Product Market Competition and Equity Returns*

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ABSTRACT

We develop an analytically tractable equilibrium model to examine the link between competition in product markets and stock returns. Firms maximize profits from the sale of their products to consumers, who, in turn, maximize their expected utility. Investors receive firm profits as investment returns. We characterize firms' optimal production plans and expected equity returns, and show that firm heterogeneity within an industry leads to differences in "production risk premia" across firms. In addition, we demonstrate that the intensity of product market competition can have different effects on expected returns of firms with different characteristics. The model further suggests that the size and value effects may partly arise at the industry level. We show empirically that the compensation for bearing cash flow risk resulting from competition in output markets is economically significant and that product market competition is associated with expected returns in ways that are consistent with the model.

This paper develops a model that links product market competition to firms' expected equity returns. There are reasons to believe that this link, although little studied, is valid and likely important. Firms' operations consist of a series of activities. They perform initial market research, develop products, obtain financing from investors, engage in production, and finally sell the products to consumers. The nature of competition in product markets affects firms' behavior in almost every phase of this process. Firms' product market strategies influence their profits, free cash flows, and investors' valuation of these cash flows in financial markets. In short, product market competition can be value-relevant.

We explicitly model the interaction between investors, firms, and consumers in the presence of oligopolistic product market competition. Risk-averse consumers make optimal purchase decisions while facing uncertainty about the future performance of the firms' products. Firms seek to maximize their expected profits net of production costs, while taking into account their competitors' product market strategies. Competition affects firm values because equilibrium prices of their products are affected by the output choices of their rivals. Investors optimally allocate funds to maximize their expected utility. At the investment stage, the technological progress that firms will be able to make is uncertain, and so are the future selling prices of their products. This makes firms' earnings and equity payoffs risky, leading investors to require compensating expected returns. The result is a link between competition among firms in product markets and firms' expected returns in equity markets.

Our paper makes both theoretical and empirical contributions. Theoretically, we characterize firms' optimal production plans and expected equity returns in a general framework. As usual, the expected return is proportional to the sensitivity of equity payoff to aggregate payoff. Thus, firms whose profits co-move more strongly with the aggregate profit of all firms in the industry are riskier and earn higher expected returns. Since profits are the result of optimal production in our model, we call the reward for bearing such risk the production risk premium.

In equilibrium, firms with products that have higher "performance ratios" (i.e. products that are more reliable and/or have lower marginal production costs) are larger in size, have lower book-to-market-ratios, and lower production risk premia and hence expected returns. The basic intuition is that firms that manufacture products with superior expected performance end up being less risky in equilibrium. This result suggests the possibility that the size and value effects partially arise at the industry level.[1] The empirical implication is that firms with relatively high product performance ratios are expected to generate relatively low expected returns.

In addition, expected returns of firms that manufacture products with relatively low performance ratios increase in the intensity of product market competition, while the expected returns of firms with relatively high performance-ratio products can increase or decrease in the extent of competition. The direct effect of increased competition is the reduction in firms' expected profitability relative to profit variability, leading to higher risk and expected returns. However, there is also an indirect effect. Specifically, increased competition within an industry leads to higher product substitutability, which has different effects on the expected returns of firms producing low-performance and high-performance products. While the former are hurt by increased similarity/substitutability of products, the latter benefit from the former's worsened competitive position. The result is that the risk and expected returns of firms producing low-performance products increase in the intensity of product market competition, whereas the effects of competition on risk and expected returns of firms manufacturing high-performance products depends on the relative strengths of the direct and indirect effects.

We have two empirical contributions. First, we show that the production risk premium is economically significant. This premium can, in principle, be measured by the profit beta. However, this presents an empirical challenge given the difficulty in estimating low-frequency betas. Instead, we take advantage of an equivalent characteristic representation of the expected return. By assumption, the expected return is proportional to the expected earnings-to-price ratio (EPR). This is simply a restatement of the model's premise that firms distribute profits as dividends, which are valued by investors at the firms' market capitalization. Our model's content is the determination of the firms' profits in oligopolistic product markets.

We argue that industry-adjusted earnings-to-price ratio (EPR) is a suitable (inverse) proxy for the product performance ratio. Using this proxy, we find that firms with higher industry-adjusted EPRs earn higher subsequent returns. Specifically, the zero-cost portfolio that is long the highest and short the lowest industry-adjusted EPR quintiles earns an average value-weighted return of 38bp per month. This production risk premium is particularly strong when firms of similar size within their industries are compared, among which competition is likely to

[1]For these empirical regularities, see, among others, Fama and French (1993, 1996) and Daniel and Titman (1997).

be fiercest. In a double sort on size and excess EPR, the production risk premium is statistically significant at 1% for all the size quintiles but the largest, ranging between 39bp and 72bp. These premia barely change upon risk-adjustment, delivering four-factor alphas of 24bp to 72bp, all of which are significant. This result is robust to additionally conditioning on the book-to-market ratio and to using alternative earnings measures. We further highlight the difference between our excess EPR portfolios and raw EPR portfolios, whose return dispersion significantly shrinks after controlling for the value factor, a property known since Fama and French (1996).

Second, we find support for the model's prediction that the effects of competition on expected returns are not uniform across firms. Specifically, expected returns of firms with high industry-adjusted EPRs are increasing in competition: the difference in risk-adjusted mean return between the tercile of firms operating in most competitive industries and the tercile of firms in least competitive industries is $19 - 21$bp per month. Expected returns of firms with low industry-adjusted EPRs are decreasing in measures of competition. The difference in raw and risk-adjusted returns between most and least competitive industries ranges from -36bp to -29bp per month. These results complement the findings in Hou and Robinson (2006), who document a negative relation between equity returns and industry concentration, and of Hoberg and Phillips (2009), who find that high industry-level stock market valuation, investment, and financing precede low stock returns in competitive industries.[2] Our results show that the effects of industry competitive structure on firms' expected returns depend crucially on firms' competitive position within their industries.

