Organization Capital and the Cross-Section of Expected Returns*

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Abstract

Organization capital is a production factor that is embodied in the firm's key talent and has an efficiency that is firm specific. As a result, both shareholders and management have a claim on the cash flows accruing from organization capital. Because the division of rents between shareholders and key talent can systematically vary over time, shareholders investing in organization capital are exposed to additional risks. In our model, key talent can transfer a fraction of the firm's organization capital to a new enterprise, and the benefits of this reallocation vary systematically. This outside option determines the division of cash flows from organization capital between shareholders and key talent, and renders firms with high organization capital riskier. We construct a measure of organization capital based on readily available accounting data and find that firms with more organization capital relative to their industry peers outperform firms with less organization capital by 4.7% per year. This dispersion in risk premia is not explained by the CAPM, the Fama and French (1993) or Carhart (1997) models. Our model offers additional testable implications that are supported by the data.

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Economists have long recognized the importance of organization capital. In the first chapter of "The Wealth of Nations," Adam Smith describes how the process of manufacturing a pin is divided into 18 separate steps. If each man had "wrought separately and independently, they certainly could not each of them have made twenty." However, production was organized so that a single worker would perform a small number of these discrete tasks. In this manner, Smith states that "ten men could make some 48,000 pins a day," increasing productivity by a factor of 240. This set of processes that enhance a firm's output, holding labor and physical capital fixed, is an example of organization capital. In this paper, we develop a structural model to explore the effect of organization capital on asset prices. We argue that shareholders consider firms with high levels of organization capital to be riskier than firms with more physical capital, and provide empirical evidence supporting this claim.

Organization capital is a durable input in production that is distinct from physical capital. In our model, the distinguishing features of organization capital are that its efficiency is partly firm specific and that it is embodied in the firm's key talent. Together, these two characteristics imply that both shareholders and key talent have a claim on the cash flows accruing from organization capital. Consider a production supervisor from Adam Smith's factory. This manager has knowledge about the production process in the pin factory, hence she embodies some of the factory's organization capital. If she chose to, she could start her own pin factory and mimic her old factory's production process. Her benefit from leaving her existing firm depends on the effectiveness of her new firm in deploying the transferred organization capital. Depending on the value of her outside option, she may be able to negotiate an increase in her compensation to induce her to stay with the existing firm. Thus, she would be able to extract some rents from the organization capital that she embodies.

We argue that shareholders investing in firms with high organization capital are exposed to additional risks, because they can appropriate only a fraction of the cash flows from organization capital. The cash flows which accrue to shareholders are jointly determined by the fundamental shocks driving the productivity of organization capital within the firm, as well as by the shocks determining the division of surplus between shareholders and key talent. As a result, even if the total cash flows from organization and physical capital have the same exposure to systematic risks, the share of cash flows that accrue to shareholders can have distinct dynamic properties. Our model features a shock to the level of productivity of organization capital deployed in new firms, which we refer to as the level of frontier organization capital technology. This shock could reflect the 'state-of-the-art' organization practices, or the ease of reallocating resources to new firms. The frontier technology shock determines the outside option of key talent and hence the share of cash flows from organization capital that shareholders can appropriate. Thus, the shareholders' cash flows from physical and organization capital can have different risk exposures to the frontier technology shock. As a result, heterogeneity in firms' asset composition between physical and organization capital leads to differences in risk premia.

To study the empirical relation between organization capital and risk premia, we construct a measure of organization capital using widely available accounting data. Following the accounting literature on measuring organization capital (see Lev and Radhakrishnan (2005)), we measure the stock of organization capital by accumulating firms' Selling, General, and Administrative (SG&A) expenses using the perpetual inventory method.[1] We rank firms based on their ratio of organization capital to book assets relative to their industry peers, since the accounting treatment of SG&A expenses varies across industries.

Our measure of organization capital is correlated with a number of firm characteristics in a manner that is consistent with our model. After controlling for physical capital and labor, we find that firms with higher levels of organization capital to book assets (O/K) have higher output. Both in the data and in the model, high-O/K firms are smaller, have higher Tobin's Q and display higher levels of executive compensation. In addition, high-O/K firms have higher managerial quality scores according to the measure of Bloom and Van Reenen (2007), and are more likely to list 'loss of key personnel' as a risk factor in their 10K filings.

The evidence suggests that shareholders demand higher risk premia to invest in firms with high levels of organization capital relative to firms with more physical capital. We document this difference in risk premia by constructing a portfolio that is long firms with more organization capital relative to their peers (high-O/K) and is short firms with more physical capital relative to their peers (low-O/K). The portfolio of firms with high- minus low-O/K (the OMK portfolio) has average returns of 4.7% per year and a Sharpe ratio close to the market portfolio. Moreover, the OMK portfolio is uncorrelated with other risk factors such as the market portfolio, size, value or momentum. Thus, the dispersion in expected returns arising from heterogeneity in the ratio of organization capital to assets is not explained by the CAPM, the Fama and French (1993) or Carhart (1997) models. Our model implies that this spread in average returns arises because the OMK portfolio is negatively correlated with the systematic frontier technology shock. Consistent with this prediction, a two-factor model that includes the market and the OMK portfolio prices the cross-section of firms sorted on O/K or on their beta with the OMK portfolio.

Our model can quantitatively replicate these findings, matching the dispersion in firm characteristics and risk premia associated with organization capital. The calibrated model

[1] Lev and Radhakrishnan (2005) argue that the SG&A expense includes most of the expenditures that generate organization capital. Our methodology is also consistent with advice from popular textbooks on value investing, which advocate capitalizing SG&A expenses to detect off balance sheet sources of firm value (Greenwald, Kahn, Sonkin and Biema, 2004).

matches the observed difference in average returns between high and low organization capital firms, assuming the restructuring shock carries a negative premium. We argue that a negative risk premium on the frontier technology shock is consistent with general equilibrium. An improvement in the frontier technology leads to more restructuring and reallocation of organization capital from old firms into new firms. Since restructuring entails substantial costs, high reallocation states should be characterized by lower consumption in the short run. In the long run consumption increases, as more firms upgrade to the frontier technology. Thus, our frontier technology shock generates similar consumption dynamics to those generated by investment shocks. The assumption of a negative premium on the frontier shock is consistent with the findings of Papanikolaou (2011), who argues that investment shocks lead to high marginal utility of wealth.

Our model delivers a number of additional testable implications. In particular, the realized return of the OMK portfolio should be negatively correlated with the aggregate level of compensation to key talent, the level of reallocation and the level of investment in organization capital. Furthermore, our model implies that the sensitivity of firm profits to firm output increases with the ratio of organization to physical capital, whereas the sensitivity of firm profits to aggregate output is the same across firms. We find support for these implications in the data.

In summary, our work identifies a new source of risk for shareholders: systematic fluctuations in the division of surplus between key talent and shareholders. From the perspective of shareholders, investing in key talent and organization capital is risky, since unlike physical capital, shareholders do not own all the cashflow rights. Key talent may leave the firm when their outside option exceeds their inside value. Consequently, organization capital has risk characteristics distinct from those of physical capital, and the risk inherent in this type of specific and intangible form of capital requires significant risk premia.

1 Related research

Our paper belongs to a growing body of work that explores the role of organization capital in the production process and analyzes its properties. Prescott and Visscher (1980) present a theory of organization capital as "firm-specific human capital" and derive implications for firm growth and size. Hall (2000b) models the process of accumulation and deterioration of organization capital, illustrating the similarities with physical capital. Atkeson and Kehoe (2005) argue that organization capital is an important input into firms' production and measure its contribution using a structural model. Carlin, Chowdhry and Garmaise (2011) study the firm's investment in organization capital by developing a model of intra-firm communication. Lustig, Syverson and Van Nieuwerburgh (2011) analyze the effect of technological innovation and organization capital on managerial compensation. Lustig et al. argue that the growing importance of organization capital in the production process is one of the leading causes in the observed increase in compensation inequality and pay for performance sensitivity, and the accompanying decrease in labor market reallocation. Our work builds upon Atkeson and Kehoe (2005) and Lustig et al. (2011), and introduces a common stochastic component in the productivity of organization capital in new firms, or frontier technology using the language of Atkeson and Kehoe. This stochastic component affects the division of surplus between shareholders and key talent, and thus represents a source of systematic risk that shareholders demand compensation for. We contribute to this literature by analyzing the effect of this systematic source of risk on the valuation of organization capital.

Our model is consistent with a set of stylized features of the data. Jovanovic and Rousseau (2001) provide evidence that the productivity of organization capital varies by vintage, consistent with the presence of a systematic component in the productivity of organization capital in new firms. Foster, Haltiwanger and Krizan (2001) argue that reallocation is an integral determinant of productivity growth. However, Foster et al. show that reallocation is accompanied with a costly period of learning. This reallocation cost can induce investors to place a high value on resources in states where corporate restructuring occurs. In our model, this reallocation or restructuring occurs following improvements in organization technology. In our model, the frontier technology shock bears important similarities to investment shocks. Papanikolaou (2011) provides evidence that states with good investment opportunities are states where the marginal value of wealth is high.

Moreover, our paper is related to the asset-pricing literature concerned with deriving joint implications for firm valuation and investment decisions. Berk, Green and Naik (1999), Gomes, Kogan and Zhang (2003) and Kogan and Papanikolaou (2010) show how the composition of firm value between growth opportunities and assets in place can lead to differences in systematic risk exposures across firms. Zhang (2005) illustrates how asymmetric adjustment costs and operating leverage can lead to the value premium. Bazdrech, Belo and Lin (2009) extend the model in Zhang (2005) to allow for adjustment costs to labor and find a negative relationship between labor hiring rates and average returns. Lin (2009) and Belo, Vitorino and Lin (2011) explore the role of R&D and brand capital for asset risk premia respectively. With the exception of Kogan and Papanikolaou (2010), all of these papers feature a single aggregate shock. These models generate heterogeneity in asset risk premia through endogenous movements in conditional betas with the market portfolio, implying that the conditional CAPM should describe the cross-section of expected returns. In the data, the conditional CAPM fails to price the cross-section of stocks sorted by book-to-market or size

(Petkova and Zhang, 2005; Lewellen and Nagel, 2006; Roussanov, 2009; Nagel and Singleton, 2010). We find that the conditional CAPM also fails to price the cross-section of firms sorted on organization to physical capital. This failure of the conditional CAPM in pricing the cross-section of O/K portfolios casts doubt on a number of alternative explanations for our findings that are based on operating leverage or investment irreversibility.

There are inherent difficulties involved in the measurement of organization capital (Blair and Wallman, 2001; Black and Lynch, 2005). Black and Lynch argue that one of the main difficulties is that organization capital "cannot be wholly controlled by the firm". Our measure of organization capital is motivated by Lev and Radhakrishnan (2005), who argues that firm SG&A expenditures create corporate value through the formation of organization capital. A number of papers in the organizations literature measure the quality of the firm's organizational structure and management practices using surveys (Caroli and Van Reenen, 2001; Bresnahan, Brynjolfsson and Hitt, 2002; Bloom and Van Reenen, 2007). Our measure has the advantage that it is readily available for a long time period and a large number of firms. The second alternative method of measuring organization capital is as a residual from a structural model. While this methodology avoids some of the difficulties inherent in measuring intangibles, the resulting estimates are sensitive to the model specification. McGrattan and Prescott (2001) and Hall (2000a; 2001) argue that intangible capital played an important role in the valuation of the US corporate sector in the 1990s. Atkeson and Kehoe (2005) estimate that the payment flows to the owners of organization capital constitute 8% of output for manufacturing firms. Hansen, Heaton and Li (2005) measure intangible capital by requiring that risk adjusted investment returns to total capital should be equated across firms.

2 Model

We develop a model illustrating how, from the shareholders' perspective, investment in organization capital entails different risks than investment in physical capital. In our view, there are two defining characteristics of organization capital. First, organization capital is embodied in highly specialized labor inputs, and thus is distinct from physical capital. We will refer to these specialized labor inputs as key talent throughout the paper, examples of which is management and technical personnel that are essential to the firm. Second, the efficiency of organization capital is specific to the firm, which distinguishes it from general human capital.[2]

[2] An alternative definition of organization capital could be firm-specific human capital, consistent with the views in Prescott and Visscher (1980).

The unique nature of organization capital implies that both shareholders and key talent have a claim to its cash flows. In particular, organization capital is embodied in key talent, and it is therefore potentially movable across firms. As a result, key talent can extract a payment from the shareholders equal to its outside option. The value of this claim depends on the efficiency of organization capital in new firms. Shareholders have a claim to the residual cash flows, and the value of this claim depends on the difference between the inside and outside value of organization capital. Furthermore, systematic movements in the efficiency of organization capital in new firms lead to systematic movements in the division of organization capital rents between shareholders and key talent. Therefore, shareholders investing in firms with organization capital are exposed to additional risks.

We first a present a simple model in Section 2.1 that illustrates these ideas. The basic model illustrates why firms with different ratios of organization to physical capital may have different risk premia. This simple model yields closed-form solutions and captures the main ideas behind our paper. In Section 2.2 we extend the basic model along a number of dimensions. The extended model yields additional predictions and helps us assess the quantitative importance of organization capital in explaining the cross section of expected returns.

2.1 Basic model

There are two factors of production, physical capital K and organization capital O. Given an endowment of physical and organization capital, a firm produces a flow of output given by:

$$y_{i,t} = \theta_t \, K_i + \theta_t \, e^{\varepsilon_i} \, O_i. \tag{1}$$

Both capital stocks are subject to a common technology shock θ. To illustrate the main mechanism, for now we assume that the endowment of physical K_i and organization capital O_i, as well as the efficiency of the firm's organization ε_i, are constant over time.[3]

Organization capital is embodied in key talent, while the productivity of the firm's stock of organization capital O_i depends on the efficiency of that firm's organization ε_i. The level of efficiency ε_i can be viewed as the quality of the match between the firm and key talent. The firm-specificity of ε captures the idea that part of the knowledge embodied in organization capital is specific to the firm.

[3]Our production function is similar to van Rens (2004) and assumes that there are no complementarities between organization and physical capital. We do so in order to preserve tractability and illustrate our economic mechanism. Exploring the complementarities between organization and physical capital could be important, but we leave it for future work.

The total factor productivity shock θ evolves according to a geometric random walk:

$$d\theta_t = \sigma_\theta \, \theta_t \, dZ_t^\theta, \tag{2}$$

where dZ_t^θ is a Wiener process, and σ_θ corresponds to the volatility of the common TFP shock θ. The productivity shock θ affects physical and organization capital symmetrically, thus all firms will have the same sensitivity of revenue with respect to θ.

Over time, new technologies which improve the frontier efficiency of organization capital emerge. In the spirit of Atkeson and Kehoe (2005), only new firms can adopt these new technologies. These new firms can attract organization capital away from existing firms. In particular, the key talent can decide at any time τ to leave the existing firm and transfer part of the accumulated knowledge and existing organization structure O to a newly created firm. For now, we assume that this option can be exercised only once. Once the key talent decides at some time τ to adopt the new technology, the new firm operates at a level of organizational efficiency $\varepsilon_i = x_\tau$ forever. The level of frontier efficiency x evolves according to a random walk:

$$dx_t = \sigma_x \, dZ_t^x, \tag{3}$$

where σ_x is the volatility of x and dZ_t^x is a Wiener process independent from dZ_t^θ. Equation (3) implies that the frontier level of organizational efficiency x is stochastic and varies systematically, capturing the idea that the benefit of upgrading to new technologies varies with the state of the economy.

