	15.2	14.5	17.6	22.7
Q5–Q1 (ICC)	15.3	20.4	9.3	21.7	20.9	6.1	15.6
Turnover rate: mean	11.8	10.0	0	0	12.2	71.5	3.2
Q5–Q1 (ICC)	2.4	1.8	0	0	2.3	7.2	0.9
Issuance/asset: mean	1.8	1.3	1.2	61.7	1.5	1.3	0.2
Q5–Q1 (ICC)	2.5	0.6	0.2	4.1	0.7	0.2	0.3

standard deviation, as in the data. Panel D of Table XI shows that a one-standard-deviation increase in ln(ICC) is associated with a 2.076-percentage-point increase in talent turnover in the model, whereas an increase of 1.546 percentage points can be seen in the data. With respect to the interaction effect with financial constraints risk (approximated by the ICC spread), Panel D shows that the coefficient is −8.657 in the model and −4.158 in the data.[36]

C.3. Inspecting the Mechanisms in the Model

In Table XII, we conduct quantitative comparative static analyses by turning off the key frictions one at a time. The crucial feature of customer capital is its inalienability associated with key talents. If we instead assume that the turnover of key talents does not damage customer capital (by setting $m = 0$), the CAPM α of the long-short portfolio sorted on the ICC would drop to 1.45%, and the annual turnover rate would also drop to zero (see columns (2) and (3) in Table XII). This is because the value of outside options is very low for key talents, and thus firms can keep key talents at very low cost. As the table shows, compensation accounts for only 5.7% of firm sales on average. Moreover, as firms become less financially constrained when talent compensation declines, they would issue less equity and the CAPM α of the long-short portfolio sorted on the cash ratio would also decline substantially to 1.69%.

If we assume that firms have access to a perfect financial market (by setting $\gamma_H = \varphi = 0$), the CAPM α of the long-short portfolio sorted on the ICC would drop significantly to 0.62% (compare columns (2) and (4) in Table XII). Moreover, both the spread on the cash ratio and the annual turnover rate would

[36] We do not report the model's quantitative implication on the interaction effect with noncompete enforceability Table VIII) because it is not clear how variation in the state-level noncompete enforcement index can be quantitatively mapped to variation in the model parameter m. However, as we show in Panel C of Figure 4, our model's prediction is qualitatively consistent with the data.

become zero. These results together suggest that the interaction between the ICC and financial constraints is what drives the quantitative implications of the model in the two cross sections. The average compensation-to-sales ratio would increase to 15.2% because now the value of key talents' outside options would be higher as the new firms they create do not face any financing frictions. Note that although compensation would increase, its effective cost would decrease, as the marginal value of internal funds is always equal to 1. Moreover, in the absence of financing costs, firms would not hold cash and thus they would issue equity whenever their contemporaneous net income turns negative. The firm's annual amount of equity issuance would increase to 61.7% of its assets on average, much larger than that in the data.

If we assume that no nonpecuniary private benefits are associated with customer capital (by setting $h = 0$), the CAPM α of the long-short portfolio sorted on the ICC and on the cash ratio would drop to 3.45% and 2.75%, respectively. The CAPM α would drop because nonpecuniary private benefits mitigate operating leverage for low-ICC firms to a greater extent (see columns (2) and (5) in Table XII). Key talents would demand 1.2% more compensation in the absence of nonpecuniary private benefits, making firms more financially constrained. This leads in turn to a 2.9% increase in the cash-to-asset ratio, a 2.2% increase in the annual turnover rate, and a 0.2% increase in the equity issuance-to-asset ratio.

If we assume that shareholders can replace key talents freely (by setting $\theta_h = \infty$), the implied annual turnover rate would increase to 71.5%, much larger than what we see in the data. Moreover, because replacing existing key talents with new talents that receive less compensation essentially reduces a firm's financial constraints, the CAPM α of the long-short portfolio sorted on the ICC and on the cash ratio would drop significantly to 1.33% and 1.12% respectively. Firms would hold less cash because of the ability to replace contracts (see columns (2) and (6) in Table XII), and the cash-to-asset ratio would drop to 14.1%, with a smaller difference in the cross section of the ICC. Moreover, the value of outside options for key talents would increase because they can now create a firm with no entrenchment. The average compensation-to-sales ratio would increase to 17.6%.