Our paper adds to the growing literature that strives to explain stylized facts in equity markets by linking expected returns to firms' real activity. For example, in the real options models of Berk, Green and Naik (1999) and Carlson, Fisher, and Giammarino (2004), in the neoclassical model of Zhang (2005), and in the endogenous pricing-kernel model of Sagi, Spiegel, and Watanabe (2009), firms' physical investment plays a critical role in generating such empirical regularities as the size, value, and investment effects. The models by Gomes, Kogan, and Zhang (2003), Kogan (2004), and Cooper (2006) share similar features. In contrast, our paper seeks the explanation in product market competition.

[2]In addition, Gaspar and Massa (2006) show that firms that enjoy market power and those that operate in concentrated industries have lower idiosyncratic return volatility, while Irvine and Pontiff (2008) associate the positive temporal trend in average idiosyncratic volatility to more intense competition in product markets.

A paper closely related to ours is Aguerrevere (2009), who analyzes how competition in product markets affects the relation between firms' real investment decisions and the dynamics of their asset returns. Using a real options model, he shows that firms in more competitive industries earn higher returns during times of weak demand, while firms in more concentrated industries earn higher returns during times of strong demand. Our model is different from Aguerrevere (2009) in that we allow for heterogeneity in firms' characteristics, multiplicity of products manufactured by each firm, utility-maximizing consumers and investors, and market clearing in both the product and equity markets. This implies that the pricing kernels for firms' products and equities are endogenously determined in their respective markets. Unlike Aguerrevere (2009), firms in our model do not have real options. An additional difference is that we analyze the relation between expected returns, firm characteristics, and industry structure, whereas Aguerrevere (2009) studies the relation between firms' betas and their book-to-market ratios.

The remainder of the paper is organized as follows. The next section presents the general model and analytically solves for its unique equilibrium. Section 2 examines the relation between firms' product performance ratios, expected returns, and characteristics, as well as the relation between firms' expected returns and industry characteristics under a reasonable parametrization of the general model. In Section 3 we empirically estimate the production risk premium and examine the relation between expected returns and industry structure for firms with various industry-adjusted earnings-to-price ratios. The last section concludes.

1. General framework

1.1 Overview

In this section we introduce a general model that links firms' expected returns in equity markets to competition in product markets. The model features three dates and three types of agents: firms, consumers, and investors. At date 0, investors make investment decisions while facing uncertainty regarding the technological progress that firms can make. At the same time, firms compete in product markets and choose outputs with an objective of maximizing their date-1 expected profits, while taking into account other firms' choices and consumers' downward-sloping demand curves. At date 1, consumers purchase firms' products to maximize their expected utility, while facing uncertainty regarding future product performance. Firms' profits are distributed to investors and returns on investment are realized. At date 2, all uncertainty is resolved and consumers derive their utility. Below we set out the model starting with the products.

1.2 Products

Throughout the paper, a lower case italic letter represents a scalar, a lower-case bold letter a vector, and an upper-case bold letter a matrix. There is a single consumption good that serves as the numeraire of the economy. The firms produce a total of N products, whose performance is measured by the units of the consumption good they deliver. The product performance is random and represented by an N vector, $\mathbf{d}$. At date 0, $\mathbf{d}$ is distributed multivariate normally with mean vector μ and variance-covariance matrix $\mathbf{\Sigma}$,

$$\mathbf{d} \sim N(\mu, \mathbf{\Sigma}),$$

where $\mathbf{\Sigma}$ is symmetric positive definite. A diagonal element of $\mathbf{\Sigma}$ represents the degree of uncertainty about a product's performance, and therefore is a measure of the product's reliability. An off-diagonal element of $\mathbf{\Sigma}$ can be interpreted as the degree of substitutability between two products. We will return to this point after deriving the price function for the products.

We now describe the agents. There is no information asymmetry among agents at each date and all parameters are known to all agents at all times.

1.3 Consumers

At date 1, consumers enter the market with exogenous endowment, w_{C_1}. Since the products have already been manufactured, the technological progress firms made during the product development phase becomes public at this point. To model this, we assume that the consumers receive a vector of signals, $\mathbf{z}$, about product performance of the following form:

$$\mathbf{z} = \mathbf{d} + \varepsilon,$$

where ε is an N vector of noise independent of $\mathbf{d}$, and it is distributed multivariate normally with mean zero and positive definite variance-covariance matrix $\mathbf{\Sigma}_\varepsilon$. Given the signal, the consumers form their beliefs about the product performance. By the projection theorem, they perceive that the product performance is multivariate normal with mean vector μ_C and variance-covariance matrix $\mathbf{\Sigma}_C$, where

$$\mu_C \equiv \mathbb{E}(\mathbf{d}|\mathbf{z}) = \mu + \mathbf{\Sigma}(\mathbf{\Sigma} + \mathbf{\Sigma}_\varepsilon)^{-1}(\mathbf{z} - \mu), \tag{1}$$

$$\mathbf{\Sigma}_C \equiv \mathbb{V}\text{ar}(\mathbf{d}|\mathbf{z}) = \mathbf{\Sigma} - \mathbf{\Sigma}(\mathbf{\Sigma} + \mathbf{\Sigma}_\varepsilon)^{-1}\mathbf{\Sigma} = (\mathbf{\Sigma}^{-1} + \mathbf{\Sigma}_\varepsilon^{-1})^{-1},$$

and we used the so-called updating formula in the last equality.[3] Thus, the posterior mean μ_C is a weighted average of the prior mean μ and the signal $\mathbf{z}$, tilted more toward the signal as the signal becomes more accurate. The posterior variance $\mathbf{\Sigma}_C$ is reduced because, due to the independence of noise, the prior precision and noise precision (inverse variances) add up.