The creation of a new firm also requires a positive amount of physical capital K_i. The key talent can buy this physical capital from the existing shareholders at its market price, and finance this purchase by issuing shares in the new firm. The existing shareholders are indifferent between selling their claim to physical capital K_i to the key talent or continuing the operation of the old firm. To keep the number of firms constant, we assume the former. Our assumption implies that new technologies are adopted through a process of creation and destruction, in which inefficient organization technologies ε are replaced with the frontier level of organizational efficiency x.

This process of creation and destruction can be interpreted in a number of ways. For instance, if the shareholders in the new firm are different from the shareholders in the existing firm, then this process resembles a management buy-out, a start-up, or other forms of venture financing, depending on how the purchase of physical capital is financed. Alternatively, if the shareholders in the old firm also own shares in the new firm, then we can interpret this process as restructuring. In this case, when the firm decides to 'upgrade' its organization capital at time τ, the firm undergoes a period of extensive reorganization which leads to a higher level of organization efficiency x.

The stochastic discount factor (SDF) in this economy is given by:

$$d\pi_t = -r\,\pi_t\,dt - \gamma_\theta\,\pi_t\,dZ_t - \gamma_x\,\pi_t\,dZ_t^x, \tag{4}$$

where the parameters r, γ_θ and γ_x correspond to the interest rate and the price of risk for the aggregate technological shock θ and the frontier shock x respectively.

The value of an existing firm equals the sum of the value of physical capital plus the value of organization capital:

$$V_{it} = V_{it}^K + V_{it}^O. \tag{5}$$

Given the specification of output (1), the SDF (4) and the value of the option to upgrade to a new level of organization efficiency, we value each component of firm value in equation (5) separately. We then determine the division of the value of organization capital V^O between shareholders and key talent.

The value of physical capital V^K equals the present value of the cash flows accruing from physical capital:

$$V^K(K_i,\theta_t) = E_t \int_t^\infty \frac{\pi_s}{\pi_t}\theta_s\,K_i\,ds = \frac{\theta_t}{\bar{r}}\,K_i. \tag{6}$$

Equation (6) shows that V^K equals the present value of cash flows from physical capital discounted at the risk-adjusted rate $\bar{r} = r_f + \sigma_\theta\,\gamma_\theta$. Shareholders have a claim to the firm's physical capital K_i, hence they can fully appropriate V^K. As a result, the value of physical capital V^K does not depend on the frontier shock x.

The value of organization capital V^O equals the present value of the discounted future cash flows during the time that organization capital remains with this firm ($t < \tau$), plus its outside value $\overline{V}^O$ in the event of reallocation at the optimal stopping time τ:

$$V^O(\theta_t\,O_i,\varepsilon_i,x_t) = E_t \int_t^\tau \frac{\pi_s}{\pi_t}\theta_s\,e^{\varepsilon_i}O_i\,ds + E_t\left[\frac{\pi_\tau}{\pi_t}\,\overline{V}^O(\theta_\tau,O_i,x_\tau)\right]. \tag{7}$$

If the key talent exercises their outside option at time τ, then organization capital will forever operate at a level of efficiency $\varepsilon_i = x_\tau$. Thus, the value of organization capital once the outside option is exercised equals:

$$\overline{V}^O(\theta_t\,O_i,x_t) = E_t \int_t^\infty \frac{\pi_s}{\pi_t}\theta_s\,e^{x_t}\,O_i = \frac{\theta_t}{\bar{r}}\,e^{x_t}\,O_i. \tag{8}$$

The key talent will optimally choose the stopping time τ, balancing the gains from reallocation versus the value of the option to wait. When the efficiency of organization capital ε_i lags behind the frontier x_t, the owners of the organization capital have an incentive to leave for a newly created firm. The gain from reallocation depends on the value of the inside minus the outside option, i.e. on ε_i relative to x_t. As a result, key talent will reallocate organization capital to a new firm once the value of the outside option exceeds the level of productivity in the existing firm $\varepsilon^*(x_t) \geq e_i$. The threshold $\varepsilon^*(x)$ satisfies the indifference condition:

$$V^O(\theta_t\, O_i, \varepsilon^*(x_t), x_t) = \overline{V}^O(\theta_t\, O_i, x_t). \tag{9}$$

The following proposition solves for the value of organization capital in Equation (7) and the optimal exercise boundary $\varepsilon^*(x)$ in closed form:

Proposition 1. *The value of organization capital equals:*

$$V^O(\theta_t\, O_i, \varepsilon_i, x_t) = \frac{\theta_t}{\bar{r}} O_i \left[e^{\varepsilon_i} + \frac{\sigma_x}{\sqrt{2\,\bar{r}}}\, e^{\bar{x}_i + \frac{\sqrt{2\,\bar{r}}}{\sigma_x}\,(x_t - \bar{x}_i)} \right], \tag{10}$$

where $\bar{x}_i = \varepsilon_i - \log\left(1 - \frac{\sigma_x}{\sqrt{2\,\bar{r}}}\right)$*. The threshold* $\varepsilon^*(x)$ *at which it is optimal to reallocate the organization capital is given by:*

$$\varepsilon^*(x_t) = x_t + \log\left(1 - \frac{\sigma_x}{\sqrt{2\,\bar{r}}}\right). \tag{11}$$

Proof: The key talent faces an optimal stopping time problem. The key talent chooses a threshold $\bar{x}$, such that it adopts the new technology if $x_t \geq \bar{x}$. We conjecture that the value of organization capital equals $\theta_t\, O_i\, v(x)$. Equation (7) implies that for $t < \tau$, the unknown function $v(x)$ satisfies the following ordinary differential equation:

$$e^{\varepsilon} - \bar{r}v(x) + \frac{1}{2}\sigma_x^2 v_{xx}(x) = 0 \qquad \text{if} \quad x < \bar{x}.$$

The solution to the ordinary differential equation is given by:

$$v(x) = \frac{e^{\varepsilon_i}}{\bar{r}} + C_1 e^{\frac{\sqrt{2\,\bar{r}}}{\sigma_x}\,x_t} + C_2 e^{-\frac{\sqrt{2\,\bar{r}}}{\sigma_x}\,x_t}.$$

The three unknown constants $\bar{x}$, C_1 and C_2 are jointly determined by: i) the boundary condition $\lim_{x\to-\infty} V^O(\theta_t\, O_i, \varepsilon_i, x_t) = \frac{\theta_t}{\bar{r}}\, e^{\varepsilon_i}\, O_i$, which guarantees that the option to move to the new technology is worthless when x is very low, implying that $C_2 = 0$; ii) the smooth-pasting condition $v_x(\bar{x}) = e^{\bar{x}}/\bar{r}$; and iii) the indifference (value-matching) condition $v(\bar{x}) = e^{\bar{x}}/\bar{r}$. Under the regularity condition $\bar{r} > \frac{1}{2}\sigma_x^2$, the exercise threshold $\bar{x}$ is finite, and equals $\bar{x}_i = \varepsilon_i - \log\left(1 - \frac{\sigma_x}{\sqrt{2\,\bar{r}}}\right)$. Rearranging this equation yields the threshold $\varepsilon^*(x)$ in (11). ■

Proposition 1 solves for the total value of organization capital V^O. The value of organization capital is increasing in both the level of organization efficiency in the existing firm ε_i and the level of frontier technology x. This value V^O must be split between shareholders and key talent, since both have a claim on the cash flows accruing from organization capital O. Hence, the final step to determining the shareholder value of the firm consists of computing the value of organization capital that can be captured by shareholders. This value equals the difference between the total value of organization capital (7) and the rents that key talent can extract.

The rents that key talent can extract from organization capital depend on the efficiency of organization capital in new firms, which is determined by x_t. Prior to time τ, key talent has the option to depart for a new firm and receive a payoff $\overline{V}^O$, given by equation (8). Shareholders can prevent this reallocation by promising key talent a continuation value W_{it} that is at least as high as the key talent's outside option $\overline{V}^O$. We assume that shareholders cannot commit to giving key talent a payoff greater than its outside option, hence $W_{it} = \overline{V}^O_{it}$ always.[4] Given this credible promise, the present value of rents that shareholders can extract from organization capital equals the difference between the total value of organization capital (10) and the value of key talent's outside option (8):

$$V^{OS}(\theta_t\, O_i, \varepsilon_i, x_t) = \frac{\theta_t}{\bar{r}} O_i \left(e^{\varepsilon_i} + \frac{\sigma_x}{\sqrt{2\,\bar{r}}}\, e^{\bar{x} + \frac{\sqrt{2\,\bar{r}}}{\sigma_x}\,(x_t - \bar{x})} - e^{x_t} \right). \tag{12}$$

The value that shareholders can extract from organization capital (12) is comprised of two terms. The first term $\frac{\theta_t}{\bar{r}} O_i\, e^{\varepsilon_i}$ is increasing in the efficiency level of organization capital, since shareholders own a claim to the firm-specific level of organizational efficiency ε_i. Absent the option to upgrade to the new technology, this would be the only source of value. However, the key talent owns the decision right to leave for a new firm and operate at a level of organization efficiency x, thus it will capture some rents from organization capital. The value of these rents depends on the key talent's outside option, which is determined by x relative to the firm-specific level of efficiency ε_i. Hence, shareholders effectively have a short position in an option whose value is increasing in the level of frontier technology x. The value of this option is captured by the last two terms in equation (12).

The total shareholder value of the firm equals the sum of the values of physical (6) and

[4]This assumption simplifies our analysis. Given that we effectively assume that shareholders and key talent are diversified, their marginal utility does not depend on ε_i. In this case, allowing for firm commitment yields an indeterminacy in terms of payment plans. Lustig et al. (2011) consider risk averse managers and analyze the case where key talent extracts more surplus than its outside option. In this case, as long as the surplus that shareholders can extract falls when the key talent's outside option increases, our results would be qualitatively similar.

organization capital (12):

$$V_{it}^{S} = \frac{\theta_t}{\bar{r}} \left[K_i + O_i \left(e^{\varepsilon_i} + \frac{\sigma_x}{\sqrt{2\,\bar{r}}}\, e^{\bar{x} + \frac{\sqrt{2\,\bar{r}}}{\sigma_x}\,(x_t - \bar{x})} - e^{x_t} \right) \right]. \tag{13}$$

The shareholder value of the firm is decreasing in the level of the frontier technology shock x.[5] Prior to the reallocation of organization capital ($x < \bar{x}_i$) an increase in the frontier shock x leads shareholders to concede more rents to key talent in order to induce them to remain within the firm. When shareholders are unwilling to give up more rents to key talent, key talent decides to leave. At the point $x = \bar{x}_i$, the value of organization capital to shareholders (12) is zero and shareholder value consists only of claims to physical capital K_i. Shareholders sell their claim on the physical capital K_i at the market price V^K to the key talent, which finances this purchase by issuing new shares.

From the shareholders' perspective, firms with more organization capital are exposed to additional risks, because the division of surplus between key talent and shareholders depends on the level of frontier technology x. An application of Ito's lemma on the shareholder value of the firm (13) implies that the firm's stock return equals

$$\begin{aligned} \frac{d\,V_{it}^{S} + D_{it}\,dt}{V_{it}^{S}} - r_f\,dt \quad &= \quad E_t\left[\frac{d\,V_{it}^{S} + D_{it}\,dt}{V_{it}^{S}} - r_f\,dt\right] + \sigma_\theta\,dZ_t^{\theta} \\ &\quad - \frac{O_i\,e^{x_t}\left[1 - e^{(\bar{x}-x_t)\left(1 - \frac{\sqrt{2\,\bar{r}}}{\sigma_x}\right)}\right]}{K_i + O_i\left[e^{\varepsilon_i} + \frac{\sigma_x}{\sqrt{2\,\bar{r}}}\,e^{\bar{x} + \frac{\sqrt{2\,\bar{r}}}{\sigma_x}\,(x_t - \bar{x})} - e^{x_t}\right]}\,\sigma_x\,dZ_t^{x}. \end{aligned} \tag{14}$$

Firms in this economy are exposed to two distinct sources of risk, the productivity shock θ and the frontier shock x. The shock θ affects the productivity of all capital, hence all firms have the same exposure to θ, as we see from the second term in equation (14). By contrast, firms' exposure to the technology shock x is increasing in their ratio of organization to physical capital O/K, which is captured by the last term in equation (14).

Given that the shareholder value of organization capital V^{OS} declines with the level of frontier technology x, our model predicts that high-O/K firms drop in value relative to low-O/K firms following a positive shock to x. Thus, the first prediction of our model is that a portfolio that buys high-O/K firms and sells low-O/K firms (OMK) will be negatively correlated with the frontier technology shock x.

In equilibrium, asset risk premia are determined by factor loadings times the price of risk. Combining the equation characterizing stock returns (14) with the stochastic discount

[5] The requirement that the threshold $\bar{x}$ is finite yields $\bar{r} > \frac{1}{2}\sigma_x^2$ which together with $x < \bar{x}$ imply that $V_x^{OS} < 0$.

factor (4) yields:

$$
\begin{aligned}
E_t\left[\frac{d\,V_{it}+D_{it}\,dt}{V_{it}}-r_f\,dt\right] &= -cov_t\left[\frac{d\,\pi_t}{\pi_t},\frac{d\,V_{i,t}}{V_{i,t}}\right]\\
&= \gamma_\theta\sigma_\theta-\gamma_x\,\sigma_x\frac{O_i\,e^{x_t}\,\left[1-e^{(\bar{x}-x_t)\left(1-\frac{\sqrt{2\,\bar{r}}}{\sigma_x}\right)}\right]}{K_i+O_i\left[e^{\varepsilon_i}+\frac{\sigma_x}{\sqrt{2\,\bar{r}}}\,e^{\bar{x}+\frac{\sqrt{2\,\bar{r}}}{\sigma_x}\,(x_t-\bar{x})}-e^{x_t}\right]}. \quad (15)
\end{aligned}
$$

All firms have the same exposure to the TFP shock θ, therefore cross-sectional differences in risk premia are driven by heterogeneity in the ratio of organization to physical capital O/K. The price of risk of the frontier shock γ_x determines whether organization capital commands a higher or a lower risk premium than physical capital. In our calibration section 4.1, we argue that a negative risk premium for the frontier shock x is consistent with economic intuition and the difference in average returns between firms with high and low organization capital.

The model presented thus far captures the main intuition of the paper. Organization capital is exposed to an additional source of risk relative to physical capital, because shareholders do not necessarily appropriate all the benefits accruing from it. In particular, shareholders receive lower payments from organization capital when the outside option of key talent improves. Shareholders demand compensation for this risk because the outside option of key talent varies in a systematic way. In particular, this outside option depends on the productivity of organization capital deployed in new firms, which in our model is captured by the frontier technology shock x. An increase in the frontier shock x reduces the share of cash flows that shareholders can extract from organization capital. If firms vary in their amount of organization capital to physical capital O_i/K_i, then they will differ in their share price exposure to the frontier technology x. As a result, heterogeneity in firms' asset composition leads to differences in risk premia.

2.2 Extended model

In this section, we extend the model in Section 2.1 to allow for endogenous accumulation of physical and organization capital. In addition, we allow for the option to upgrade to the new technology to remain active regardless of whether the firm has done so in the past. To ensure that this option is infrequently exercised, we allow for costs to reallocating organization capital. These extensions do not qualitatively affect our inferences derived from the model in Section 2.1, but instead generate additional testable predictions that help validate the model.