Finally, we study the role of lumpy negative cash flow shocks. If we assume that there are no lumpy cash flow shocks (by setting $\xi = 0$), the CAPM α of the long-short portfolio sorted on the ICC would decrease slightly to 4.58% and the CAPM α of that sorted on the cash ratio would decrease by about 0.57%, from 3.74% to 3.17% (see columns (2) and (7) in Table XII). Firms would become less financially constrained, hold less cash, and issue less equity. The high-ICC firms would reduce their cash holdings more than the low-ICC firms—the difference in average cash ratio between Q1 and Q5 would decrease from 6.7% to 3.4%. The average turnover rate would decrease to 3.2% even though the compensation-to-sales ratio would increase from 13.3% to 22.7% given the increase in the value of outside options for key talents.

V. Conclusions

This paper is the first to study the fragility of customer capital due to its inalienability caused by limited legal enforcement and, more importantly, its interaction with financial constraints such as those in Bolton, Chen, and Wang (2011, 2013). The model shows that financial constraints shocks (Whited and Wu (2006), Buehlmaier and Whited (2018)), as aggregate economic shocks, have strong asset pricing implications and are significantly priced in the cross section. In particular, the model shows that firms' heterogeneous response to aggregate financial constraints shocks, in terms of their stock returns and talent turnover rate, is simultaneously reflected in two cross sections—the cross section sorted on the ICC and that sorted on the extent to which firms are financially constrained.

Based on a proprietary, granular brand perception survey database, we find empirical evidence that strongly supports the model's implications. Firms with higher ICC have higher average (risk-adjusted) excess returns. The ICC spread is highly correlated with the financial constraints factor constructed based on Whited and Wu (2006) and Buehlmaier and Whited (2018). And firms with higher ICC are associated with a higher talent turnover rate, with this pattern more pronounced in periods of heightened financial constraints risk.

Initial submission: March 9, 2018; Accepted: September 16, 2019
Editors: Stefan Nagel, Philip Bond, Amit Seru, and Wei Xiong

REFERENCES

Aaker, David A., 2012, Building Strong Brands (Simon and Schuster, New York).

Ai, Hengjie, and Anmol Bhandari, 2018, Asset pricing with endogenously uninsurable tail risks, Working paper w24972, NBER.

Ai, Hengjie, Mariano Massimiliano Croce, and Kai Li, 2013, Toward a quantitative general equilibrium asset pricing model with intangible capital, *Review of Financial Studies* 26, 491–530.

Ai, Hengjie, and Dana Kiku, 2013, Growth to value: Option exercise and the cross section of equity returns, *Journal of Financial Economics* 107, 325–349.

Ai, Hengjie, and Rui Li, 2015, Investment and CEO compensation under limited commitment, *Journal of Financial Economics* 116, 452–472.

Ai, Hengjie, Kai Li, Jun Li, and Christian Schlag, 2020, The collateralizability premium, *Review of Financial Studies* 33, 5821–5855.

Akerlof, George A., and Rachel E. Kranton, 2005, Identity and the economics of organizations, *Journal of Economic Perspectives* 19, 9–32.

Albuquerque, Rui, and Hugo A. Hopenhayn, 2004, Optimal lending contracts and firm dynamics, *Review of Economic Studies* 71, 285–315.

Alfaro, Ivan, Nicholas Bloom, and Xiaoji Lin, 2018, The finance uncertainty multiplier, NBER Working Paper No. 24571.

Altinkilic, Oya, and Robert S. Hansen, 2000, Are there economies of scale in underwriting fees? Evidence of rising external financing costs, *Review of Financial Studies* 13, 191–218.

Alvarez, Fernando, and Urban J. Jermann, 2000, Efficiency, equilibrium, and asset pricing with risk of default, *Econometrica* 68, 775–797.