With the updated beliefs, the consumers make their purchase decisions by allocating their endowment to the N products manufactured by firms and to a risk-free bond. The bond is in infinitely elastic supply and pays a fixed gross interest rate of R_f for the price of unity. Let $\mathbf{q_D}$ be the N vector of consumer demand for the products. Then, the consumers' terminal wealth, w_{C_2}, is given by

$$w_{C_2} = \mathbf{s}'\mathbf{q_D} + R_f w_{C_1}, \tag{2}$$

$$\mathbf{s} \equiv \mathbf{d} - R_f\mathbf{p},$$

where $\mathbf{p}$ is the N vector of product prices and $\mathbf{s}$ the N vector of what we call the "excess performance," or the vector of net delivery of the consumption good from a unit purchase of each product financed by a short position in the bond.

The consumers maximize expected negative exponential utility defined over their terminal

[3]For $\mathbf{A}$ and $\mathbf{C}$ nonsingular and $\mathbf{B}$ of full rank,

$$[\mathbf{A} \pm \mathbf{BCB}']^{-1} = \mathbf{A}^{-1} \mp \mathbf{A}^{-1}\mathbf{B}[\mathbf{C}^{-1} \pm \mathbf{B}'\mathbf{A}^{-1}\mathbf{B}]^{-1}\mathbf{B}'\mathbf{A}^{-1}.$$

See, for example, Greene (2003, p.822, Equation (A-66b)). Take $A = \mathbf{\Sigma}^{-1}$, $\mathbf{B} = \mathbf{I}$, and $\mathbf{C} = \mathbf{\Sigma}_\varepsilon^{-1}$.

wealth, w_{C_2}, with constant absolute risk-aversion (CARA) coefficient θ_C:

$$\max_{\mathbf{q_D}} \mathbb{E}[u(w_{C_2})|\mathbf{z}] = -\exp(-\theta_C CE_C), \tag{3}$$

$$CE_C \equiv \mathbb{E}(w_{C_2}|\mathbf{z}) - \frac{\theta_C}{2}\mathbb{V}\text{ar}(w_{C_2}|\mathbf{z}), \tag{4}$$

where CE_C is the certainty equivalent of the consumers' terminal wealth. Since w_{C_2} is distributed normally, maximizing the CARA utility in (3) is equivalent to maximizing the certainty equivalent in (4). This yields the N vector of first order conditions,

$$\mathbb{E}(\mathbf{d}|\mathbf{z}) - R_f\mathbf{p} - \theta_C\mathbb{V}\text{ar}(\mathbf{d}|\mathbf{z})\mathbf{q_D} = 0. \tag{5}$$

Solving (5) for the date-1 product prices results in the price function for the firms' products:

$$\mathbf{p} = \frac{1}{R_f}(\mu_C - \theta_C\mathbf{\Sigma}_C\mathbf{q}), \tag{6}$$

where we have imposed the market clearing condition,

$$\mathbf{q_D} = \mathbf{q}, \tag{7}$$

and $\mathbf{q}$ is the vector representing the quantities of the N products supplied by the firms. $\mathbf{q}$ is determined through firms' profit maximization, which is introduced below. As in a standard mean-variance problem, Equation (5) implies that the products' expected excess performance is linear in supply:

$$\mathbb{E}(\mathbf{s}|\mathbf{z}) = \theta_C\mathbf{\Sigma}_C\mathbf{q}.$$

Note that the price function in (6) is equivalent to the reduced-form demand curve in a Cournot-type competition with heterogeneous products (e.g., Vives (1999)). To see this, write its i^{th} element as

$$p_i = \frac{1}{R_f}\left(\mu_{Ci} - \theta_C\sum_{j=1}^{N}\sigma_{Cij}q_j\right),$$

where μ_{Ci} is the i^{th} element of μ_C, σ_{Cij} is the $(i,j)^{\text{th}}$ element of $\mathbf{\Sigma}_C$, and q_j is the j^{th} element of $\mathbf{q}$. Each diagonal element of $\mathbf{\Sigma}_C$ represents the effect of an increase in a firm's output on its own product price. Each off-diagonal element of $\mathbf{\Sigma}_C$, σ_{Cij}, represents the effect of a change in product j's output level on the equilibrium price of product i. The larger σ_{Cij}, the stronger the effect of product j's demand on product i's equilibrium price. The closer σ_{Cij} to σ_{Cii}, the closer substitutes products i and j are. When the two products are produced by different firms, σ_{Cij} represents the effect of a firm's product market strategy (q_j) on the other firm's equilibrium strategy (q_i) and product value (p_i), and hence the extent of "competitive interaction" among the two firms. When the two products are manufactured by the same firm, σ_{Cij} measures the degree of cannibalization among them.

1.4 Firms

At date 0, K firms compete in the product market, recognizing that they will face the consumers' downward-sloping demand curve in (6) when they sell their products at date 1. Let N_k be the number of products firm k manufactures, where $\sum_{k=1}^{K} N_k = N$ by construction. The firm's date-1 profit can be written as

$$\pi_k = (\mathbf{p}_k - \mathbf{c}_k)'\mathbf{q}_k, \tag{8}$$

where $\mathbf{p}_k$, $\mathbf{c}_k$, and $\mathbf{q}_k$ are N_k vectors of firm k's portions of the product price vector $\mathbf{p}$, the production cost vector $\mathbf{c}$, and the output vector $\mathbf{q}$, respectively, all of which have length N. The randomness in product prices comes from μ_C in Equation (6). This implies that product prices are distributed multivariate normally with mean vector $\mu_{\mathbf{p}}$ and variance-covariance matrix $\mathbf{\Sigma}_{\mathbf{p}}$, where

$$\mu_{\mathbf{p}} \equiv \mathbb{E}(\mathbf{p}) = \frac{1}{R_f}(\mathbb{E}[\mu_C] - \theta_C \mathbf{\Sigma}_C \mathbf{q}) = \frac{1}{R_f}(\mu - \theta_C \mathbf{\Sigma}_C \mathbf{q}), \tag{9}$$

$$\mathbf{\Sigma}_{\mathbf{p}} \equiv \mathbb{V}\mathrm{ar}(\mathbf{p}) = \frac{1}{R_f^2}\mathbb{V}\mathrm{ar}(\mu_C) = \frac{1}{R_f^2}\mathbf{\Sigma}(\mathbf{\Sigma} + \mathbf{\Sigma}_\varepsilon)^{-1}\mathbf{\Sigma}. \tag{10}$$