There exists a continuum of firms which produce a common output good using capital K and organization capital O. Firm i produces a flow of output given by:

$$y_{i,t} = \theta_t \, e^{u_{it}} \, K_{it} + \theta_t \, e^{\varepsilon_{i,t}} \, O_{it}. \tag{16}$$

The output of the firm is affected by a common productivity shock θ, whose evolution is given by:

$$d\theta_t = \mu_\theta \, \theta_t \, dt + \sigma_\theta \, \theta_t \, dZ_t^\theta. \tag{17}$$

The productivity of a firm's physical and organization capital has firm-specific components u_i and ε_i respectively. These firm-specific shocks evolve according to:

$$du_{i,t} = -\kappa_u \, u_{i,t} \, dt + \sigma_u dZ_t^{u_i}, \tag{18}$$

$$d\varepsilon_{i,t} = -\kappa_\varepsilon \, \varepsilon_{i,t} \, dt + \sigma_\varepsilon dZ_t^{\varepsilon_i}. \tag{19}$$

The firm can accumulate physical and organization capital over time through investment:

$$dK_{it} = (i_{Kit} - \delta_K) K_{it} \, dt, \tag{20}$$

$$dO_{it} = (i_{Oit} - \delta_O) O_{it} \, dt. \tag{21}$$

Here, i_K and i_O represent the firm's investment in physical and organization capital respectively. Both physical and organization capital depreciate over time at rates δ_K and δ_O respectively. Physical capital depreciates as it physically deteriorates or becomes obsolete. Similarly, organization capital depreciates either because it becomes obsolete or because key talent retires.

The firm can increase its stock of physical capital by an absolute amount $i_K \, K$ by purchasing $c_k/\lambda_k \, i_K^{\lambda_k} \, K$ units of the investment good at a relative price $\xi_t = c_q \, \theta_t$.[6] Therefore, the total output cost of increasing the physical capital stock by an absolute amount $i_K \, K$ equals:

$$C_K(i_K, K; \theta) = \theta \, \frac{c_k \, c_q}{\lambda_k} \, i_K^{\lambda_k} \, K. \tag{22}$$

In our investment cost formulation (22), the value of the parameter $\lambda_k > 1$ captures the steepness of the adjustment cost function. Moreover, the marginal cost of investing in physical capital increases in the TFP shock θ, as well as the investment rate i_K. In addition, the

[6]Our formulation for the adjustment costs to investment follows Jermann (1998). The assumption that the relative price of new investment goods is increasing in the TFP shock θ arises naturally in general equilibrium, if θ does not affect the productivity of the sector producing investment goods. For instance, in the two-sector general equilibrium model of Papanikolaou (2011), the relative price of capital goods is increasing in the TFP shock in the sector producing consumption goods.

firm can expend resources and increase its stock of organization capital O_i. The firm can increase its stock of organization capital by an absolute amount $i_O\, O$ at a total output cost of:

$$C_O(i_O, O; \theta) = \theta\, \frac{c_o}{\lambda_o}\, i_O^{\lambda_o}\, O. \tag{23}$$

Just like physical capital, the creation of new organization capital is subject to convex costs, parameterized by $\lambda_o > 1$. Moreover, the marginal cost of investment in organization capital increases with the common productivity shock θ, which can be interpreted as a congestion cost. For instance if investment in organization capital requires an input whose supply is independent of θ (i.e, worker time) then the marginal cost would be increasing in θ just as in the case of investment goods.

Just as in the model described in section 2.1, new technologies which improve the frontier efficiency of organization capital emerge over time. The owners of organization capital can decide at any time τ to adopt these new technologies, by reallocating the organization capital to a new firm which operates at a level of organizational efficiency $\varepsilon_i = x_\tau$. In contrast to the model in section 2.1, this option can be exercised multiple times. After the new technology is adopted, the efficiency of organization capital evolves stochastically according to equation (19) above. Hence, it may be optimal for key talent to adopt a new technology again in the future. The frontier level of efficiency x evolves according to:

$$dx_t = -\kappa_x\, x_t\, dt + \sigma_x\, dZ_t^x. \tag{24}$$

The mean-reverting formulation for x ensures that the distribution of firm-specific productivity levels ε_i is stationary.

In contrast to the basic model in Section 2.1, adopting the new level of organization efficiency x is costly. Specifically, upgrading an amount O of organization capital to the frontier level of technology involves a cost equal to:

$$C_R(O; \theta) = c_R\, \theta\, O. \tag{25}$$

Without loss of generality, we assume that this cost is paid by the key talent. This restructuring cost can be interpreted in a number of ways. For instance, if the adoption of new technology occurs via the key talent moving to a new firm, then there might be setup or financing costs involved in starting a new firm. If the adoption occurs through restructuring the existing firm, as in a management buyout, then this cost can be interpreted as an interruption of the production process due to the necessary retraining of workers and adjustment of the organization structure to the new technology. More generally, this restructuring cost captures the idea that part of the accumulated knowledge embedded in O may be tied to the existing organization technology of the firm, and hence might become obsolete with the new technology. Hence, upgrading to the new technology involves an immediate loss in resources given by (25), but no immediate increase in output.[7]

The presence of constant returns to scale in production implies that firm boundaries are not defined in our model. To resolve this indeterminacy, we assume that once key talent decides to move to a new firm, the existing shareholders sell their claim on physical capital, along with its current level of productivity u_i, to the key talent at its market value. The shareholders are indifferent to doing so, since at that point they earn zero rents from organization capital. The key talent finances this purchase of physical capital by issuing new shares. Our assumption implies that the number of firms is constant, as new firms replace existing firms that lose the key talent.

The solution of the extended model closely follows the solution of the basic model in Section 2.1. The shareholder value of the firm is given by the proposition below:

Proposition 2. *The shareholder value of the firm equals:*

$$V_{it}^{S} = \theta_t \Big[q(u_{it})\, K_{it} + \Big(v(\varepsilon_{it}, x_t) - \bar{v}(x_t) \Big)\, O_{it} \Big], \tag{26}$$

The function $q(u)$ is the solution to the Hamilton-Jacobi-Bellman equation:

$$0 = \max_{i_K} \left\{ e^{u} - \frac{c_k\, c_q}{\lambda_k} i_K^{\lambda_K} - (\bar{r} + \delta_K - i_K)\, q(u) - \kappa_u\, u\, q'(u) + \frac{1}{2}\sigma_u^2\, q''(u) \right\}, \tag{27}$$

where $\bar{r} = r_f - \mu_\theta + \gamma_\theta \sigma_\theta$. The function $v(\varepsilon, x)$ solves the boundary value problem:

$$\begin{aligned} 0 = \max_{i_O} \Big\{ & e^{\varepsilon} - \frac{c_o}{\lambda_o} i_O^{\lambda_o} - (\bar{r} + \delta_O - i_O)\; v(\varepsilon, x) - \kappa_\varepsilon\, \varepsilon\, v_\varepsilon(\varepsilon, x) + \frac{1}{2}\sigma_\varepsilon^2 v_{\varepsilon\varepsilon}(\varepsilon, x) \\ & - \kappa_x\, (x - \overline{x}) v_x(\varepsilon, x) + \frac{1}{2}\sigma_x^2\, v_{xx}(\varepsilon, x) \Big\}, \qquad \text{if} \quad \varepsilon \geq \varepsilon^*(x) \end{aligned} \tag{28}$$

where $\bar{x} \equiv \frac{-\sigma_x \lambda_x}{\kappa_x}$. The outside option of key talent equals $\overline{V}_{it}^{O} = \theta_t O_{it} \bar{v}(x_t)$, where:

$$\bar{v}(x) \equiv \max[v(x, x) - c_R, 0]. \tag{29}$$

[7] The reallocation cost C_R can vary systematically over time, as in Eisfeldt and Rampini (2006). For instance, if the adoption of the new technology takes the form of key talent starting a new firm, then there are direct costs involved in setting up the new firm and securing financing, which may vary systematically over time. We can interpret part of the time-variation in the technology shock x is as capturing the time-varying benefit of adopting the new technologies, minus the associated costs.

The reallocation threshold $\varepsilon^*(x)$ *is the solution to:*

$$v(\varepsilon^*(x), x) = \bar{v}(x). \tag{30}$$

Investment in physical and organization capital is given by:

$$i_K(u) = \left(\frac{q(u)}{c_k\, c_q}\right)^{\frac{1}{\lambda_k - 1}}, \tag{31}$$

$$i_O(\varepsilon, x) = \left(\frac{v(\varepsilon, x)}{c_o}\right)^{\frac{1}{\lambda_o - 1}}. \tag{32}$$

Proof: See supplementary appendix.

Proposition 2 shows that the shareholder value of the firm is equal to the value of physical capital, plus the value of the rents that shareholders can extract from physical capital. This latter component of shareholder value represents a source of risk that shareholders of firms with high organization capital are exposed to. Hence, the risk premium required by shareholders to invest in firm i equals:

$$E_t\left[\frac{d\,V_{it} + D_{it}\,dt}{V_{it}} - r_f\,dt\right] = \left(\gamma_\theta\,\sigma_\theta + \gamma_x\,\sigma_x\,\gamma(\varepsilon_{i,t}, x_t)\,\frac{(v(\varepsilon_t, x_t) - \bar{v}(x_t))\,O_{it}}{q(u)\,K_{it} + (v(\varepsilon_t, x_t) - \bar{v}(x_t))\,O_{it}}\right) dt \tag{33}$$

where $\gamma(\varepsilon, x) \equiv \partial \log(v(\varepsilon, x) - \bar{v}(x))/\partial x < 0$.

Equation (33) yields the same intuition as equation (15) in the basic model. Cross-sectional differences in risk premia across firms arise only due to firms' differential sensitivity to the frontier shock x, which is captured by the last term in equation (33). This heterogeneity in firms' exposure to the frontier shock arises due to differences in their asset composition O/K and productivity of organization capital ε. The price of risk of the frontier technology shock γ_x determines the sign and the magnitude of the difference in risk premia between organization and physical capital.

In contrast to the basic model, the accumulation of physical and organization capital is an endogenous decision on the part of the firm. Given the fact that the marginal cost of investment in both physical and organization capital in (22)-(23) is increasing in the total factor productivity shock θ, the accumulation of physical and organization capital depends on the firm-specific shocks u_i and ε_i and the frontier level of efficiency x, but not on the aggregate TFP shock θ. Equations (31)-(32) imply that investment in physical and organization capital increase in their firm-specific levels of efficiency u_i and ε_i respectively.

In addition, equation (32) shows that investment in organization capital is increasing in the total value of organization capital. Since the level of frontier technology x increases the total value of organization capital (i.e, $v_x(\varepsilon, x) > 0$), our model predicts that investment in organization capital $i_O(\varepsilon, x)$ is increasing in the level of frontier technology x.[8]

Proposition 2 shows that it is optimal to reallocate organization capital to a new firm if the value of the outside option is high enough $\varepsilon_{it} \leq \varepsilon^*(x_t)$. This reallocation threshold $\varepsilon^*(x)$ is an increasing function of the frontier shock x, since reallocation becomes more attractive when the frontier efficiency level is high. Thus, the amount of technology adoption, regardless of whether it takes the form of reallocation to a new firm or restructuring of the existing firm, is an increasing function of x. Hence, our model implies that the aggregate amount of reallocation or restructuring should be negatively correlated with a portfolio long high-O/K firms and short low-O/K firms.

In addition, Proposition 2 has implications about Tobin's Q, defined as the market value of the firm V^S divided by the replacement cost of *physical* capital ξK:

$$Q_{it} = \left(q(u_{it}) + \left(v(\varepsilon_{it}, x_t) - \bar{v}(x_t) \right) O_{it}/K_{it} \right) c_q^{-1}. \tag{34}$$

A firm's organization capital is included in shareholder value, but is not included in the denominator of Tobin's Q in (34). Therefore, holding constant the firm-specific shocks u_{it} and ε_{it}, Tobin's Q is increasing in the ratio of organization to physical capital O_i/K_i. However, this does not necessarily imply that Tobin's Q and O/K are unconditionally positively correlated at the firm level. A positive productivity shock u increases Tobin's Q, but it also leads to an increase in the investment rate in physical capital and therefore to a lower O/K ratio.

The final step in characterizing the solution to the model is to compute the dynamics of compensation to key talent. Just as in the basic model, we assume that shareholders have limited commitment, hence key talent can extract a value at most equal to its outside option $\overline{V}^O$ from the existing shareholders. In order for the organization capital to remain with the firm, the continuation value of key talent W_{it} has to equal its outside option in all states of the world:

$$W_{it} = \theta_t \, O_{i,t} \, \bar{v}(x_t). \tag{35}$$

[8]We derive this prediction under the assumption that irrespective of whether management or shareholders alone own the decision right to investment in organization capital, the two parties agree to choose the optimal level of investment i_O that maximizes the total value of organization capital. However, if the level of investment in organization capital is not observable to both parties, then there could be over- or under-investment in organization capital, since both parties do not equally share the costs and benefits. Analyzing the effect of the conflicts of interest between key talent and shareholders in investment in organization capital is an important question that we leave for future research.

Shareholders can implement this continuation value by promising key talent a flow payment of $w_{it}\,dt$ as long as organization capital remains in the firm. Hence, the continuation value of key talent equals the present value of compensation while organization capital remains in the existing firm plus the option value of moving to a new firm:

$$W_{it} = E_t \int_t^{\tau} \frac{\pi_s}{\pi_t} w_{is} ds + E_t \left[\frac{\pi_\tau}{\pi_t} \, \theta_\tau \, O_{i\tau} \, \overline{v}(x_\tau) \right]. \tag{36}$$

Given equations (35) and (36), we can explicitly solve for the dynamics of compensation to key talent w_{it}. The requirement that the key talent's continuation value equals its outside option in every state of the world pins down W_{it} and W_{it+dt}. Shareholders will then compensate the key talent in such a way to ensure that promises are kept, i.e. $W_{it} = w_{it}\,dt + E_t \frac{\pi_{t+dt}}{\pi_t} W_{it+dt}$ always holds. The following corollary describes the compensation dynamics to key talent:

Corrolary 1. *The key talent in firm i receives a flow payment $w_{it}\,dt$ every period:*

$$w_{it} = \left(\bar{r} + \delta_O - i_O(\varepsilon_{it}, x_t) + \kappa_x \, (x_t - \bar{x}) \, \frac{\overline{v}_x(x_t)}{\overline{v}(x_t)} - \frac{1}{2} \, \sigma_x^2 \, \frac{\overline{v}_{xx}(x_t)}{\overline{v}(x_t)} \right) \, \theta_t \, O_{i,t} \, \overline{v}(x_t), \tag{37}$$

where $\overline{v}(x)$ is defined in proposition (2).

Corollary 1 shows that the compensation to key talent is increasing proportionally to the value of its outside option $\bar{v}(x_t)$. Hence, an increase in the frontier technology shock x leads to an increase in the compensation of key talent. The term $\bar{r} + \delta_O$ inside the parenthesis is constant and compensates the key talent for the cost of waiting, exposure to the technology shock θ and the fact that organization capital depreciates over time. The second term inside the parenthesis is negative and decreasing in the level of investment in organization capital. Key talent is willing to accept a lower compensation today in return for the firm increasing its investment in organization capital, since doing so raises the key talent's outside option. Hence, the cost of investment in organization capital is implicitly shared between shareholders and key talent. The third term inside the parenthesis is increasing in x because the frontier shock x is mean-reverting. The temporary increase in outside option implies that key talent receives an accelerated payment today, hence the compensation to key talent increases faster than its outside option. Finally, the last term in equation (37) illustrates that key talent is willing to accept a lower flow payment today as the volatility of the frontier shock x increase, due to the convexity of the outside option $\bar{v}(x)$.