Alvarez, Fernando, and Urban J. Jermann, 2001, Quantitative asset pricing implications of endogenous solvency constraints, *Review of Financial Studies* 14, 1117–1151.

Arrow, Kenneth, 1999, Observations on social capital, in I. Serageldin, and P. Dasgupta, eds.: Social Capital: A Multifaceted Perspective (The World Bank, Washington, DC).

Babina, Tania, 2020, Destructive creation at work: How financial distress spurs entrepreneurship, *Review of Financial Studies* 33, 4061–4101.

Baghai, Ramin, Rui Silva, Viktor Thell, and Vikrant Vig, 2017, Talent in distressed firms: Investigating the labor costs of financial distress, SSRN Working paper.

Banerjee, Shantanu, Sudipto Dasgupta, and Yungsan Kim, 2008, Buyer-supplier relationships and the stakeholder theory of capital structure, *Journal of Finance* 63, 2507–2552.

Baron, Matthew, and Wei Xiong, 2017, Credit expansion and neglected crash risk, *Quarterly Journal of Economics* 132, 713–764.

Belo, Frederico, and Xiaoji Lin, 2012, The inventory growth spread, *Review of Financial Studies* 25, 278–313.

Belo, Frederico, Xiaoji Lin, and Santiago Bazdresch, 2014, Labor hiring, investment, and stock return predictability in the cross section, *Journal of Political Economy* 122, 129–177.

Belo, Frederico, Xiaoji Lin, Jun Li, and Xiaofei Zhao, 2017, Labor-force heterogeneity and asset prices: The importance of skilled labor, *Review of Financial Studies* 30, 3669–3709.

Belo, Frederico, Xiaoji Lin, and Maria Ana Vitorino, 2014, Brand capital and firm value, *Review of Economic Dynamics* 17, 150–169.

Belo, Frederico, Xiaoji Lin, and Fan Yang, 2019, External equity financing shocks, financial flows, and asset prices, *Review of Financial Studies* 32, 3500–3543.

Berk, Jonathan B., Richard C. Green, and Vasant Naik, 1999, Optimal investment, growth options, and security returns, *Journal of Finance* 54, 1553–1607.

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

Bloom, Nicholas, 2009, The impact of uncertainty shocks, *Econometrica* 77, 623–685.

Bloom, Nicholas, and John Van Reenen, 2007, Measuring and explaining management practices across firms and countries, *Quarterly Journal of Economics* 122, 1351–1408.

Bolton, Patrick, Hui Chen, and Neng Wang, 2011, A unified theory of Tobin's q, corporate investment, financing, and risk management, *Journal of Finance* 66, 1545–1578.

Bolton, Patrick, Hui Chen, and Neng Wang, 2013, Market timing, investment, and risk management, *Journal of Financial Economics* 109, 40–62.

Bolton, Patrick, Jose Scheinkman, and Wei Xiong, 2006, Executive compensation and short-termist behaviour in speculative markets, *Review of Economic Studies* 73, 577–610.

Bolton, Patrick, Neng Wang, and Jinqiang Yang, 2019a, Investment under uncertainty with financial constraints, *Journal of Economic Theory* 184, 104912.

Bolton, Patrick, Neng Wang, and Jinqiang Yang, 2019b, Optimal contracting, corporate finance, and valuation with inalienable human capital, *Journal of Finance* 74, 1363–1429.

Bradley, Michael, and Michael Rosenzweig, 1992, The untenable case for chapter 11, *Yale Law Review* 101, 1043–1089.

Bronnenberg, Bart J., Jean-Pierre H. Dubé, and Matthew Gentzkow, 2012, The evolution of brand preferences: Evidence from consumer migration, *American Economic Review* 102, 2472–2508.

Brown, James R., Gustav Martinsson, and Bruce C. Petersen, 2012, Do financing constraints matter for R&D? *European Economic Review* 56, 1512–1529.

Brown, James R., and Bruce C. Petersen, 2011, Cash holdings and R&D smoothing, *Journal of Corporate Finance* 17, 694–709.