Each firm maximizes its expected profit with respect to its output:[4]

$$\max_{\mathbf{q}_k} \mathbb{E}(\pi_k) = [\mathbb{E}(\mathbf{p}_k) - \mathbf{c}_k]'\mathbf{q}_k. \tag{11}$$

The first order condition is:

$$\mathbb{E}(\mathbf{p}_k) - \mathbf{c}_k + \frac{\partial \mathbb{E}(\mathbf{p}'_k)}{\partial \mathbf{q}_k}\mathbf{q}_k = 0. \tag{12}$$

Differentiating firm k's portion of Equation (9) with respect to $\mathbf{q}_k$, we obtain

$$\frac{\partial \mathbb{E}(\mathbf{p}'_k)}{\partial \mathbf{q}_k} = -\frac{\theta_C}{R_f}\mathbf{\Sigma}_{Ckk}, \tag{13}$$

where $\mathbf{\Sigma}_{Ckk}$ is the N_k by N_k diagonal block of $\mathbf{\Sigma}_C$ in the rows and columns corresponding to firm k. Stacking the first order condition (12) across all firms using Equations (9) and (13) along with $\mathbb{E}(\mu_C)= \mu$ yields

$$\theta_C(\mathbf{\Sigma}_C+\mathbf{D}_{\mathbf{\Sigma}_C})\mathbf{q} = \mu - R_f\mathbf{c}, \tag{14}$$

where $\mathbf{D}_{\mathbf{\Sigma}_C}$ is the block diagonal matrix containing $\mathbf{\Sigma}_{Ckk}$'s in the main diagonal:

$$\mathbf{D}_{\mathbf{\Sigma}_C} \equiv \begin{pmatrix} \mathbf{\Sigma}_{C11} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \mathbf{\Sigma}_{C22} & \ddots & \vdots \\ \vdots & \ddots & \ddots & \mathbf{0} \\ \mathbf{0} & \cdots & \mathbf{0} & \mathbf{\Sigma}_{CKK} \end{pmatrix}.$$

Solving for $\mathbf{q}$ gives the unique vector of the N firms' equilibrium outputs,

$$\mathbf{q} = \frac{1}{\theta_C}(\mathbf{\Sigma}_C + \mathbf{D}_{\mathbf{\Sigma}_C})^{-1}(\mu - R_f\mathbf{c}). \tag{15}$$

[4]Assuming value maximization instead does not change the result materially. To see this, suppose firm k maximizes its market value,

$$\max_{\mathbf{q}_k} v_{0_k}h_k = h_k[\mathbb{E}(v_{1_k}) - \mathbb{E}(\Delta v_k)]/R_f = \{[\mathbb{E}(\mathbf{p}_k) - \mathbf{c}_k]'\mathbf{q}_k - h_k\theta_I\mathbf{q}'_k\mathbf{\Sigma}_{\mathbf{p}k\cdot}\mathbf{q}\}/R_f,$$

where we have substituted Equations (26), (16), (11), and (23). The first order condition adds the derivative of the second term, $-h_k\theta_I[\mathbf{\Sigma}_{\mathbf{p}k\cdot}\mathbf{q} + \mathbf{\Sigma}_{\mathbf{p}kk}\mathbf{q}_k]$, to the left hand side of Equation (12). Stacking the result across the firms produces an equivalent of Equation (14), $[\theta_C(\mathbf{\Sigma}_C+\mathbf{D}_{\mathbf{\Sigma}_C}) + R_f h_k\theta_I(\mathbf{\Sigma}_\mathbf{p} + \mathbf{D}_{\mathbf{\Sigma}_\mathbf{p}})]\mathbf{q} = \mu - R_f\mathbf{c}$. But since $\mathbf{\Sigma}_\mathbf{p}$ is proportional to $\mathbf{\Sigma}_C$ by Equations (29) and (30), the solution is $\mathbf{q} = \frac{1}{\theta_C + h_k\theta_I/\gamma R_f}(\mathbf{\Sigma}_C + \mathbf{D}_{\mathbf{\Sigma}_C})^{-1}(\mu - R_f\mathbf{c})$, which is proportional to Equation (15).

The firms distribute their date-1 profits to investors. If there are h_k shares of firm k's equity outstanding, the date-1 value of each share is

$$\pi_k/h_k \equiv v_{1_k}. \tag{16}$$

In what follows, we normalize h_k to one without loss of generality.

1.5 Investors

At date 0, investors are born with endowment w_{I_0}. They live for two periods and derive utility from consumption, or equivalently, wealth at date 1. At date 0 they can invest in the K firms' stocks and the risk-free bond. The investors' wealth at date 1, w_{I_1}, is given by

$$w_{I_1} = \boldsymbol{\Delta}\mathbf{v}'\mathbf{1}_K + R_f w_{I_0}, \tag{17}$$

$$\boldsymbol{\Delta}\mathbf{v} \equiv \mathbf{v}_1 - R_f\mathbf{v}_0, \tag{18}$$

where $\mathbf{v}_0$ is the K vector of date-0 firm values, $\mathbf{v}_1$ the K vector of date-1 firm values (i.e. profits, as follows from (16)), $\boldsymbol{\Delta}\mathbf{v}$ the K vector of excess payoffs, i.e., the net payoffs from a zero-cost portfolio long each firm, financed by a short position in the bond, and $\mathbf{1}_K$ is the K vector of ones.