There are three additional predictions that follow directly from Corollary 1. First, the compensation to key talent (37) is increasing in the level of organization capital O_i. Thus, firms with more organization capital will have higher levels of executive compensation. Second, the average level of executive compensation $\bar{w}_t = \int w_{it}\,di$ is increasing in the frontier level of efficiency x. As a result, the aggregate level of executive compensation should be negatively correlated with a portfolio long high-O/K firms and short low-O/K firms. Third, the sensitivity of firm profits to firm output increases with the ratio of organization to physical capital. To see this, note that the compensation to key talent (37) does not increase with the firm-specific shocks u_i and ε_i. Therefore, firm earnings (defined as $y_i - w_i$) will increase by a proportionally greater amount than firm output y_i following a positive shock in either u_i or ε_i. This increased sensitivity depends on the ratio w_i/y_i, which itself is increasing in O/K. By contrast, the compensation to key talent w_{it} increases proportionally with θ, implying that the elasticity of firm profits with respect to aggregate output is independent of the level of organization to physical capital.

To summarize, our model implies that a firm's ratio of organization to physical capital O/K determines the shareholders' required rate of return. Organization capital is risky because a positive shock to the frontier level of efficiency x leads to a drop in the shareholder value of organization capital. Consequently, a portfolio long high-O/K and short O/K firms (OMK) will be negatively correlated with the frontier shock. In addition, our extended model yields a number of predictions. The level of the frontier technology shock is positively correlated with the following observable variables: the average level of executive compensation $\bar{w}_t = \int w_{it}\, di$; the aggregate level of reallocation or restructuring $\int \mathbf{1}_{\varepsilon_{it} \leq \varepsilon^*(x_t)} K_{it}\, di / \int K_{it}\, di$; and iii) the firm-level of investment in organization capital $i_O(\varepsilon, x)$. Finally, our model implies that the sensitivity of firm profits to firm output is increasing in the level of organization capital. We empirically explore these predictions in Section 4.4.

3 Measuring organization capital

3.1 Methodology

We construct a direct measure of organization capital using Selling, General, and Administrative (SG&A) expenditures. The U.S. GAAP definition of the SG&A expense states that this item represents all commercial expenses of operation (i.e., expenses not directly related to product production) incurred in the regular course of business pertaining to the securing of operating income. The largest component of SG&A is typically labor related expenses.

Our measure is motivated by Lev and Radhakrishnan (2005), who use SG&A to measure flows to organization capital. SG&A contains the part of labor expenses that cannot be directly attributed to a particular unit of output. Hence, any spending on the part of the firm to increase its organization capital will be included in the SG&A expense. Lev and Radhakrishnan (2005) and Lev (2001) present detailed arguments and examples of how resources allocated to this expense yield improvements in employee incentives, internal communication systems, distribution systems, and other examples of organization capital. Our model suggests that one use a measure which accumulates investment in capital which is intangible, specific, and closely tied to labor inputs. A large part of SG&A is comprised by expenses related to labor and information technology (white collar wages, training, consulting, and IT expenses), and this is consistent with the idea that any accrued value will be somewhat firm specific and must be shared with key talent.

We construct the stock of organization capital O using the perpetual inventory method.[9] Specifically, we recursively construct the stock of organization capital by accumulating the deflated value of SG&A expenses:

$$O_{i,t} = (1 - \delta_O)O_{i,t-1} + \frac{SGA_{i,t}}{cpi_t}, \tag{38}$$

where cpi_t denotes the consumer price index. To implement the law of motion in Equation (38) we must choose an initial stock and a depreciation rate. We choose the initial stock according to

$$O_0 = \frac{SGA_1}{g + \delta_O}. \tag{39}$$

For most of our analysis, we use a depreciation rate of 15%, which is equal to the depreciation rate used by the BEA in their estimation of R&D capital in 2006. We choose g to match the average real growth rate of firm-level SG&A expenditures, which in our sample equals 10%. Finally, we treat missing values in the SG&A expense as zero. Our results are robust to dropping the first five years of data for every firm, which minimizes the impact of the initialization scheme O_0, and are robust to a choice of depreciation rate δ_O between 10% and 50% (see the supplementary appendix for more details).

To the extent that some SG&A expenditures do not constitute investment in organization capital, we will be measuring this capital with error. Accounting practices governing the exact composition of SG&A expenditures vary across industries, hence this error may have an industry component. To address this concern, in our empirical work we compare firms on their ratio of organization capital to assets relative to their industry peers. Specifically, we first group firms into 17 industries based on the Fama and French (1997) classification. Then, within each industry, we assign firms a rank (1 to 5) based on the firm's quintile of the ratio of organization capital to book assets. Finally, we form 5 value-weighted portfolios based on each firm's within-industry organization capital rank, and rebalance these portfolios in June

[9] The Bureau of Economic Analysis (BEA) uses a similar methodology to construct a stock of Research and Development capital, see Sliker (2007).

every year. Therefore, portfolio 1 (5) contains firms in the lowest (highest) O/K-quintile in each industry. This procedure ensures that our results are driven by within- rather than between-industry variation in the contribution of organization capital to firm value.

Our sample includes all non-financial firms in *Compustat* with fiscal year ending in December, with common shares, that are traded on NYSE, AMEX and NASDAQ, with non-missing SIC codes, and with non-zero values of organization capital. Our sample includes a total of 5,917 firms, which collectively represent about 60% of the total market capitalization of firms in *CRSP*. Our sample period is 1970-2008.

3.2 Validation

Our measure of organization capital is constructed using the firm's SG&A expenditures, which can include other items that are unrelated to improving the organizational efficiency of the firm. As such, it is liable to measure investment in organization capital with error. In this section, we consider five ways of validating our measure. First, as long as organization capital is embodied in the key employees of the firm, we imagine such firms to be dependent on the loss of key personnel. Second, high organization capital firms should also follow better managerial practices. Third, the organizations literature has documented strong complementarities between organization capital and IT spending, and we explore whether the same is true for our measure. Fourth, we explore whether firms with more organization capital to assets have higher productivity, after controlling for physical capital and labor. Finally, our model implies that the aggregate level of Tobin's Q should increase with the aggregate ratio of organization to physical capital, and we explore whether this is indeed the case.

Evidence from SEC filings

Our model implies that shareholders investing in firms with high organization capital are exposed to the risk of key talent leaving the firm. Firms are obliged to disclose potential risk factors that might adversely affect future performance in the managerial discussion section of their 10-K filings. We explore whether firms with more organization capital are more likely to list loss of key personnel as a risk factor. We focus on a random sample of 100 firms, constructed by randomly selecting 5 firms every year from the top and bottom quintile of firms in terms of organization capital to assets (relative to their industry peers). We restrict attention to the years for which the SEC filings are electronically available (1996-2005).

We find that firms with more organization capital are more likely to list as a risk factor that they are dependent upon a number of key personnel, the loss of which might adversely affect future performance. Out of the 50 firms in the high organization capital to assets quintile, 48% list the loss of key personnel as a risk factor. In contrast, only 20% of the 50 firms in the bottom organization capital to assets quintile list the loss of key personnel as a risk factor for future performance. Assuming independent observations, a difference in means test rejects the null that the two fractions are equal with a t-statistic of 3.

Evidence from managerial quality surveys

Bloom and Van Reenen (2007) develop an interview-based survey tool designed to quantify management practices across firms.[10] Firms are scored on a scale of 1 to 5 based on their responses to a managerial survey relative to a benchmark of global best practices. The survey defines and assigns scores from one (worst practice) to five (best practice) to eighteen management practices used by industrial firms. These practices are grouped into four areas: operations (three practices), monitoring (five practices), targets (five practices), and incentives (five practices). Bloom and Van Reenen find that the average management practice score is strongly correlated with firm performance and Tobin's Q. Other research using the same data shows that better management practices are associated with greater productivity of information technology (Bloom, Sadun and Van Reenen, 2011) and more efficient production (see Bloom, Sadun and Reenen (2009) for a survey).

Our measure of organization capital is correlated with the managerial quality score constructed by Bloom and Van Reenen. The 2004 survey data contains a cross-section of 250 US firms that overlap with our sample.[11] Focusing on the period 2000-05, we estimate a regression of the organization capital measure on the managerial score measure:

$$\frac{O_{it}}{A_{it}} = a + b\, M_i + u_{it}, \tag{40}$$

and cluster the standard errors by firm. The estimated coefficient b is positive, and equal to 0.13, while the t-statistic is equal to 1.94. Thus, the evidence suggests that our measure of organization capital that is constructed using accounting data is informative about the quality of management practices across firms.

[10] In 2003, Bloom and Van Reenen founded the World Management Survey in order to systematically collect quantitative data on management practices and organization structures for domestic and international firms. The data from Bloom and Van Reenen (2007) covers 732 medium sized manufacturing firms in the US, France, Germany and the UK and comprises the largest and most comprehensive output from the World Management Survey thus far.

[11] We are grateful to Nicholas Bloom for performing this analysis, since the data is not publicly available.

Evidence from investment in information technology

Bresnahan et al. (2002) and Bloom et al. (2011) find evidence suggesting the presence of strong complementarities between organization capital and information technology (IT). We explore whether firms with more organization capital according to our measure also have a greater demand for IT. We obtain information on the IT spending budget for a sample of 500 firms from Information Week for the years 1995 and 1996. The firms participating in the Information Week survey are selected based on the amount of IT spending and a subjective assessment of their information technology activities.

We find that firms with more organization capital to assets relative to their industry peers have a greater demand for IT. As we see in Table 3, firms in the high-O/K portfolio spend almost twice as much on IT relative to book assets than low-O/K firms (2.10% vs 1.17%). Hence, the evidence supports the view that our measure of organization capital is correlated with firms' demand for IT.

Evidence from firm profitability

Organization capital is a factor of production that is usually omitted from productivity calculations. Hence, we expect that firms with high organization capital have higher productivity, accounting for physical capital and labor. We focus on two measures of productivity. The first measure is the ratio of sales to book assets. The second measure of productivity is the regression residual of log sales on log capital and labor, where the intercept and slopes are allowed to vary by industry-year (see the data appendix for details).

We find that firms with higher ratios of organization capital to assets are more productive using both measures. This evidence is supportive of the view that our measure of organization capital is a factor of production than enhances output, holding other inputs constant. Our evidence is consistent with the findings of De and Dutta (2007) and Tronconi and Vittucci Marzetti (2011). Both papers construct a similar measure of organization capital by capitalizing SG&A expenditures and report similar results for a sample of Indian IT firms and a large sample of European firms respectively.

Evidence from Tobin's Q

Organization capital increases the shareholder value of the firm, yet it is not typically included in measures of the capital stock. Thus, we would expect that Tobin's Q is increasing in the ratio of organization to physical capital. This is true at the aggregate, but not at the firm level. As we see from equation (34), Tobin's Q is not a sufficient statistic for O/K in our model. The reason is that Tobin's Q also depends on the firm productivity shocks u and

ε, which are endogenously correlated with O/K. However, in the aggregate these shocks are diversified, hence the aggregate level of Tobin's Q is increasing in the aggregate ratio of organization to physical capital O/K.

We explore whether our empirical measure of organization capital is related to Tobin's Q at the aggregate level. In figure 2 we plot the aggregate Tobin's Q versus the ratio of the aggregate accumulated stock of organization capital O_t to the replacement cost of physical capital K_t, constructed as in Salinger and Summers (1983).[12] The two series are highly correlated (73%), but inference is hampered by the fact that both series appear to be non-stationary in our sample. The Augmented Dickey-Fuller (ADF) test fails to reject the presence of a unit root in either series, even in the presence of a deterministic trend. However, the ADF test fails to reject the null of no co-integration at the 10% level, implying that the two series co-move at lower frequencies. We conclude that organization capital may drive some of the low frequency movements in Tobin's Q, although there are clearly other factors that affect Tobin's Q at business cycle frequencies.

4 Model predictions

In this section, we explore the predictions of our model in the data. In addition, we explore whether our model can quantitatively replicate the main features of the data by replicating our estimation results on simulated data from the model.

4.1 Calibration

In order to evaluate the ability of the model to quantitatively replicate the data, we calibrate the extended model described in Section 2.2. We select parameters to match key moments of the data, and document the properties of the solution. We solve the two Hamilton-Jacobi-Bellman equations (27)-(28) through value function and policy iteration following Kushner and Dupuis (1992). We simulate the model at a monthly frequency and aggregate the data to form annual observations. Each simulation contains 1,500 firms and has a length of 80 years. We drop the first half of each simulation sample to avoid dependence on initial values, and repeat the process 5,000 times.

[12]Salinger and Summers (1983) compute the replacement value of the capital stock using the perpetual inventory method, and deflate investment expenditures using the price of investment goods. Given the rapid decline in the relative price of investment goods during the last three decades, the last step is important in capturing the time-series behavior of the aggregate organization-to-physical capital ratio.

Parameters of the firm economic environment

Table 1 shows the parameters used in our calibration. Our model contains a total of 19 parameters. We set the depreciation rate of physical capital to $\delta_K = 6\%$, which is consistent with values commonly used in the macroeconomic literature. We set the depreciation rate of organization capital to $\delta_O = 15\%$ to be consistent with our empirical implementation. These values are also consistent with empirical estimates of the depreciation rate of physical and intangible capital (Pakes and Schankerman, 1979; Nadiri and Prucha, 1996).

We choose the remaining 17 parameters to approximately match 17 aggregate and cross-sectional moments in the data. In Table 2 we compare the moments in the data that we target with their model-implied counterparts. We report the median moment, along with the 5% and 95% percentiles across simulations. We set values $\mu_\theta = 0.25\%$ for the mean growth rate and $\sigma_\theta = 0.11$ for the volatility of the common technology shock to approximately match the mean growth rate and the volatility of dividends, as well as the volatility of the returns to the market portfolio. We choose the parameters governing the rate of mean-reversion and volatility of the firm-specific shocks to approximately match the cross-sectional dispersion in profitability, organization to physical capital, and firm size in the data ($\kappa_u = 0.12$; $\kappa_\varepsilon = 0.35$; $\sigma_u = 25\%$; $\sigma_\varepsilon = 45\%$).

The literature offers little guidance in selecting the parameters governing the dynamics of the frontier technology shock x or the costs associated with organization capital. We calibrate these parameters to match the dynamics of capital reallocation and investment in organization capital in the model. Thus, we set the cost of reallocation to $c_R = 1.75$; the convexity of adjustment costs to organization capital to $\lambda_o = 3.2$; the rate of mean-reversion of the frontier technology shock to $\kappa_x = 0.10$; and the volatility of the frontier technology shock to $\sigma_x = 14\%$. These choices ensure that our model approximately matches the volatility and serial correlation of the average rate of investment in organization capital, and the mean and the volatility of the average rate of capital reallocation from Eisfeldt and Rampini (2006).