Brown, Jennifer, and David A. Matsa, 2016, Boarding a sinking ship? An investigation of job applications to distressed firms, *Journal of Finance* 71, 507–550.

Buehlmaier, Matthias M. M., and Toni M. Whited, 2018, Are financial constraints priced? Evidence from textual analysis, *Review of Financial Studies* 31, 2693–2728.

Buera, Francisco J., and Yongseok Shin, 2013, Financial frictions and the persistence of history: A quantitative exploration, *Journal of Political Economy* 121, 221–272.

Campbell, John, Jens Hilscher, and Jan Szilagyi, 2008, In search of distress risk, *Journal of Finance* 63, 2899–2939.

Carhart, Mark M., 1997, On persistence in mutual fund performance, *Journal of Finance* 52, 57–82.

Carlson, Murray, Adlai Fisher, and Ron Giammarino, 2004, Corporate investment and asset price dynamics: Implications for the cross-section of returns, *Journal of Finance* 59, 2577–2603.

Chen, Hui, Winston Dou, Hongye Guo, and Yan Ji, 2020, Feedback and contagion through distressed competition, Working paper, University of Pennsylvania.

Chevalier, Judith A., and David S. Scharfstein, 1996, Capital-market imperfections and countercyclical markups: Theory and evidence, *American Economic Review* 86, 703–725.

Cochrane, John H., 1991, Production-based asset pricing and the link between stock returns and economic fluctuations, *Journal of Finance* 46, 209–237.

D'Acunto, Francesco, Ryan Liu, Carolin Pflueger, and Michael Weber, 2018, Flexible prices and leverage, *Journal of Financial Economics* 129, 46–68.

Daniel, Kent, and Tobias J. Moskowitz, 2016, Momentum crashes, *Journal of Financial Economics* 122, 221–247.

DeMarzo, Peter, and Yuliy Sannikov, 2006, Optimal security design and dynamic capital structure in a continuous-time agency model, *Journal of Finance* 61, 2681–2724.

DeMarzo, Peter M., Michael J. Fishman, Zhiguo He, and Neng Wang, 2012, Dynamic agency and the q theory of investment, *Journal of Finance* 67, 2295–2340.

Donangelo, Andres, Francois Gourio, Matthias Kehrig, and Miguel Palacios, 2019, The cross-section of labor leverage and equity returns, *Journal of Financial Economics* 132, 497–518.

Dou, Winston, and Yan Ji, 2020, External financing and customer capital: A financial theory of markups, *Management Science* (forthcoming).

Dou, Winston, Yan Ji, and Wei Wu, 2020a, Competition, profitability, and discount rates, *Journal of Financial Economics* (forthcoming).

Dou, Winston, Yan Ji, and Wei Wu, 2020b, The oligopoly Lucas tree: Consumption risk and industry-level risk exposure, Working paper, University of Pennsylvania.

Dumas, Bernard, 1989, Perishable investment and hysteresis in capital formation, NBER Working paper.

Durlauf, Steven N., 2002, On the empirics of social capital, *The Economic Journal* 112, F459–F479.

Durlauf, Steven N., and Marcel Fafchamps, 2005, Social capital, in Philippe Aghion, and Steven Durlauf, eds.: Handbook of Economic Growth (Elsevier, Amsterdam).

Eisfeldt, Andrea L., and Tyler Muir, 2016, Aggregate external financing and savings waves, *Journal of Monetary Economics* 84, 116–133.

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

Eisfeldt, Andrea L., and Adriano A. Rampini, 2008, Managerial incentives, capital reallocation, and the business cycle, *Journal of Financial Economics* 87, 177–199.

Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3–56.

Fama, Eugene F., and Kenneth R. French, 2015, A five-factor asset pricing model, *Journal of Financial Economics* 116, 1–22.

Fama, Eugene F., and James D. MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, *Journal of Political Economy* 81, 607–636.

Faulkender, Michael, and Rong Wang, 2006, Corporate financial policy and the value of cash, *Journal of Finance* 61, 1957–1990.