Investors maximize expected negative exponential utility defined over their date-1 wealth with CARA coefficient θ_I:

$$\max_{\mathbf{x}} \mathbb{E}[u(w_{I_1})] = -\exp(-\theta_I CE_I), \tag{19}$$

$$CE_I \equiv \mathbb{E}(w_{I_1}) - \frac{\theta_I}{2}\mathbb{V}ar(w_{I_1}). \tag{20}$$

The assumption of information symmetry implies that the investors can solve the firms' problems and know the optimal $\mathbf{q}$ in (15). The maximized profit in (8) is linear in prices $\mathbf{p}$ and hence in signals $\mathbf{z}$, and therefore is normally distributed. Maximizing the certainty equivalent CE_I in (20), the first-order conditions of the investors' optimization problem in (19) can be written as:

$$\mathbb{E}(\boldsymbol{\Delta}\mathbf{v}) - \theta_I \mathbb{V}ar(\mathbf{v}_1)\mathbf{1}_K = 0. \tag{21}$$

1.6 Equilibrium Expected Returns

From Equation (21) we can compute expected returns once we calculate $\mathbb{V}\text{ar}(\mathbf{v}_1)$ and $\mathbb{E}(\mathbf{v}_1)$ embedded in $\mathbb{E}(\Delta\mathbf{v})$. First, using the expressions for the equity payoff in (16), the firm profits in (8), and the product price variance in (10), the $(k,m)^{\text{th}}$ element of $\mathbb{V}\text{ar}(\mathbf{v}_1)$ is

$$\mathbb{C}\text{ov}(v_{1_k}, v_{1_m}) = \mathbb{C}\text{ov}(\pi_k, \pi_m) = \mathbf{q}_k'\mathbb{C}\text{ov}(\mathbf{p}_k, \mathbf{p}_m')\mathbf{q}_m = \mathbf{q}_k'\boldsymbol{\Sigma}_{\mathbf{p}km}\mathbf{q}_m, \tag{22}$$

where $\boldsymbol{\Sigma}_{\mathbf{p}km}$ is the N_k by N_m block of $\boldsymbol{\Sigma}_{\mathbf{p}}$ in the rows and columns corresponding to firms k and m, respectively:

$$\boldsymbol{\Sigma}_{\mathbf{p}} \equiv \begin{pmatrix} \boldsymbol{\Sigma}_{\mathbf{p}11} & \cdots & \boldsymbol{\Sigma}_{\mathbf{p}1k} \\ \vdots & \ddots & \vdots \\ \boldsymbol{\Sigma}_{\mathbf{p}k1} & \cdots & \boldsymbol{\Sigma}_{\mathbf{p}KK} \end{pmatrix}.$$

From the k^{th} element of Equation (21), firm k's expected excess payoff is

$$\mathbb{E}(\Delta v_k) = \theta_I\mathbf{q}_k'(\boldsymbol{\Sigma}_{\mathbf{p}k1}\mathbf{q}_1 + \cdots + \boldsymbol{\Sigma}_{\mathbf{p}kK}\mathbf{q}_K) = \theta_I\mathbf{q}_k'\boldsymbol{\Sigma}_{\mathbf{p}k\cdot}\mathbf{q}, \tag{23}$$

where $\boldsymbol{\Sigma}_{\mathbf{p}k\cdot}$ is the rows of $\boldsymbol{\Sigma}_{\mathbf{p}}$ corresponding to firm k. For $k \neq m$, Equation (23) indicates that the covariance matrix of technological shocks, $\boldsymbol{\Sigma}_{\mathbf{p}km}$, also measures how firm m's output choice affects firm k's expected equity payoffs.

To compute date-0 share prices, first use Equations (12) and (13) to evaluate firm k's maximized profit in (11):

$$\max_{\mathbf{q}_k}\mathbb{E}(\pi_k) = -\mathbf{q}_k'\frac{\partial\mathbb{E}(\mathbf{p}_k')}{\partial\mathbf{q}_k}\mathbf{q}_k = \frac{\theta_C}{R_f}\mathbf{q}_k'\boldsymbol{\Sigma}_{Ckk}\mathbf{q}_k. \tag{24}$$

Then from Equation (16), firm k's expected equity payoff is

$$\mathbb{E}(v_{1_k}) = \mathbb{E}(\pi_k) = \frac{\theta_C}{R_f}\mathbf{q}_k'\boldsymbol{\Sigma}_{Ckk}\mathbf{q}_k. \tag{25}$$

By the definition of expected excess payoffs in (18), firm k's date-0 share price is

$$v_{0_k} = [\mathbb{E}(v_{1_k}) - \mathbb{E}(\Delta v_k)]/R_f. \tag{26}$$

Then, its expected excess return is

$$\mathbb{E}(R_k) = \frac{\mathbb{E}(\Delta v_k)}{v_{0_k}} = \frac{\mathbb{E}(\Delta v_k)}{[\mathbb{E}(v_{1_k}) - \mathbb{E}(\Delta v_k)]/R_f} = \frac{1}{[\mathbb{E}(v_{1_k})/\mathbb{E}(\Delta v_k) - 1]/R_f} \equiv \frac{1}{1/f_k - 1/R_f}, \quad (27)$$

which increases in

$$f_k = \frac{1}{\frac{1}{\mathbb{E}(R_k)} + \frac{1}{R_f}} \equiv \frac{R_f \mathbb{E}(\Delta v_k)}{\mathbb{E}(v_{1_k})} = \frac{\theta_I R_f^2}{\theta_C} \frac{\mathbf{q}_k' \mathbf{\Sigma}_{\mathbf{p}k\cdot} \mathbf{q}}{\mathbf{q}_k' \mathbf{\Sigma}_{Ckk} \mathbf{q}_k}. \quad (28)$$

f_k can be readily calculated from the solution for $\mathbf{q}$ in (15), and so can the expected excess return, $\mathbb{E}(R_k)$ in (27). We require that $f_k < R_f$ for the expected excess return to be positive.

2. Competition in Product Markets and Expected Returns

The general model presented in the previous section allows us to analyze the link between product market competition and expected returns of firms operating in an industry under tractable assumptions. We also demonstrate that empirical regularities such as the size and value effects can arise at the industry level and can be partially driven by competition in product markets.