The next set of parameters are selected to match the moments of Tobin's Q in our model. We choose values for the parameters governing the cost of investment goods $c_q = 0.13$ and the parameter $\lambda_K = 1.8$ governing the convexity of adjustment costs to physical capital to approximately match the level and cross-sectional dispersion of Tobin's Q. Moreover, we choose the parameters governing the cost of investing in physical and organization capital, $c_k = 435$ and $c_o = 625$ respectively, to approximately match the level of investment in physical and organization capital.

Parameters of the stochastic discount factor

The asset pricing implications of our model depend on the parameters of the stochastic discount factor. We set the risk-free rate to equal $r = 4\%$, which is slightly higher than the historical average (3%), but ensures that the value function does not explode at the edges of our computational grid. We choose the price of risk of the total factor productivity shock $\gamma_\theta = 0.4$ to match the average excess return of the market portfolio.

The effect of organization capital on risk premia depends on the price of risk of the frontier technology shock γ_x. In the data, firms with more organization capital to assets (O/K) have higher average returns than low-O/K firms, suggesting a negative risk price for γ_x. Hence, we choose a risk price $\gamma_x = -0.53$ to match the difference in average returns between high- and low-O/K firms.

Our choice for γ_x implies that the frontier technology shock x leads to high marginal utility states. In general equilibrium, the risk price γ_x of the frontier shock is pinned down by preferences and the dynamic response of consumption to x. In our model, high realizations of x imply that reallocation becomes more attractive (the threshold $\varepsilon^*(x)$ increases) and therefore more aggregate resources are devoted to paying the resource cost C_R in (25). In the short run, resources available for consumption are lower, since aggregate output $\int y_{it}\,di$ does not immediately increase following an increase in x. In the long run, consumption increases as more firms operate at a higher level of efficiency. We conjecture that in a general equilibrium version of our model, if investors have time-separable utility or if their elasticity of substitution is lower than their risk aversion, then high-x states will be high marginal valuation states, implying $\gamma_x < 0$.

This intuition follows Papanikolaou (2011), who explores the risk premium associated with investment shocks in general equilibrium. Investment shocks are shocks to real investment opportunities, and generate similar consumption dynamics to our frontier shock x. Our calibrated value for γ_x falls in the range of empirical estimates reported in Papanikolaou (2011), who estimates a negative price of risk for investment shocks.

Numerical solution and simulation

Figure 1 illustrates several features of the numerical solution of the model. Panel A plots the market value of physical capital $q(u_i)$, which is increasing in the level of firm-specific productivity u_i. Panel B plots the total value of organization capital $v(\varepsilon_i, x)$. The total value of organization capital is increasing in both ε_i and x, because the level of firm-specific efficiency ε_i determines the output of organization capital while it remains within the existing firm, whereas the level of frontier efficiency x determines the output of organization capital once it is deployed in a new firm.

Panel C graphs the outside option of the key talent $\bar{v}(x)$. This value increases in the level of the frontier technology shock x, since the latter determines the efficiency of organization capital in new firms. Panel D graphs the shareholder share of the value of organization capital $v(\varepsilon_i, x) - \bar{v}(x)$. The shareholder value of organization capital is increasing in the firm-specific level of efficiency ε_i, but is decreasing in the level of the frontier technology shock x. This decrease in value represents the differential source of risk that investors in firms with high levels of organization capital are exposed to.

Firms with low levels of firm-specific efficiency $\varepsilon_i < \varepsilon^*(x)$ are replaced with firms with the frontier level of technology x. Panel E plots this threshold $\varepsilon^*(x)$, which is increasing in x, as the latter improves the gains from reallocation. Therefore, the invariant distributions of the firm-specific efficiency ε_i and the frontier technology x are linked. Panel F plots the invariant joint distribution of ε_i and x, where we see that the mean of the firm-specific efficiency ε_i is increasing in the level of frontier technology. The joint distribution of ε and x illustrates the process of creative destruction in our paper: the left tail of the distribution of ε_i is replaced with the level of x, leading to an increase to the mean level of productivity ε_i among active firms.

4.2 Organization capital and firm characteristics

In Table 3, we document how firm differences in their ratio of organization to physical capital O/K are related to firm characteristics, both in the data (Panel A) and in the model (Panel B). We report the time-series average of the median firm characteristic in each O/K portfolio. We discuss the details behind the construction of these variables in the data appendix.

The model performs well in replicating the relation between firm characteristics and the ratio of organization to physical capital in the data. Firms with higher organization capital have higher Tobin's Q than firms with low organization capital, both in the data (1.25 vs 1.05) and in the model (1.28 vs 1.03). Even though this dispersion in Q is substantial in magnitude, it is smaller than the unconditional dispersion in Q in the data (0.84) or in the model (0.61). Hence, Tobin's Q is not a sufficient statistic for the ratio of organization to physical capital. Intuitively, the cross-sectional relationship between Tobin's Q and O/K is attenuated due to an omitted variable problem: ceteris paribus, firms with more productive physical assets (high u_i) will tend to have higher firm valuations, higher rates of physical investment i_K and thus lower levels of O/K. Consistent with this possibility, firms with a higher ratio of organization to physical capital have *lower* investment rates in physical capital K by 2.4% (2.1% in the model). Since the inter-quintile range in investment rates in the population of firms is 10.6%, this dispersion is somewhat significant.

Both in the data and in the model, firms with higher ratios of organization to physical capital O/K firms tend to have smaller market capitalization. In the model, high-O/K firms have smaller market capitalization than low-O/K firms because the shareholder value of physical capital V^K exceeds the shareholder value of organization capital V^{OS} on average. In particular, the fraction of shareholder value that is due to organization capital ranges from 37% for the firms in the high O/K portfolio to 4% for the firms in the low O/K portfolio. Moreover, our model generates a similar relation between productivity and organization capital to the data. The only exception is that when we measure productivity using the Solow residual this increasing pattern in productivity exists only among the portfolios $2-5$. This happens because low-O/K firms tend to have a higher level of productivity of physical assets u.

Furthermore, we explore whether our measure of organization capital O is correlated with measures of compensation to key talent w, as suggested by Equation (37). We find that firms with more organization capital have a higher ratio of total executive compensation to assets, both in the data (1.29% to 0.57%) and in the model (2.98% to 0.14%). The level of executive compensation is somewhat lower in the data than the model, possibly because our definition of key talent is broader than the firm executives whose compensation is reported in *Execucomp*.[13]

Finally, we document a number of other firm characteristics in the data that do not have a direct counterpart in the model. Labor expenses per worker are roughly 11% higher in the high-O/K firms relative to the low-O/K firms, suggesting that firms with more organization capital are more labor intensive and that these firms employ more skilled workers, consistent with the findings of Caroli and Van Reenen (2001) andBresnahan et al. (2002). Moreover, firms with more organization capital have lower levels of asset tangibility, measured as the ratio of property, plant and equipment to book assets. This last pattern suggests that firms with high organization capital might also have accumulated other forms of intangible capital, and is consistent with the fact that high O/K firms also have higher ratios of expenditures on advertising (6.0 vs 1.4%) or research and development (3.6 to 1.1%) to book assets. Finally, firms with more organization capital have also have lower financial leverage (0.15 vs 0.30), possibly as a result of the lower tangibility of assets or their increased risk due to organization capital.

[13]Our definition of key talent includes scientific or technical personnel that are key to the production and sales process. By contrast, firms are only required by law to disclose the compensation of their top 5 executives in their proxy statements. Hence, our measure of executive compensation likely understates the level of the flow payment to key talent w.

4.3 Asset prices

In this section, we explore the main prediction of our paper, namely that cross-sectional differences in the ratio of organization to physical capital are associated with differences in risk premia. We construct value-weighted portfolio returns for 5 portfolios sorted on the ratio of organization capital to book assets O/K, where we allow the O/K-breakpoints to vary by industry. We use monthly portfolio returns and rebalance portfolios in June every year. We replicate the same procedure on simulated data from the model. Table 4 shows the empirical results in the data (Panel A) and in the model (Panel B).

The left panel (A) shows the results in the data. Firms with a higher ratio of organization capital to book assets have 4.7% higher average returns per year than firms with low organization capital to assets. Furthermore, the portfolio long high- and short low-O/K firms has a standard deviation of 10%, implying a Sharpe ratio greater than 0.4. This difference in average returns is not explained by the CAPM, since the high organization capital portfolio has a lower market beta than the low organization capital portfolio. Consequently, the CAPM alpha of this long-short portfolio is 5.6%, and statistically significant.

Importantly, there is substantial comovement among these portfolios, and this comovement can account for these differences in risk premia. Specifically, the two-factor model that includes the market portfolio and the OMK portfolio produces alphas that are not statistically different from zero. In addition, the betas with respect to the OMK portfolio are monotonically increasing from -0.37 to 0.63. These results imply that high-O/K firms tend to comove more with other high-O/K than with the low-O/K firms. This comovement among firms suggests that high- and low-O/K firms are exposed to different sources of risk, and this differential risk factor exposure is sufficient to explain the differences in their average returns.

The right panel (B) of Table 4 replicates these empirical results in simulated data. Our model quantitatively replicates almost all of the main features of Panel A. First, the high-minus low-O/K portfolio has an average return of 4.1% per year, and a standard deviation of 9.7%. Second, the CAPM fails at pricing the cross-section of O/K portfolios, since there is almost no dispersion in market betas. Thus, the high- minus low-O/K portfolio has a CAPM alpha of 3.7%. The model differs from the data in one dimension, namely that it does not replicate the decreasing pattern in market betas across the O/K portfolios. One explanation is that in our model firms are financed entirely by equity, whereas in the data they are also financed by debt. Table 3 shows that, empirically, high-O/K firms have lower financial leverage. If we create the equivalent of levered returns in the model using the empirical leverage of the O/K portfolios, our model replicates this decreasing pattern in market betas.

Furthermore, these differences in average returns among the O/K portfolios are not explained by differences in risk exposures to the SMB and HML factors of Fama and French (1993) or the MOM factor of Carhart (1997). As we see in Table 5, adding the Fama and French (1993) SMB and HML factors to the CAPM increases the alpha slightly to 5.9%, since there is no dispersion in loadings on either risk factor across the organization capital portfolios. By contrast, high-O/K firms have slightly higher loadings on the momentum MOM factor than low-O/K firms, but this difference is not sufficient to explain the difference in risk premia. As a result, the high- minus low-O/K portfolio has an alpha of 4.2% with the Carhart (1997) four factor model, and this alpha is statistically significant at the 1% level.

In summary, firms with high organization to physical capital O/K have higher average returns than low-O/K firms. Our model implies that this difference in average returns arises because high- and low-O/K firms have differential sensitivities to the frontier organizational efficiency shock x. The fact that a portfolio of high- minus low-O/K firms, along with the market portfolio, yields alphas that are not statistically different from zero supports the view that differences in average returns across firms sorted on organization capital arise due to differences in risk exposures.

A direct corollary of a risk-based story is that sorting firms based on their *beta* with respect to the OMK portfolio, rather than O/K, should also lead to differences in average returns. The data are consistent with a risk-based explanation. As we can see in Table 6, sorting firms into portfolios based on their univariate beta with the OMK portfolios leads to differences in risk premia. The average difference in returns between the high- and low-β^{omk} portfolio is 2.91%, with a t-statistic of 1.16, and the CAPM alpha of this portfolio is 4.89% with a t-statistic of 2. Part of the reason for the lower Sharpe and information ratio of the high- minus low-β^{omk} portfolio is its increased volatility relative to the OMK portfolio (15.5% versus 10.1%). See the appendix A for the details on how the 5 beta-OMK portfolios are constructed.

4.4 Additional predictions

The evidence in Section 4.3 is consistent with the view that the difference in average returns between high- and low-O/K firms is due to their differential exposure to a source of systematic risk. Our model identifies this source of systematic risk with the frontier technology shock x, which leads to systematic movements in the division of cash flows between shareholders and management.

It is difficult to relate the frontier shock to the stock returns of high- and low-O/K

directly, since the frontier shock is not observable in the data. However, our model offers testable predictions that relate the realized returns of the OMK portfolio to aggregate variables that are positively related to the frontier shock x. Specifically, our model implies that returns to the OMK portfolio are negatively correlated with the aggregate level of executive compensation, the rate of reallocation, and the amount of investment in organization capital. In this section, we explore these predictions and along with our model's implications about the dynamics of firm cash flows.

Executive compensation

To test the prediction of our model regarding the aggregate level of executive compensation, we obtain data from Frydman and Saks (2010) on the aggregate time-series of executive compensation. We focus on four measures of aggregate compensation, namely the mean and median level of compensation of either the top 3 executives or of the CEO only. Given these measures of aggregate executive compensation $\bar{w}_t$, we estimate:

$$\Delta \log \bar{w}_t = a_0 - b_0 \, R_t^{omk} - b_1 \, R_{t-1}^{omk} + \rho \Delta \log \bar{w}_{t-1} + e_t. \tag{41}$$

We estimate the above equation via OLS and report the estimated coefficients (b_0, b_1), along with Newey-West standard errors, in Panel A of Table 7. Consistent with our model, the estimated coefficients $\hat{b}_1$ are positive and statistically significant across the four measures of aggregate compensation. Our results are quantitatively similar if we control for the return to the market portfolio at t and $t-1$ in the right hand side of equation (41), as we show in the supplementary appendix. Panel B illustrates that the corresponding estimates on simulated data from the model are comparable to the results obtained in the data.

Reallocation

Next, we explore how measures of reallocation or restructuring of existing firms are correlated with the realized returns to the OMK portfolio. One difficulty is that our model is silent as to the exact form of this reallocation. For example, organization and physical capital may be reallocated to a new firm which starts at the frontier level of efficiency. We examine a variety of measures of physical and human capital reallocation, namely data on capital reallocation from Eisfeldt and Rampini (2006), data on CEO turnover, and data on new public offerings from Ibbotson, Sindelar and Ritter (1994). Alternatively, the key talent can buy the old firm from the existing shareholders and restructure its organization to upgrade to the frontier level x. The closest equivalent of this form of reallocation in the data is a management buyout (MBO). We obtain data on new management buyouts from Haddad, Loualiche and Plosser (2011).

We test our model's implication about measures of the aggregate rate of reallocation X, by estimating:

$$X_t = a_0 - b_0\, R_t^{omk} - b_1\, R_{t-1}^{omk} + \rho \hat{X}_{t-1} + e_t. \tag{42}$$

Our first two measures of reallocation X are the sum sales of of property plant and equipment, and the sum of mergers and acquisitions across all firms from Eisfeldt and Rampini (2006). We normalize both measures by the total sum of property, plant and equipment across firms, and estimate the standard errors using Newey-West. Our third measure of reallocation is the CEO turnover rate. Our last two measures of reallocation X are the number of new public offerings (IPO) and the number of management buyouts (MBO) in a given year. Since these last two measures are count variables, we estimate equation (42) using a poisson count regression.

We report the estimated coefficients in Table 8. As we see in Panel A, we find that all measures of reallocation are negatively correlated with the realized returns of the OMK portfolio. When we control for the return to the market portfolio at t and $t-1$ in the right hand side of equation (42), all reallocation measures except the number of new IPOs are negatively and statistically significantly related to the returns of the market portfolio (see supplementary appendix for results). Panel B illustrates that the empirical results are consistent with the model. In the model, both the rate of new firm creation, as well as the rate of capital reallocation are positively correlated with the frontier shock x, and therefore negatively correlated with returns of the OMK portfolio.