Favilukis, Jack, and Xiaoji Lin, 2016a, Does wage rigidity make firms riskier? Evidence from long-horizon return predictability, *Journal of Monetary Economics* 78, 80–95.

Favilukis, Jack, and Xiaoji Lin, 2016b, Wage rigidity: A quantitative solution to several asset pricing puzzles, *Review of Financial Studies* 29, 148–192.

Favilukis, Jack Y., Xiaoji Lin, and Xiaofei Zhao, 2020, The elephant in the room: The impact of labor obligations on credit markets, *American Economic Review* 110, 1673–1712.

Fresard, Laurent, 2010, Financial strength and product market behavior: The real effects of corporate cash holdings, *Journal of Finance* 65, 1097–1122.

García, Diego, and Øyvind Norli, 2012, Geographic dispersion and stock returns, *Journal of Financial Economics* 106, 547–565.

Garlappi, Lorenzo, Tao Shu, and Hong Yan, 2008, Default risk, shareholder advantage, and stock returns, *Review of Financial Studies* 21, 2743–2778.

Garlappi, Lorenzo, and Hong Yan, 2011, Financial distress and the cross-section of equity returns, *Journal of Finance* 66, 789–822.

Garmaise, Mark J., 2011, Ties that truly bind: Noncompetition agreements, executive compensation, and firm investment, *Journal of Law, Economics, and Organization* 27, 376–425.

Gerzema, John, and Edward Lebar, 2008, The Brand Bubble: The Looming Crisis in Brand Value and How to Avoid It (Jossey-Bass, San Francisco, CA).

Gilchrist, Simon, Raphael Schoenle, Jae Sim, and Egon Zakrajsek, 2017, Inflation dynamics during the financial crisis, *American Economic Review* 107, 785–823.

Gilchrist, Simon, and Egon Zakrajšek, 2012, Credit supply shocks and economic activity in a financial accelerator model, in Alan Blinder, Andrew Lo, and Robert Solow, eds.: Rethinking the Financial Crisis (Russell Sage Foundation, New York).

Gilson, Stuart C., and Michael R. Vetsuypens, 1993, CEO Compensation in financially distressed firms: An empirical analysis, *Journal of Finance* 48, 425–458.

Glaeser, Edward L., David Laibson, Jose A. Scheinkman, and Christine L. Soutter, 1999, What is social capital? The determinants of trust and trustworthiness, Harvard Institute of Economic Research Working Papers 1875.

Gomes, Joao, Leonid Kogan, and Lu Zhang, 2003, Equilibrium cross section of returns, *Journal of Political Economy* 111, 693–732.

Gomes, Joao F., 2001, Financing investment, *American Economic Review* 91, 1263–1285.

Gomes, Joao F., and Lukas Schmid, 2010, Levered returns, *Journal of Finance* 65, 467–494.

Gomes, Joao F., Amir Yaron, and Lu Zhang, 2006, Asset pricing implications of firms' financing constraints, *The Review of Financial Studies* 19, 1321–1356.

Gourio, Francois, and Leena Rudanko, 2014, Customer capital, *Review of Economic Studies* 81, 1102–1136.

Goyal, Vidhan K., and Wei Wang, 2017, Provision of management incentives in bankrupt firms, *Journal of Law, Finance, and Accounting* 2, 87–123.

Graham, John R., 2000, How big are the tax benefits of debt? *Journal of Finance* 55, 1901–1941.

Grullon, Gustavo, George Kanatas, and James P. Weston, 2004, Advertising, breadth of ownership, and liquidity, *Review of Financial Studies* 17, 439–461.

Hadlock, Charles J., and Joshua R. Pierce, 2010, New evidence on measuring financial constraints: Moving beyond the KZ index, *Review of Financial Studies* 23, 1909–1940.

Hall, Bronwyn H., and Josh Lerner, 2010, The financing of R&D and innovation, *Handbook of the Economics of Innovation* 1, 609–639.