2.1 An Analytical Example

For analytical tractability, assume that industries are independent in that both $\mathbf{\Sigma}$ and $\mathbf{\Sigma}_\varepsilon$ are block diagonal with each main diagonal block representing an industry. For instance, Table 1 shows an example for $\mathbf{\Sigma}$ with two industries.

Insert Table 1 here

The first industry has two firms and the second industry three, with different numbers of products. Because of the block diagonal assumption, $\mathbf{\Sigma}_C$ and $\mathbf{\Sigma}_\mathbf{p}$ are also block diagonal and each industry can be analyzed separately using the framework developed in Section 1. Thus, we omit the industry subscript in what follows, but note that industries can have different parameter values across them. For simplicity, further assume the following parametrization within an industry:

Assumption 1 *(Product homogeneity within a firm and common substitutability) Assume that industries are independent. Within each industry, all products share the common substitutability parameter, ρ. Within each firm, products are homogeneous. Specifically,*

$$\mu_k = \mu_k \mathbf{1}_{N_k}, \quad \mathbf{c}_k = c_k \mathbf{1}_{N_k}, \quad \mu_k - R_f c_k > 0 \ \forall k, \quad \mathbf{\Sigma}_\varepsilon = \gamma \mathbf{\Sigma},$$

$$\mathbf{\Sigma}_{km} = \begin{cases} \sigma_k^2 \begin{pmatrix} 1 & \rho & \cdots & \rho \\ \rho & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & \rho \\ \rho & \cdots & \rho & 1 \end{pmatrix} & \textit{if } k = m, \\ \rho \sigma_k \sigma_m \mathbf{1}_{N_k} \mathbf{1}'_{N_m} \ \textit{if } k \neq m, \end{cases}$$

where $\mathbf{\Sigma}_{km}$ is the N_k by N_m block of $\mathbf{\Sigma}$ corresponding to the rows for firm k and the columns for firm m. These parameter values can vary across industries.

The inequality restriction requires that a project's net risk-neutral payoff be positive. The condition $\mathbf{\Sigma}_\varepsilon = \gamma \mathbf{\Sigma}$ parsimoniously models the presumption that the signals for unreliable products are noisy. This also allows us to simplify Equations (1) and (10) as

$$\mathbf{\Sigma}_C = \frac{\gamma}{1+\gamma} \mathbf{\Sigma}, \tag{29}$$

$$\mathbf{\Sigma}_{\mathbf{p}} = \frac{1}{(1+\gamma) R_f^2} \mathbf{\Sigma}. \tag{30}$$

The rest of the conditions imply that products are homogeneous within a firm and that the product substitutability parameter, $\rho < 1$, is common across the firms.[5] In what follows, we focus our attention on the case of $\rho > 0$ that corresponds to competition in strategic substitutes, in which firms' output reaction functions are downward-sloping, i.e., an increase in a firm's output reduces its rivals' profits and optimal output levels. Competition in substitutes has a more intuitive appeal than competition in complements ($\rho < 0$), in which case an increase in a firm's output positively contributes to its rivals' profits.

[5]The condition $\rho < 1$ implies that the effect of a change in a firm's output on the price of its own product is larger than the effect of a corresponding change in the firm's rivals' outputs (see Vives (1999)). This also ensures that $\mathbf{\Sigma}$ is positive definite as has been assumed.

The parametrization in Assumption 1 is not implausible if, for example, a technological shock commonly affects firms in the industry and each firm applies its own implementation of the new technology to its products. Note that the number of products, N_k, the mean performance of products manufactured by firm k, μ_k, the per-unit production cost, c_k, and product reliability, σ_k, can still vary across firms.

Given product homogeneity within a firm, we look for an equilibrium in which a firm produces the same quantity of each of its products, denoted q_k for firm k. If we indeed find a solution, it is unique since q_k in Equation (15) is unique. The following theorem summarizes the result:

Theorem 1. *Under product homogeneity within a firm and common substitutability (Assumption 1), there is a unique equilibrium in which firm k produces quantity q_k of each of its products:*

$$q_k = \frac{1+\gamma}{\gamma\theta_C} \cdot \frac{\delta + PR_k}{[2(1-\rho)+\rho N_k]\sigma_k}, \quad PR_k \equiv \frac{\mu_k - R_f c_k}{\sigma_k}, \quad \delta \equiv \frac{-\rho \sum_{m=1}^{K} \frac{N_m PR_m}{2(1-\rho)+\rho N_m}}{1+\rho \sum_{m=1}^{K} \frac{N_m}{2(1-\rho)+\rho N_m}}.$$

Note that δ is common across firms. Thus, when products are substitutes ($\rho > 0$), firms with larger scopes (N_k) produce fewer units per product, ceteris paribus. This can be understood as product cannibalization: the larger a firm's product line-up is, the more it is concerned about the reduced residual demand for its products as it manufactures a larger quantity of a particular product. A firm with relatively broad scope internalizes the cannibalization effect of increasing output more than a firm with relatively narrow scope does. In other words, the more dominant a firm is (the higher its N_k), the more similar its optimization problem is to the problem of a monopolist.[6]

Another interesting result is that, since $2(1-\rho)+\rho N_k > 0$ due to the positive definiteness of $\mathbf{\Sigma}$,[7] firms with more reliable (lower σ_k), higher performing (higher μ_k), and lower cost (lower c_k) products manufacture larger quantities of each product in equilibrium, ceteris paribus. We call PR_k the product performance-reliability ratio, or simply the performance ratio. It is a

[6]In contrast, when $\rho < 0$, i.e., products are complements, firms with larger scopes produce more units of each product in equilibrium. This is because the production of complements encourages one another's production. When $\rho = 0$, q_k does not depend on the firms' scopes because a product's quantity does not affect the prices of other products.