Investment in organization capital

In our model, the optimal level of investment in organization capital (32) is increasing in the firm-level of organization capital efficiency ε_i and the frontier level of technology x. To test our model's predictions about investment in organization capital, we need proxies for x and ε. We construct a proxy for the frontier shock x using the accumulated relative realized returns of the OMK portfolio $R_t^x = -\sum_{l=0}^{L} R_{t-l}^{omk}$. We chose a maximum lag length of $L=3$, but varying L between 2 and 6 has little quantitative impact on our results. We proxy for the firm-specific productivity shock ε_i using the firm's Tobin's Q, the firm's sales growth Δy and the firm's return on assets ROA.

We test our model's implications about investment in organization capital i_{Oit} by estimating:

$$i_{Oit} = a_0 + a_1\, R_{t-1}^x + a_2\, Q_{it-1} + a_3\, \Delta y_{it-1} + a_4\, ROE_{it-1} + \gamma_i + e_{it}, \tag{43}$$

where γ_i is a firm dummy. We winsorize all variables every year at the 1% level to remove the effect of outliers, and cluster the standard errors by firm and year.

We present the results in Table 9. The left panel (A) shows the estimation results in actual data. The estimated coefficient a_1 of investment in organization capital on our return-based proxy for the frontier shock x is positive and statistically significant across specifications. In addition, the coefficients a_2-a_4 are also positive and statistically significant, implying that firms invest more in organization capital when they are more productive, more profitable, and when Tobin's Q is high. The right panel (B) of Table 9 replicates our empirical procedure in simulated data. We report the median coefficient and t-statistic across simulations. The results in simulated data are qualitatively and quantitatively very similar, except for the fact that Q, Δy, and ROA are highly correlated. Hence, when we include all three measures of firm profitability $(Q, \Delta y, ROA)$ and firm-fixed effects, the estimated coefficient a_4 on Tobin's Q in the simulated data is negative.

Finally, we quantify the percentage of the time-series variation in the investment in organization capital that can be explained by our proxy for x. To do so, we compute the aggregate investment rate in organization capital $\bar{i}_{Ot} = \sum_{i=1}^{N_t} I_{Oit} / \sum_{i=1}^{N_t} O_{it-1}$ and the median investment rate i_{Ot} across firms, and plot it versus our proxy for the frontier technology shock R^x_{t-1} in figure 3. The correlation between the aggregate (median) investment rate and R^x_{t-1} is equal to 27% (45%) and is statistically significant at the 5% (1%) level. Thus, our return-based proxy for x can explain a substantial fraction of the time-series variation in organization capital investment.

Operating leverage

Here, we explore how the sensitivity of firm earnings E to firm y_{it} or aggregate $\bar{y}_t$ output varies with the level of organization to physical capital. We do so by estimating:

$$\Delta \log E_{it} = a_0 + z_i + a_1 \Delta y_{it} + \sum_{d=2}^{5} a_d D_{dt-1} \times \Delta \log y_{it} + e_{it} \tag{44}$$

$$\Delta \log E_{it} = b_0 + z_i + b_1 \Delta \bar{y}_t + \sum_{d=2}^{5} b_d D_{dt-1} \times \Delta \log \bar{y}_t + e_{it}, \tag{45}$$

where E_{it} equals operating cash flows;[14] y_{it} is firm sales; $\bar{y}_t$ is aggregate output (GDP) or total industry sales (using the 17 industry Fama-French classification); D_{dt} is a dummy taking the

[14]In the model, we define firm earnings as $E_{it} = y_{it} - w_{it}$. This definition is closest in spirit to measuring cash flows as income minus operating costs, before capital depreciation. However, our measure of investment in organization capital (SG&A expenses) is treated as a cost given current accounting rules. Hence, an alternative definition of earnings in the model could be $y - w - C_O$. Our simulation results are qualitatively and quantitatively similar under this alternative definition of earnings.

value 1 if the firm belongs in quintile d at time t in terms of its ratio of organization capital to assets O/K; and z_i are firm fixed effects. We cluster the standard errors by firm and year.

Our model implies that the sensitivity of firm earnings to firm output is increasing in the ratio of organization to physical capital O/K. Consequently, we expect that the coefficients a_d in equation (44) are positive and increasing in d. By contrast, the sensitivity of firm earnings to aggregate output $\bar{y}_t = \int y_{it} di$ is independent of the firm's O/K ratio, implying that the estimated coefficients b_d in equation (45) should not be statistically different from zero.

Table 10 shows that the empirical results are consistent with the model. The estimated coefficients a_d are positive and statistically significant, implying that firms with higher ratios of organization to physical capital O/K have greater sensitivity of earnings to firm sales. This difference in sensitivities is economically sizeable: a 1% increase in sales growth increases operating cash flows by 1.1% in low O/K firms, versus 1.4% in high-O/K firms. These magnitudes are also consistent with those implied by the model: a 1% increase in firm sales leads to an increase of operating cash flows of 1% and 1.3% for firms in the bottom and top O/K quintile respectively.

By contrast, and consistent with our model, all firms have the same sensitivity of earnings to aggregate shocks. In the data, the estimated coefficients b_d are not statistically significantly from zero, regardless of whether we measure aggregate output by GDP or industry sales. The fact that in the data, high-O/K firms have the same sensitivity of cash flows to aggregate shocks as low-O/K firms, helps exclude alternative explanations for our asset pricing results that rely on the interpretation of SG&A expenditures as fixed costs. Under this alternative, firms with greater SG&A expenditures would be firms with greater operating leverage, thus leading to the counter-factual prediction that firms with higher organization capital to assets would display greater sensitivity of earnings to aggregate shocks.

5 Robustness checks and alternative explanations

In this section we briefly describe a number of robustness tests and explore a number of alternative explanations. The full set of results is available in the internet appendix.

5.1 Robustness checks

Our results are quantitatively similar to the following robustness tests: i) forming equal- rather than value-weighted portfolios; ii) sorting firms into portfolios unconditionally based on organization capital to book assets, as opposed to within industry; iii) scaling the stock of organization capital by property, plant and equipment (PPE) or the replacement value of capital as in Salinger and Summers (1983) instead of book assets; iv) measuring investment in organization capital as SG&A expenses minus advertising expenditures, restricting the sample to the set of firms that report advertising expenses as a line item.[15]

Furthermore, we explore whether sorting firms on other accounting variables, namely accumulated sales, costs of goods sold, inventories, depreciation, research and development expenses or advertising expenses, relative to book assets, produces similar results. Except sales, none of these variables are successful at consistently generating differences in expected returns, CAPM and Fama and French (1993) alphas across the high and low portfolio. Out of these six cases, the variable that yields results closest to ours is firm sales. This fact is consistent with our model, since firm expenditures in organization capital are an increasing function of the productivity of organization capital ε and therefore firm output y. Sorting firms in portfolios according to accumulated sales over assets leads to quantitatively similar results in simulated data, as we show in the supplementary appendix.

5.2 Alternative Explanations

The CAPM fails to explain the cross-section of O/K portfolios, since high-O/K firms have lower market betas than low-OK firms. However, it is possible that the market betas of these firms vary systematically over time. In particular, if high O/K firms are riskier than low-O/K firms in bad times, and the price of risk is counter-cyclical, then our results could be explained by the conditional CAPM.

A number of alternative models could imply that high-O/K firms are riskier than low-O/K firms in bad times. These alternative explanations fall into two broad categories. First, maintaining a firm's organization capital may entail some fixed costs. In this case, a negative aggregate productivity shock will lead to a greater decrease in firm profits of high-O/K firms relative to low-O/K firms. Second, investment in organization capital is irreversible. If firms cannot disinvest of their organization capital following an adverse productivity shock, their stock price will be more sensitive to aggregate fluctuations. See Lev (1974) and Kogan (2001) for a theoretical illustration of these two mechanisms.

We test the general alternative hypothesis that firms with more organization capital have increased sensitivity to aggregate shocks in states when the conditional equity premium is

[15] Advertising expenditures could contribute to the accumulation of brand capital, which we view as a different type of intangible capital than organization capital (Belo et al., 2011). In our view, the key difference is that brand capital is identified with the firm, hence shareholders retain full ownership and cashflow rights. Not all firms report advertising expenses separately, but in the set of the firms that do so, advertising expenses constitute approximately 10% of total SG&A expenses.

high. We do so in three steps. In the first step, we estimate conditional market betas for the high minus low organization capital portfolio using weekly data. We use non-overlapping windows of 52 weekly observations to form a time-series of annual market betas. In the second step, we estimate the conditional equity premium by regressing market returns on a set of conditioning variables:

$$R_{mktt} - R_{ft} = a + bX_{t-1} + e_t. \tag{46}$$

Our set of conditioning variables X includes the dividend yield, term spread, risk free rate and credit spread from Petkova and Zhang (2005) and the *cay* variable of Lettau and Ludvigson (2001). Given the estimates of a and b, we construct the conditional equity premium as $\gamma_t \equiv E_{t-1}[R_{mktt} - R_{ft}] = \hat{a} + \hat{b}X_{t-1}$. In the third step, we examine the correlation between the conditional equity premium γ_t and the market beta of the OMK portfolio, which is equal to the difference in market beta between high- and low-O/K firms $\beta_t^{omk} \equiv \beta_t^5 - \beta_t^1$. If the correlation between γ_t and β_t^{omk} is positive, then high-O/K firms have higher systematic risk than low O/K firms when the conditional equity premium is high, thus potentially justifying the difference in risk premia.

We find no evidence that high-O/K firms are riskier than low-O/K firms at times when the conditional equity premium is high. The correlation between the market beta of the OMK portfolio β_t^{omk} and the conditional equity premium γ_t estimated in equation (46) is negative and ranges from -37.5% to -7.1% depending on the specification. More generally, the correlation between β_t^{omk} and future excess market returns R^e_{mktt+1} is not statistically significant and equal to -8%. Thus, the conditional CAPM performs even worse than the unconditional CAPM, since high-O/K firms have *lower* market betas than low-O/K firms when the conditional equity premium is high.

6 Conclusion

This paper considers the appropriate discount rate investors should use to value organization capital. Investing in firms with high levels of organization capital exposes shareholders to additional risks because shareholders do not own all the cash flows from organization capital. In our model, organization capital is embodied in key talent. As a result, shareholders cannot appropriate all the cash flows from organization capital. However, because the efficiency of organization capital is partly firm specific, shareholders can capture some of its value.

The share of cash flows from organization capital which shareholders can capture varies systematically with the outside option of the firm's key talent. In our model, this outside option is driven by the frontier efficiency at which organization capital can be deployed in new firms. When the efficiency of organization capital in new firms improves, shareholders must offer higher compensation to induce the key talent to remain with the firm. As a result, cash flows to shareholders from organization capital are negatively correlated with the frontier technology shock.

Our calibrated model quantitatively matches the dispersion in firm characteristics and risk premia associated with organization capital. In our calibration, we assume that the frontier shock leads to high marginal valuation states. This choice is motivated by the fact that an increase in the rate of reallocation will reduce current output, since restructuring is costly. As a result, shareholders demand a higher risk premium to invest in firms with more organization capital because these firms drop in value when more resources are lost to restructuring.

Finally, our model delivers a set of testable predictions that are supported by the data. Our model relates the realized returns of firms with high and low organization capital to the aggregate level of executive compensation, measures of reallocation, and investment in organization capital. Moreover, it offers predictions about the sensitivity of firm cash flows to idiosyncratic and aggregate shocks.

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Tables

Table 1: Parameters

Parameter	Symbol	Value
Technology		
Growth rate of TFP-shock	μ_θ	0.00
Volatility of TFP-shock	σ_θ	0.11
Mean-reversion parameter of frontier shock	κ_x	0.10
Volatility of frontier shock	σ_x	0.20
Mean-reversion parameter of firm O-specific shock	κ_ε	0.35
Volatility of firm O-specific shock	σ_ε	0.45
Mean-reversion parameter of firm K-specific shock	κ_u	0.12
Volatility of firm K-specific shock	σ_u	0.25
Investment and reallocation		
Convexity of adjustment costs for investment in O-capital	λ_O	3.20
Proportional adjustment cost for investment in O-capital	c_O	625
Depreciation rate of O-capital	δ_O	0.15
Proportional reallocation cost of O-capital	c_R	1.75
Convexity of adjustment costs for investment in K-capital	λ_K	1.80
Proportional adjustment cost for investment in K-capital	c_k	435
Cost of investment goods	c_q	0.13
Depreciation rate of K-capital	δ_K	0.06
Stochastic discount factor		
Risk-free rate	r	0.04
Price of risk of TFP-shock	γ_θ	0.40
Price of risk of reallocation shock	γ_x	-0.533

Table 1 describes the parameters used in calibration.

Table 2: Aggregate and firm-specific moments

Moment	Data	Model		
		Median	5%	95%
Aggregate moments				
Mean of dividend growth	0.025	0.028	-0.012	0.056
Volatility of dividend growth	0.118	0.116	0.084	0.278
Mean of investment rate in O-capital	0.211	0.199	0.189	0.217
Volatility of investment rate in O-capital	0.015	0.009	0.004	0.020
Autocorrelation of investment rate in O-capital	0.817	0.861	0.693	0.943
Mean of capital reallocation rate	0.042	0.051	0.001	0.277
Volatility of capital reallocation rate	0.026	0.088	0.003	0.283
Asset returns				
Mean excess return of market portfolio	0.064	0.049	0.012	0.083
Volatility of market portfolio return	0.171	0.128	0.105	0.159
Firm moments				
Tobin' s Q (median)	1.101	1.107	1.018	1.321
Tobin' s Q (IQR)	0.848	0.614	0.452	0.835
Organization-to-physical capital (median)	1.079	0.678	0.394	1.678
Organization-to-physical capital (IQR)	1.320	0.770	0.444	1.910
Investment rate in O-capital (median)	0.222	0.172	0.158	0.197
Investment rate in K-capital (median)	0.111	0.099	0.097	0.108
Cashflows-to-Capital (IQR)	0.234	0.145	0.119	0.242
Firm size (log) (IQR)	2.207	1.377	1.236	1.487

Table 2 presents the target moments used for calibration. We compare the moments in the data, versus moments of simulated data. We report median values across simulations, along with the 5% and 95% percentiles. Moments of dividend growth are from the long sample in Campbell and Cochrane (1999). The rate of capital reallocation is from Eisfeldt and Rampini (2006), defined as the sum of sales of property, plant and equipment plus the sum of mergers and acquisitions to the sum of property, plant and equipment. The remaining moments are computed using Compustat data over the 1970-2008 period (see Appendix A for variable definitions). The firm-specific moments are time-series averages of the median and inter-quintile range (IQR).