Hall, Robert E., and Dale W. Jorgenson, 1969, Tax policy and investment behavior: Reply and further results, *The American Economic Review* 59, 388–401.

Hamada, Robert S., 1972, The effect of the firm's capital structure on the systematic risk of common stocks, *Journal of Finance* 27, 435–452.

Hart, Oliver, and John Moore, 1994, A theory of debt based on the inalienability of human capital, *Quarterly Journal of Economics* 109, 841–879.

Henderson, M. Todd, 2007, Paying CEOs in bankruptcy: Executive compensation when agency costs are low, *Northwestern University Law Review* 101, 1543–1618.

Hirshleifer, David, Po-Hsuan Hsu, and Dongmei Li, 2013, Innovative efficiency and stock returns, *Journal of Financial Economics* 107, 632–654.

Hirshleifer, David, Po-Hsuan Hsu, and Dongmei Li, 2017, Innovative originality, profitability, and stock returns, *Review of Financial Studies* 31, 2553–2605.

Holmstrom, Bengt, 1979, Moral hazard and observability, *Bell Journal of Economics* 10, 74–91.

Holmstrom, Bengt, and Paul Milgrom, 1987, Aggregation and linearity in the provision of intertemporal incentives, *Econometrica* 55, 303–328.

Hou, Kewei, Chen Xue, and Lu Zhang, 2015, Digesting anomalies: An investment approach, *Review of Financial Studies* 28, 650–705.

Iyer, Rajkamal, Jose-Luis Peydro, Samuel da Rocha-Lopes, and Antoinette Schoar, 2014, Interbank liquidity crunch and the firm credit crunch: Evidence from the 2007–2009 crisis, *Review of Financial Studies* 27, 347–372.

Jenter, Dirk, and Fadi Kanaan, 2015, CEO turnover and relative performance evaluation, *Journal of Finance* 70, 2155–2184.

Jermann, Urban, and Vincenzo Quadrini, 2012, Macroeconomic effects of financial shocks, *American Economic Review* 102, 238–271.

Jorgenson, Dale, 1963, Capital theory and investment behavior, *American Economic Review* 53, 247–259.

Kaplan, Steven N., and Luigi Zingales, 1997, Do investment-cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics* 112, 169–215.

Keller, Kevin Lane, 2008, Strategic Brand Management: Building, Measuring, and Managing Brand Equity (Pearson Education, London).

Kogan, Leonid, and Dimitris Papanikolaou, 2014, Growth opportunities, technology shocks, and asset prices, *Journal of Finance* 69, 675–718.

Kogan, Leonid, Dimitris Papanikolaou, Amit Seru, and Noah Stoffman, 2017, Technological innovation, resource allocation, and growth, *Quarterly Journal of Economics* 132, 665–712.

Koh, Ping-Sheng, and David M. Reeb, 2015, Missing R&D, *Journal of Accounting and Economics* 60, 73–94.

Kumar, Praveen, and Dongmei Li, 2016, Capital investment, innovative capacity, and stock returns, *Journal of Finance* 71, 2059–2094.

Lach, Saul, and Mark Schankerman, 1989, Dynamics of R&D and investment in the scientific sector, *Journal of Political Economy* 97, 880–904.

Larkin, Yelena, 2013, Brand perception, cash flow stability, and financial policy, *Journal of Financial Economics* 110, 232–253.

Lev, Baruch, 1974, On the association between operating leverage and risk, *Journal of Financial and Quantitative Analysis* 9, 627–641.

Li, Dongmei, 2011, Financial constraints, R&D investment, and stock returns, *Review of Financial Studies* 24, 2974–3007.

Li, Guan-Cheng, Ronald Lai, Alexander D'Amour, David M. Doolin, Ye Sun, Vetle I. Torvik, Z. Yu Amy, and Lee Fleming, 2014, Disambiguation and co-authorship networks of the U.S. patent inventor database (1975–2010), *Research Policy* 43, 941–955.

Livdan, Dimitry, Horacio Sapriza, and Lu Zhang, 2009, Financially constrained stock returns, *Journal of Finance* 64, 1827–1862.