[7]Specifically, pre- and post-multiplying a vector of ones to $\mathbf{\Sigma}_{kk}$ must yield a positive scalar, $\sigma_k^2[N_k + (N_k^2 - N_k)\rho] > 0$, which is a sufficient condition for the relation in question.

reward-risk ratio analogous to the Sharpe ratio of a financial investment.

Equipped with the explicit analytical solution, we are ready to analyze the relation between expected returns, industry structure, and firm characteristics.

2.2 Industry Structure and Expected Returns

We begin this subsection by analyzing the production risk premium – a reward for the risk caused by product market competition. We then proceed to examining the effects of changing the structure of an industry in which firms compete on the equilibrium expected returns of firms operating in that industry. To simplify the analysis, we make the following assumption.

Assumption 2 *(Common number of products per firm) Assume that all firms have the same degree of diversification (i.e. all firms produce the same number of products, $N_k = N_m = n \ \forall \ k, m$).*

Note that we still allow for heterogeneity in expected performance of products produced by a firm, μ_k, in production costs, c_k, and in the reliability of firms' products, σ_k. We begin by analyzing the relation between firms' expected returns and their effectiveness in product markets (i.e. their product performance ratios).

Proposition 1. *(Production risk premium) Consider an industry with product homogeneity within a firm and common substitutability (Assumption 1), in which firms produce an equal number of substitute products (Assumption 2). Then, a firm's expected return, $\mathbb{E}(R_k)$, is decreasing in its product performance ratio, PR_k.*

A firm's product performance ratio has three components: expected performance, production cost, and reliability. Firms producing better performing and less costly products have higher equilibrium profit margins. In other words, their expected profits relative to the variability of profits are higher than those of firms producing products that are costlier and/or have lower expected performance. Similarly, increasing product reliability (reducing σ_k) increases expected profits relative to profit variability. Thus, a higher product performance ratio, PR_k, makes a firm less risky and increases its date-zero value, leading to a lower expected return. Since profits are the result of optimal production in our model, we call the difference between the reward for holdings the claims to more risky profits of lower-PR firms relative to the rewards for holding the claims to less risky profits of higher-PR firms the production risk premium.

The following proposition describes the relation between the number of firms operating in an industry and these firms' expected returns, while holding all other components of industry structure constant.

Proposition 2. *(Competition and expected returns, part I) Consider an industry with product homogeneity within a firm and common substitutability (Assumption 1), in which firms produce an equal number of substitute products (Assumption 2). Then, holding constant the number of products manufactured by each firm, n, the industry product substitutability parameter, ρ, and the average firm-level product performance ratio, $\overline{PR}$,*
i) as the number of firms, K, increases, any firm's expected return, $\mathbb{E}(R_k)$, increases;[8]
ii) as the number of firms, K, increases, the absolute value of the return spread between any two firms, k and m, $\mid \mathbb{E}(R_k) - \mathbb{E}(R_m) \mid$ increases.

The intuition behind Proposition 2 is quite simple. As the competition in the product market intensifies, equilibrium prices of firms' products decrease, leading to a reduction in firms' expected profit margins. On the other hand, the variability of profit margins is not affected by competition. Thus, increased competition results in riskier claims to firms' profits. Since these claims are held by risk-averse investors, increased competition leads to lower date-0 firm values and higher expected returns. Firms with lower product performance ratios are hurt the most by an increase in industry's competitiveness. The result is that their riskiness increases relative to that of firms with higher product performance ratios, leading to an increase in the absolute return spread between any two firms having different product performance ratios.

Proposition 2 assumes that the number of products produced by each firm, the product substitutability parameter, and the average product performance ratio are held constant as the number of firms is varied. The first assumption of the constant number of products-per-firm, n, is made in order to separate the effects on expected returns of changes in industry structure

[8]Following a large body of industrial organization literature, we treat the number of firms, K, as a continuous variable. See, for example, Ruffin (1971), Okuguchi (1973), Dixit and Stiglitz (1977), and Loury (1979). See Suzumura and Kiyono (1987) for a discussion of the effect of departure from a continuous number of firms on equilibrium conditions. Seade (1980) justifies the practice of treating the number of firms as a continuous variable by arguing that it is always possible to use continuous differentiable variables and restrict attention to the integer realizations of these variables.

from the effects of diversification, which would be present if n varied together with K. The assumption that the average firms-level product performance ratio, $\overline{PR}$, is independent of the number of firms in an industry is made in order to focus on the effects of changes in industry structure, as opposed to changes in firms' product performance and/or product reliability, as emphasized in Proposition 1.

The assumption that the product substitutability parameter, ρ, is held constant as the number of firms in the industry, K, is raised is less benign, as there are reasons to believe that ρ and K are unlikely to be independent. From the first glance, it seems that a simple industry equilibrium model with endogenous entry and fixed entry cost would lead to a negative relation between product substitutability within an industry and the equilibrium number of firms in that industry. That is because for a given number of firms product differentiation (substitutability) effectively reduces (increases) competition among firms and increases (reduces) equilibrium expected profits.

However, the assumption of identical entry costs into different industries and at different points in time may be unrealistic. While the cross-sectional relations between entry costs on one side and equilibrium product substitutability and equilibrium industry structures on the other side are hard to pinpoint empirically because of the multitude of factors affecting industry structure that may vary across industries in addition to ρ and K (e.g., the typical age of firms in various industries, the shape of typical production functions and cost structures), these effects are more readily observable as particular industries evolve. One example is the evolution of the pharmaceutical industry in the U.S., which experienced a dramatic shock to entry cost into it in 1984, when the Drug Price Competition and Patent Term Restoration Act was signed into law. This act dramatically reduced the complexity of tests that generic manufacturers have to pass before starting to produce generic drugs, slashing the costs of entry faced by generic drug producers. The result was a spike in entry by the latter (e.g., Grabowski and Vernon (1984)). On the other hand, since generic drugs have to be bioequivalent to pioneering drugs, entry by generic producers clearly increased the average substitutability of products in the pharmaceutical industry.