Table 3: Firm characteristics and organization capital

A: Data					
Portfolio	Lo	2	3	4	Hi
Organization capital to book assets	0.27	0.66	1.09	1.60	2.71
Market capitalization (log, real)	4.89	4.67	4.41	4.10	3.26
Tobin's Q	1.05	1.11	1.18	1.19	1.25
Productivity - sales to book assets (%)	72.38	97.77	111.01	122.99	145.46
Productivity - Solow residual (%)	-11.38	-1.21	2.18	4.02	4.18
Investment to capital (organization, %)	27.11	25.40	22.31	21.35	17.80
Investment to capital (physical, %)	12.63	12.34	12.05	11.60	10.18
Executive compensation to book assets (%)	0.57	0.84	0.89	0.91	1.29
IT expenditures to book assets (%)	1.17	1.69	1.67	1.91	2.10
Labor expense per employee (1000, real)	54.10	54.60	55.30	56.70	60.10
Capital to labor (log)	3.66	3.28	3.01	2.83	2.56
Physical capital to book assets	38.11	30.72	26.55	24.46	21.30
R&D expenditures to book assets	1.36	2.14	3.17	4.02	6.03
Advertising expenditures to book assets	1.10	1.54	1.88	2.50	3.64
Debt to book assets	29.91	24.69	20.01	17.62	15.07
B: Model					
Portfolio	Lo	2	3	4	Hi
Organization capital to book assets	0.19	0.42	0.66	1.00	1.65
Market capitalization (log)	4.10	3.24	2.82	2.49	2.18
Tobin's Q	1.03	1.02	1.05	1.11	1.28
Productivity - sales to book assets (%)	20.18	21.94	24.59	28.59	38.77
Productivity - Solow residual (%)	1.10	-10.86	-9.38	-2.59	17.58
Investment to capital (organization, %)	19.24	19.26	19.28	19.31	19.39
Investment to capital (physical, %)	10.74	10.01	9.58	9.18	8.62
Executive compensation to book assets (%)	0.14	0.58	1.13	1.78	2.98
Value of organization capital to firm value (%)	4.03	10.37	16.39	23.84	37.30

Table 3 compares characteristics of the 5 portfolios sorted on organization to physical capital between the data (panel A) and the model (panel B). We report time-series average of the median portfolio characteristic. In the data, we sort firms in 5 portfolios based on the ratio of organization capital to book assets (Compustat item at), using industry-specific breakpoints. We use the 17 industry classification of Fama and French (1997), and rebalance portfolios every June. In simulated data, we sort firms into 5 portfolios based on the ratio of organization O_{it} to physical capital K_{it}, and rebalance every year. We report median values across simulations, along with the 5% and 95% percentiles. See Appendix A for variable definitions. The sample period is January 1970 to December 2008.

Table 4: Asset pricing: 5 portfolios sorted on O/K

	A: Data						B: Model					
Portfolio	1	2	3	4	5	5m1	1	2	3	4	5	5m1
	1: Portfolio moments						1: Portfolio moments					
$E[R]-r_f$ (%)	4.18	4.54	5.54	5.95	8.81	4.63	4.45	5.47	6.26	7.19	8.69	4.14
	(1.48)	(1.59)	(2.12)	(2.43)	(3.52)	(2.85)	(2.17)	(2.73)	(2.97)	(3.21)	(3.45)	(2.76)
σ (%)	17.50	17.71	16.26	15.17	15.55	10.10	12.74	12.64	13.19	14.00	15.72	9.67
SR (%)	23.89	25.64	34.07	39.22	56.66	45.84	34.93	43.28	47.46	51.36	55.28	42.81
	2: CAPM						2: CAPM					
α(%)	-1.19	-0.92	0.57	1.46	4.38	5.57	-0.68	0.42	1.06	1.80	3.02	3.71
	(-1.29)	(-1.07)	(0.67)	(1.54)	(3.69)	(3.47)	(-2.23)	(1.12)	(2.05)	(2.44)	(2.59)	(2.57)
β_{mkt}	1.05	1.07	0.97	0.88	0.86	-0.18	0.99	0.98	1.00	1.03	1.08	0.09
	(49.93)	(51.81)	(48.11)	(31.08)	(26.72)	(-4.30)	(40.82)	(34.08)	(25.20)	(17.83)	(11.71)	(0.79)
R^2(%)	90.07	90.90	89.44	83.78	77.62	8.29	97.65	96.63	93.93	88.48	76.74	3.27
	3: Two-factor model						3: Two-factor model					
α(%)	0.89	-0.03	-0.32	-0.17	0.89		0.04	-0.10	-0.02	0.05	0.04	
	(1.32)	(-0.04)	(-0.41)	(-0.20)	(1.32)		(0.29)	(-0.29)	(-0.06)	(0.15)	(0.29)	
β_{mkt}	0.98	1.04	1.00	0.93	0.98		1.01	0.97	0.98	0.99	1.01	
	(65.09)	(55.79)	(59.22)	(43.02)	(65.09)		(103.29)	(38.63)	(43.06)	(44.83)	(103.29)	
β_{omk}	-0.37	-0.16	0.16	0.29	0.63		-0.19	0.13	0.28	0.47	0.81	
	(-14.83)	(-5.18)	(5.93)	(8.28)	(24.89)		(-11.92)	(3.80)	(9.10)	(15.17)	(50.26)	
R^2(%)	94.33	91.65	90.33	87.23	92.82		99.62	97.58	98.16	98.40	99.76	

Table 4 shows asset pricing tests for 5 portfolios sorted on organization capital over assets relative to their industry peers (see notes to Table 3), where we rebalance portfolios in June every year. In panel 1, we report average excess returns over the risk-free rate $E[R]-r_f$, standard deviations σ and Sharpe ratios SR across portfolios. In panel 2 we report portfolio alphas and betas of a regression of excess portfolio returns on excess returns of the market portfolio. In panel 3 we report portfolio alphas and betas of a regression of excess portfolio returns on excess returns of the market portfolio and the OMK portfolio (OMK portfolio corresponds to the $5m1$ portfolio). Panel A reports results using monthly data, where the sample period is June 1970 to December 2008. Panel B shows results using simulated monthly data from the model, where we report the median coefficient across simulations. We include t-statistics in parenthesis are computed using the Newey-West estimator allowing for 1 lag of serial correlation in returns. We annualize numbers by multiplying by 12. All portfolio returns correspond to value-weighted returns by firm market capitalization

Table 5: Asset Pricing: 5 portfolios sorted on O/K, additional results

Portfolio	1	2	3	4	5	5m1
	1: Fama-French three-factor model					
$\alpha(\%)$	-1.44	-0.47	0.51	1.92	4.48	5.93
	(-1.60)	(-0.54)	(0.62)	(2.17)	(3.62)	(3.61)
β_{mkt}	1.07	1.05	0.97	0.91	0.89	-0.18
	(50.93)	(49.62)	(43.69)	(42.02)	(25.53)	(-3.99)
β_{smb}	-0.05	-0.03	0.01	-0.23	-0.14	-0.09
	(-1.67)	(-0.80)	(0.16)	(-8.52)	(-3.74)	(-1.53)
β_{hml}	0.05	-0.06	0.01	-0.03	0.01	-0.04
	(1.31)	(-1.80)	(0.15)	(-0.51)	(0.22)	(-0.51)
$R^2(\%)$	90.28	91.02	89.44	86.33	78.59	9.15
	2: Carhart four-factor model					
$\alpha(\%)$	-0.85	0.54	-0.09	1.58	3.33	4.18
	(-0.92)	(0.61)	(-0.10)	(1.76)	(2.63)	(2.55)
β_{mkt}	1.06	1.04	0.98	0.92	0.91	-0.15
	(49.20)	(49.34)	(46.85)	(41.18)	(27.37)	(-3.63)
β_{smb}	-0.05	-0.03	0.01	-0.23	-0.14	-0.08
	(-1.78)	(-1.02)	(0.22)	(-8.22)	(-3.80)	(-1.51)
β_{hml}	0.04	-0.09	0.02	-0.02	0.04	0.00
	(0.98)	(-2.56)	(0.45)	(-0.36)	(0.78)	(0.01)
β_{mom}	-0.05	-0.08	0.05	0.03	0.09	0.14
	(-2.06)	(-3.40)	(1.64)	(0.89)	(2.75)	(3.10)
$R^2(\%)$	90.43	91.43	89.62	86.39	79.29	12.92

Table 5 shows asset pricing tests for 5 portfolios sorted on organization capital over assets relative to their industry peers (see notes to Table 4) for details). In panel 1 we report portfolio alphas and betas of a regression of excess portfolio returns on excess returns of the market portfolio and the Fama and French (1993) SMB and HML factors. In panel 2 we report portfolio alphas and betas of a regression of excess portfolio returns on excess returns of the market portfolio, the Fama and French (1993) SMB and HML factors and the Carhart (1997) MOM factor. Data on SMB, HML and MOM are from Kenneth French's website. Sample period is June 1970 to December 2008. We include t-statistics in parenthesis are computed using the Newey-West estimator allowing for 1 lag of serial correlation in returns. We annualize numbers by multiplying by 12. All portfolio returns correspond to value-weighted returns by firm market capitalization

Table 6: Asset Pricing: 5 portfolios sorted on beta with OMK portfolio

Sort	1	2	3	4	5	5m1
	1: Portfolio moments					
$E[R] - r_f$ (%)	3.85	5.42	6.22	6.62	6.76	2.91
	(1.07)	(1.80)	(2.43)	(2.64)	(2.50)	(1.16)
σ (%)	22.34	18.64	15.87	15.53	16.82	15.56
SR	17.23	29.08	39.19	42.63	40.19	18.70
	2: CAPM					
α(%)	-3.08	-0.41	1.13	1.78	1.81	4.89
	(-2.27)	(-0.37)	(1.54)	(1.79)	(1.36)	(2.01)
β_{mkt}	1.31	1.10	0.96	0.92	0.94	-0.38
	(37.19)	(35.02)	(58.80)	(38.96)	(27.29)	(-5.85)
R^2(%)	86.59	87.77	92.56	87.29	77.97	14.58
	3: Two-factor model					
α(%)	-0.02	1.47	1.27	0.01	-1.20	-1.18
	(-0.01)	(1.50)	(1.65)	(0.01)	(-1.11)	(-0.64)
β_{mkt}	1.21	1.04	0.96	0.98	1.04	-0.16
	(46.81)	(44.18)	(60.74)	(51.67)	(33.47)	(-3.31)
β_{omk}	-0.53	-0.32	-0.02	0.31	0.52	1.05
	(-13.21)	(-6.65)	(-0.62)	(7.84)	(10.08)	(13.67)
R^2(%)	90.84	90.05	92.58	90.22	85.17	48.92

Table 6 shows asset pricing tests for 5 portfolios on their univariate beta with the portfolio of high- minus low-OK firms (see appendix for construction details). We compute pre-sorting univariate OMK-betas using weekly returns (see appendix A for more details) and rebalance portfolios in December every year. In panel 1, we report average excess returns over the risk-free rate $E[R]-r_f$, standard deviations σ and Sharpe ratios SR across portfolios. In panel 2 we report portfolio alphas and betas of a regression of excess portfolio returns on excess returns of the market portfolio. In panel 3 we report portfolio alphas and betas of a regression of excess portfolio returns on excess returns of the market portfolio and the OMK portfolio. Sample period is January 1971 to December 2008. All portfolio returns correspond to value-weighted returns by firm market capitalization We include t-statistics in parenthesis are computed using the Newey-West estimator allowing for 1 lag of serial correlation in returns. We annualize numbers by multiplying by 12.

Table 7: OMK portfolio returns and executive compensation

Compensation to key talent $\Delta \log \bar{w}_t$	$-R_t^{omk}$	$-R_{t-1}^{omk}$	$\Delta \log \bar{w}_{t-1}$	R^2
A. Data				
Compensation of top 3 officers, average	-0.342	2.206	0.001	0.352
	(-0.67)	(4.29)	(0.03)	
Compensation of top 3 officers, median	0.249	0.911	0.014	0.216
	(0.81)	(2.97)	(0.60)	
Compensation of CEO only, average	-0.863	2.540	-0.007	0.298
	(-1.24)	(3.64)	(-0.20)	
Compensation of CEO only, median	-0.091	1.256	0.015	0.331
	(-0.30)	(4.15)	(0.86)	
B. Model				
Compensation to key talent, average	2.026	1.926	-0.067	0.403
	(2.95)	(2.38)	(-0.36)	

Table 7 reports estimates of a time-series regression of the aggregate level of executive compensation on minus the returns of the OMK portfolio, in the data (Panel A) and in the model (Panel B). The OMK portfolio is defined as the portfolio long firms with high organization capital and short (minus) firms with low organization capital to assets (see notes to Table 3 and appendix A for more details). The data on executive compensation is from Frydman and Saks (2010) and covers the 1970-2008 period. Standard errors are computed using the Newey-West estimator allowing for 1 lag of serial correlation.

Table 8: OMK portfolio returns and reallocation

Reallocation X_t	$-R_t^{omk}$	$-R_{t-1}^{omk}$	X_{t-1}	R^2
A. Data				
Capital reallocation rate,	0.012	0.007	0.945	0.899
sale of property, plant and equipment	(2.00)	(1.17)	(17.79)	
Capital reallocation rate,	0.002	0.089	0.949	0.832
mergers and acquisitions	(0.07)	(2.53)	(13.21)	
CEO Turnover	0.009	0.091	0.374	0.462
	(0.36)	(3.35)	(1.63)	
Number of new initial public offerings,	2.189	1.267	0.002	
(poisson regression)	(2.66)	(1.10)	(4.40)	
Number of new management buyouts,	1.073	-0.461	0.024	
(poisson regression)	(2.87)	(-1.38)	(7.00)	
B. Model				
Reallocation frequency	0.214	0.186	0.797	0.737
	(2.51)	(2.50)	(7.30)	
Capital reallocation rate,	0.204	0.179	0.785	0.690
sale of physical capital K to new firms	(2.35)	(2.32)	(7.03)	

Table 8 reports estimates of a time-series regression of measures of capital reallocation on the returns of the OMK portfolio, in the data (Panel A) and in the model (Panel B). The OMK portfolio is defined as the portfolio long firms with high organization capital and short (minus) firms with low organization capital to assets (see notes to Table 3 and appendix A for more details). The data on capital reallocation rate is from Eisfeldt and Rampini (2006) and cover the 1970-2008 period; the data for CEO turnover are from Execucomp and cover the 1992-2008 period; the data on initial public offerings is from Ibbotson et al. (1994) and cover the 1975-2008 period; the data on management buyouts is from Haddad et al. (2011) and cover the 1982-2008 period. In the data section, the first three sets of rows report results using OLS, where the standard errors are computed using the Newey-West estimator allowing for 1 lag of serial correlation. The last two set of rows reports results using a poisson count regression, with robust standard errors.

Table 9: Investment in Organizational Capital

	A: Data					B: Model				
i_{Ot}	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
R^x_{t-1}	0.177	0.171	0.149	0.177	0.103	0.145	0.158	0.149	0.153	0.144
	(2.81)	(3.95)	(2.16)	(2.70)	(2.00)	(4.39)	(4.57)	(4.43)	(4.52)	(4.41)
$\log Q_{it-1}$		0.059			0.034		0.009			-0.008
		(13.04)			(6.30)		(10.00)			(-2.50)
$\Delta \log Y_{it-1}$			0.134		0.076			0.013		0.008
			(14.90)		(14.94)			(5.02)		(2.98)
ROA_{it-1}				0.024	0.034				0.033	0.049
				(1.86)	(2.60)				(15.93)	(7.59)
Obs.	49523	49523	49523	49523	49523	52500	52500	52500	52500	52500
R^2	0.004	0.071	0.113	0.005	0.578	0.137	0.191	0.177	0.241	0.360
Firm FE	-	-	-	-	Y	-	-	-	-	Y

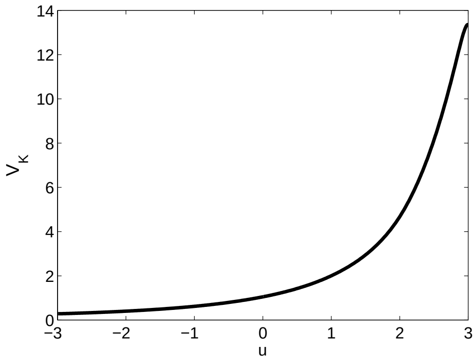
Table 9 shows estimates of a regression of investment rate in organizational capital i_{Ot} on lagged values of: minus the accumulated returns of the OMK portfolio $R^x_t \equiv -\sum_{l=1}^{3} R^1_{t-l} - R^5_{t-l}$; log Tobin's Q; log sales growth $\Delta \log Y_{it}$; profitability ROA_{it-1}. See Appendix A for variable definitions. Depending on the specification we include firm fixed effects (F). Panel A shows the empirical results in the data, where the sample period is January 1970 to December 2008. Panel B shows results in simulated data, where we report the median estimated coefficient and t-statistic across simulations. We winsorize all firm-specific variables at the 1% and 99% level every year. Standard errors are clustered by firm and year.