Lovett, Mitchell, Renana Peres, and Ron Shachar, 2014, A data set of brands and their characteristics, *Marketing Science* 33, 609–617.

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

Mandelker, Gershon N., and S. Ghon Rhee, 1984, The impact of the degrees of operating and financial leverage on systematic risk of common stock, *Journal of Financial and Quantitative Analysis* 19, 45–57.

Mizik, Natalie, and Robert Jacobson, 2008, The financial value impact of perceptual brand attributes, *Journal of Marketing Research* 45, 15–32.

Moll, Benjamin, 2014, Productivity losses from financial frictions: Can self-financing undo capital misallocation? *American Economic Review* 104, 3186–3221.

Nagel, Stefan, 2005, Short sales, institutional investors and the cross-section of stock returns, *Journal of Financial Economics* 78, 277–309.

Novy-Marx, Robert, 2011, Operating leverage, *Review of Finance* 15, 103–134.

Parrino, Robert, 1997, CEO turnover and outside succession a cross-sectional analysis, *Journal of Financial Economics* 46, 165–197.

Pástor, Ľuboš, and Robert F. Stambaugh, 2003, Liquidity risk and expected stock returns, *Journal of Political Economy* 111, 642–685.

Phillips, Gordon, and Giorgo Sertsios, 2013, How do firm financial conditions affect product quality and pricing? *Management Science* 59, 1764–1782.

Rampini, Adriano A., and S. Viswanathan, 2013, Collateral and capital structure, *Journal of Financial Economics* 109, 466–492.

Riddick, Leigh A., and Toni M. Whited, 2009, The corporate propensity to save, *Journal of Finance* 64, 1729–1766.

Rubinstein, Mark E., 1973, A mean-variance synthesis of corporate financial theory, *Journal of Finance* 28, 167–181.

Rudanko, Leena, 2017, The value of loyal customers, *FRB Philadelphia Economic Insights* 2, 11–17.

Schularick, Moritz, and Alan M. Taylor, 2012, Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870–2008, *American Economic Review* 102, 1029–1061.

Shleifer, Andrei, and Robert W. Vishny, 1990, Equilibrium short horizons of investors and firms, *American Economic Review* 80, 148–153.

Sircar, Ronnie, and Wei Xiong, 2007, A general framework for evaluating executive stock options, *Journal of Economic Dynamics and Control* 31, 2317–2349.

Sobel, Joel, 2002, Can we trust social capital? *Journal of Economic Literature* 40, 139–154.

Stein, Jeremy C., 1988, Takeover threats and managerial myopia, *Journal of Political Economy* 96, 61–80.

Stein, Jeremy C., 1989, Efficient capital markets, inefficient firms: A model of myopic corporate behavior, *Quarterly Journal of Economics* 104, 655–669.

Tavassoli, Nader T., Alina Sorescu, and Rajesh Chandy, 2014, Employee-based brand equity: Why firms with strong brands pay their executives less, *Journal of Marketing Research* 51, 676–690.

Taylor, Lucian A., 2010, Why are CEOs rarely fired? Evidence from structural estimation, *Journal of Finance* 65, 2051–2087.

Titman, Sheridan, 1984, The effect of capital structure on a firm's liquidation decision, *Journal of Financial Economics* 13, 137–151.

Titman, Sheridan, and Roberto Wessels, 1988, The determinants of capital structure choice, *Journal of Finance* 43, 1–19.

Vitorino, Maria Ana, 2014, Understanding the effect of advertising on stock returns and firm value: Theory and evidence from a structural model, *Management Science* 60, 227–245.

Weiss, Andrew, 1995, Human capital vs. signalling explanations of wages, *Journal of Economic Perspectives* 9, 133–154.

Whited, Toni M., and Guojun Wu, 2006, Financial constraints risk, *Review of Financial Studies* 19, 531–559.

Zhang, Lu, 2005, The value premium, *Journal of Finance* 60, 67–103.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1: Internet Appendix.
Replication Code.