Table 10: Organizational capital and operating leverage

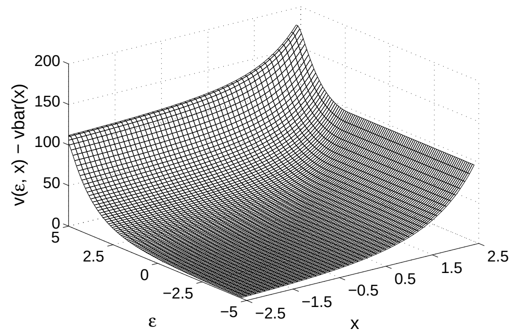
	A: Data			B: Model	
$\Delta \log E_{it}$	Firm-specific	Systematic		Firm-specific	Systematic
	(Sales)	(GDP)	(ISales)	(y_{it})	(y_t)
$\Delta \log Y_t$	1.117	2.954	0.140	1.081	0.963
	(24.84)	(5.28)	(2.44)	(196.91)	(24.24)
$D_2(O/K) \times \Delta \log Y_t$	0.108	0.004	-0.024	0.091	-0.005
	(1.99)	(0.01)	(-0.36)	(6.83)	(-0.14)
$D_3(O/K) \times \Delta \log Y_t$	0.184	0.001	0.050	0.127	-0.005
	(3.16)	(0.00)	(0.50)	(7.50)	(-0.10)
$D_4(O/K) \times \Delta \log Y_t$	0.289	-0.292	0.029	0.178	-0.003
	(5.22)	(-0.66)	(0.34)	(7.85)	(-0.04)
$D_5(O/K) \times \Delta \log Y_t$	0.303	0.027	0.032	0.255	-0.001
	(3.82)	(0.06)	(0.41)	(8.16)	(-0.01)
Observations	52035	52035	52035	58465	58465
R^2	0.288	0.147	0.141	0.833	0.112

Table 10 presents compares estimates of operating leverage across the 5 O/K portfolios in the data and in the model. We compute operating leverage with respect to idiosyncratic shocks as the slope coefficient of a regression of change in log earnings $\Delta \log E_{it}$ on change in log firm output $\Delta \log Y_{it}$. We compute operating leverage with respect to aggregate shocks as the slope coefficient of a regression of change in log earnings $\Delta \log E_{it}$ on change in log aggregate output $\Delta \log Y_{it}$. We interact firm and aggregate output with O/K-quintile dummies, where breakpoints vary by industry (see notes to Table 3). In the data, E_{it} is earnings before taxes and depreciation, firm output Y_{it} is sales, and aggregate output Y_t is gross domestic product (GDP) or industry sales (ISales). We use the 17 industry classification of Fama and French (1997). In simulated data, firm output y_{it} is given by equation (16), aggregate output $y_t = \int y_{it}\, di$ and earnings are output minus compensation to key talent w. See Appendix A for variable definitions. We include firm and O/K-quintile dummies in all specifications. Panel A shows the estimation results in the data, where the sample period is January 1970 to December 2008. Panel B shows the estimation results in simulated data, where we report the median estimated coefficient and t-statistic across simulations. We winsorize all firm-specific variables at the 1% and 99% level every year. Standard errors are clustered by firm and year.

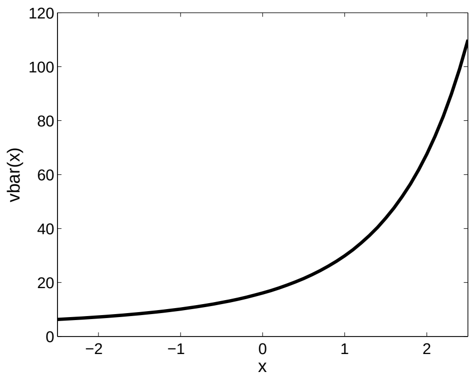
Figure 1: Model solution



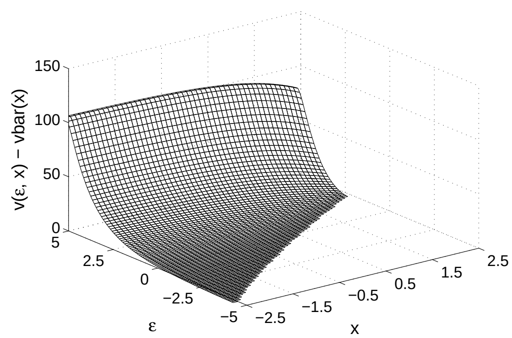
A: value of physical capital



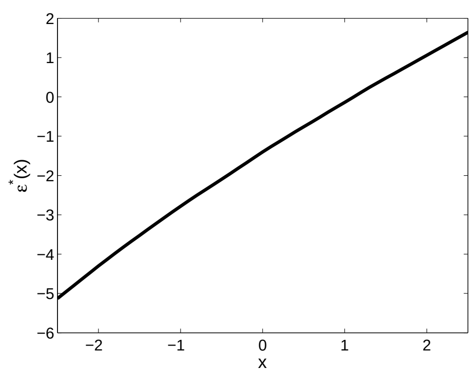
B: value of organization capital



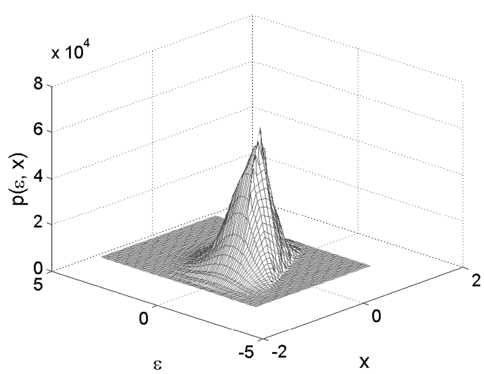
C: value of organization capital to key talent



D: value of organization capital to shareholders



E: threshold for adoption of new technology



F: invariant joint distribution of ε and x

Figure 1 plots the solution of the model as a function of the firm-specific level of productivity shocks u and ε and the level of frontier technology x. Panel A plots the market value of physical capital $q(u)$; Panel B plots the total value of organization capital $v(\varepsilon, x)$; Panel C plots the value of the outside option of key talent $\bar{v}(x)$; Panel D the value of rents that shareholders can extract from organization capital $v(\varepsilon, x) - \bar{v}(x)$; Panel E plots the threshold for the adoption of new technologies $\varepsilon^*(x)$; Panel F plots the stationary joint distribution of ε and x.

Figure 2: ratio of O- to K-capital (solid line) and Tobin's Q (dashed line), aggregate

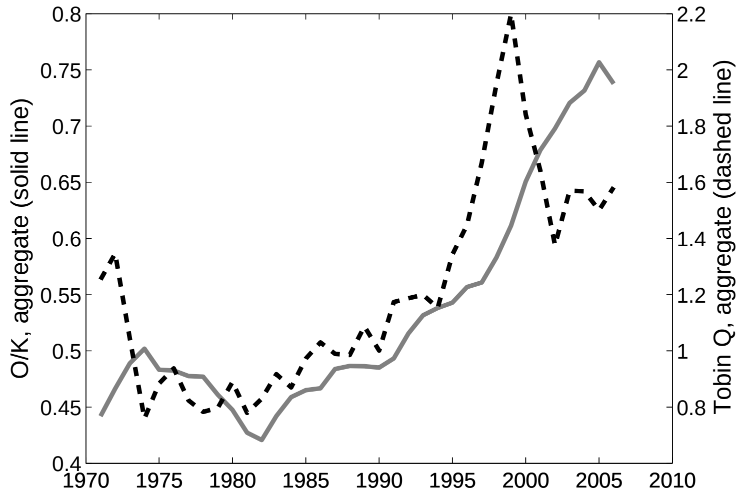
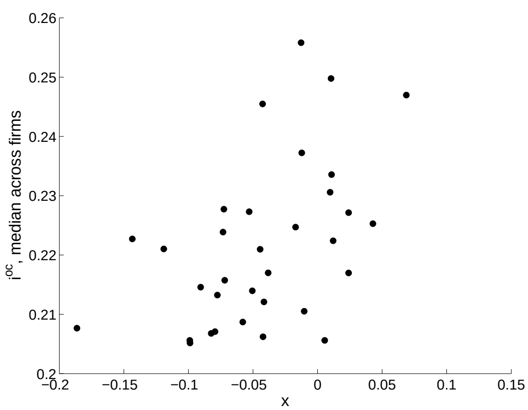
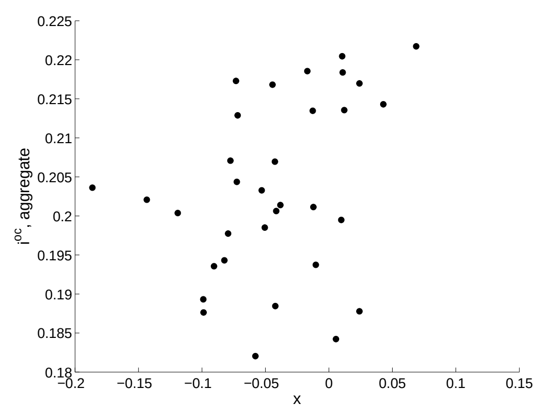


Figure 2 plots the aggregate ratio of organization to physical capital ($\sum_{i \in N_t} O_{it} / \sum_{i \in N_t} K_{it}$) versus aggregate Tobin's Q ($\sum_{i \in N_t} V_{it} / \sum_{i \in N_t} K_{it}$). See data appendix for variable definitions.

Figure 3: Investment in organization capital



A. Investment rate in O-capital versus accumulated returns to the 1-5 portfolio ($\tilde{x}$), median across firms



B. Investment rate in O-capital versus accumulated returns to the 1-5 portfolio ($\tilde{x}$), aggregate

Figure 3 plots the median investment rate in organization capital across firms (A) and the aggregate rate of investment in organization capital, versus the (negative of the) accumulated log returns on the OMK portfolio ($R_t^x = -\sum_{l=0}^{3} R_{t-l}^{omk}$). See data appendix for variable definitions.

Appendix A: Data construction

Our sample includes all firms in Compustat with December fiscal year (fyr=12), non-financial firms (SIC 6000-6799), firms with common shares (shrcd=10 and 11), firms traded on NYSE, AMEX and NASDAQ (exchcd=1,2 and 3), firms with non-missing SIC codes, and firms with non-zero values of organization capital.

All variables are from *Compustat*, unless otherwise noted. After each variable we include in parenthesis the *Compustat* item code, as well as the model equivalent when available.

- We rank firms on organization to physical capital relative to their industry peers as follows. We first sort firms into 17 industries, given the Fama and French (1997) classification. Then, within each industry, we sort firms into 5 sub-portfolios based on the ratio of organization capital to book assets. We then pool the sub-portfolios across industries to form 5 portfolios of firms sorted on O/K, where the breakpoints are industry-specific. Thus, portfolio 1 includes all the firms in the bottom quintile in terms of organization capital to assets in industry 1 through 17, etc. When computing portfolio returns, we value-weight each firm return using the firms market capitalization.
- We estimate beta-OMK using weekly data. Specifically, we use one year of non-overlapping weekly returns to estimate pre-sorting betas with respect to the OMK portfolio. Then, we sort all non-financial firms in CRSP (shrcd=10 and 11 and exchcd=1,2 and 3) into 5 portfolios based on their beta with the OMK portfolio. We rebalance the portfolios in January every year. Similar to our benchmark results, we compute breakpoints within the Fama and French (1997) 17 industries.
- The Solow residual u_{it} is the residual of a regression of log sales (data: sale; model y_{it}) to log physical capital K (data: ppegt; model: $c_q\theta_t K_{it}$) and log labor L (data: emp; model $L = 1$):

  $$\ln Sales_{it} = a_{It} + \beta_{It} \ln K_{it} + \gamma_{It} \ln L_{it} + u_{it},$$

  where we allow the coefficients a_{It}, β_{It} and γ_{It} to depend on industry (I) and time (t). In the data, we use the Fama-French 17 industry classification, while in the model we assume all firms belong to the same industry.
- Firm size is market capitalization (data: December market capitalization from CRSP; model: V_{it}^S)
- Tobin's Q is the ratio of market capitalization (data: December market capitalization from CRSP plus the book value of debt (dltt + dlc) plus the book value of preferred shares (cshpri), minus inventories (invt) divided by the book value of assets (at); model: shareholder value of the firm V_{it}^S) divided by replacement cost of capital $c_q\theta_t K_{it}$).
- The ratio of executive compensation to assets equals the ratio of total executive compensation (data: tdc2 from Compustat's Execucomp; model: w_{it}) divided by the book value of assets;
- Physical capital investment rate is the ratio of capital expenditures divided by the book value of capital (data: capx divided by ppegt; model i_{Kit});
- The stock of organization capital equals accumulated investment in organization capital minus depreciation (data: see Section 3.1; model O_{it});
- Organization capital investment rate is the ratio of SG&A divided by accumulated organization capital (data: see Section 3.1; model i_{Oit});
- Firm productivity is the ratio of firm sales (data: sale; model y_{it}) to book value of assets (data: at; model: $c_q\theta_t K_{it}$);
- Firm profitability (ROA) is the ratio of firm earnings before income, tax and depreciation (data: ib + dp; model $y_{it} - w_{it}$) to book value of assets (data: at; model: $c_q\theta_t K_{it}$). In the model, we also construct an alternative measure of earnings, where we also subtract the cost of investment in organization - capital $C_O(i_{Oit}, O_{it}; \theta_t)$, because in the data operating income is net of SG&A expenditures;
- Capital reallocation is the ratio of capital sales to total capital stock (data: from Eisfeldt and Rampini (2006); model: $\int \mathbf{1}_{\varepsilon_{it} \leq \varepsilon^*(x_t)} K_{it}\, di / \int K_{it}\, di$).

- CEO turnover is constructed using CEO turnover events from Execucomp. If the Exceutive ID for the CEO in year t is different from the ID in year $t+1$, we record this as a turnover event in year t.
- Labor expenses per employee equals Compustat xlr deflated by cpi and divided by emp.
- IT expenditure data are from from the 1995 and 1996 Information Week 500 Survey online at http://i.cmpnet.com/infoweek/545/graphics/iw500u.pdf

  and

  http://i.cmpnet.com/infoweek/596/graphics/biggest.pdf
- The remaining variables are computed as follows: financial leverage is the ratio of book value of debt to total assets, asset tangibility as the ratio of the book value of capital (item ppegt) to the book value of assets, the log capital-labor ratio as the log ratio of the book value of physical capital (ppegt) to number of employees (emp);