In addition to the anecdotal evidence above that illustrates the possibly positive relation between the number of firms in an industry and product substitutability in that industry, the interaction between equilibrium industry structure and product differentiation (substitutability) has been highlighted in numerous theoretical models. Schmalensee (1982) and Klepper (1996) illustrate the entry deterrence effect of pioneering a new product (i.e. increasing product differentiation). Shaked and Sutton (1987) show that the equilibrium number of firms is likely to be low in innovative industries in which the possibilities of ongoing product differentiation are available. More generally, a positive relation between equilibrium product substitutability and equilibrium number of firms in the industry arises as one varies the entry cost in a typical Hotelling-type spatial competition model (e.g., Economides (1989)).

To account for the likely positive relation between the number of firms in an industry and product substitutability, in what follows we make the following assumption.

Assumption 3 *(The effect of the number of firms on product substitutability) Assume that the relation between the equilibrium substitutability parameter, ρ, and the number of firms in the industry, K, is positive:* $\frac{\partial \rho}{\partial K} > 0$.

Incorporating the relation between the equilibrium product substitutability parameter in an industry and the number of firms in that industry has an important effect on the relation between expected returns and industry structure. The effect of a change in the number of firms on firm k's expected returns is

$$\frac{d\mathbb{E}(R_k)}{dK} = \frac{\partial \mathbb{E}(R_k)}{\partial K} + \frac{\partial \mathbb{E}(R_k)}{\partial \rho} \frac{\partial \rho}{\partial K}. \tag{31}$$

While the first term in the right hand side of (31) is positive (see Proposition 2), as well as the last term (see Assumption 3), the sign of the second term, $\frac{\partial \mathbb{E}(R_k)}{\partial \rho}$, depends on firm k's product performance ratio. This is summarized in the next proposition.

Proposition 3. *(Competition and expected returns, part II) Consider an industry with product homogeneity within a firm and common substitutability (Assumption 1) that increases in the number of firms in the industry (Assumption 3), in which firms produce an equal number of substitute products (Assumption 2). Then, holding the number of products manufactured by each firm, n, and the average firm-level product performance ratio, $\overline{PR}$, constant*

i) if firm k's product performance ratio, PR_k, is at or below a certain threshold, firm k's expected

return, $\mathbb{E}(R_k)$, is increasing in the number of firms in the industry, K;
ii) if firm k's product performance ratio, PR_k, exceeds a certain threshold, firm k's expected return, $\mathbb{E}(R_k)$, is decreasing in the number of firms, K, further if $\frac{\partial \rho}{\partial K}$ is sufficiently high and otherwise is increasing in K;
iii) the absolute value of the return spread between any two firms k and m, $\mid \mathbb{E}(R_k) - \mathbb{E}(R_m) \mid$ is increasing in the number of firms, K.

The direct effect of the competition on expected returns, captured in Proposition 2, is positive. Assumption 3 introduces an indirect effect. Holding the number of firms constant, an increase in product substitutability intensifies competition among firms. This intensified competition is particularly harmful for firms with relatively low product performance ratios, whose expected profits decline relative to their profit variability, leading to higher expected returns. Firms with relatively high product performance ratios benefit from the decline in the competitive position of the low-performance-firms, which leads to an increase in their expected profits relative to profit variability, and to lower expected returns. The result is that while the relation between the number of firms in an industry and expected returns of firms with relatively low product performance ratios is unambiguously negative, the relation between the number of firms and expected returns of firms with relatively high product performance ratios depends on the relative strengths of the direct and indirect effects.

2.3 Empirical Implications

Proposition 1 established the presence of the production risk premium – i.e. firms with higher (lower) product performance ratios have lower (higher) expected returns in equilibrium. Proposition 3 established that the returns of firms with relatively low product performance ratios are expected to increase in competition, while returns of firms with relatively high product performance ratios may increase or decrease in competition depending on the strength of the relation between equilibrium product substitutability and the number of firms in the industry.

In the next section we examine the production risk premium and the effect of competition on firm returns empirically. However, one difficulty is that product performance ratios are computed using the model's deep parameters, whose empirical counterparts are generally unobservable. For example, we cannot use firms' profit margins and/or their return on assets as proxies for product performance ratios because the former are equilibrium outcomes that are functions of industry structure.

A natural (inverse) proxy for a firm's product performance ratio is its earnings-to-price ratio. From the definition of profit in (16), the excess return is given by

$$R_k \equiv \frac{v_{1_k}}{v_{0_k}} - R_f = \frac{\pi_k}{MV_k} - R_f, \tag{32}$$

which immediately yields the following result:

Theorem 2. *(Expected return and EPR) A firm's expected excess return is given by the ratio of the expected profit to the market capitalization less the gross risk-free rate:*

$$\mathbb{E}(R_k) = \frac{\mathbb{E}(\pi_k)}{MV_k} - R_f. \tag{33}$$

The ratio on the right hand side of Equation (33) is nothing else than the earnings-to-price ratio (EPR), except that the numerator has the expected profit rather than the current profit, which is typically used empirically. This is due to the assumption that the whole profit is distributed as dividend to investors at date 1. Thus, firms with relatively low (high) product performance ratios have high (low) earnings-to-price ratios in equilibrium.

Note that equation (33) underscores Berk's (1995) point that relative firm size measures predict returns because firms' market values are theoretically inversely related to their risk. Likewise, the earnings-to-price ratio above is a readily available proxy for risk, potentially measured more accurately than beta. As Berk argues, this provides "a sound theoretical justification for using market value related measures to increase the power of an empirical test" (p.285).

Our model's content is the determination of the profit in the numerator of Equation (33) through competitive interactions of firms. To the extent that differences in firms' earnings-to-price ratios are due to differences in production risk premia at the industry level, we expect relative (industry-adjusted) earnings-to-price ratios to be a better proxy for product performance ratios and production risk premia than raw earnings-to-price ratios.

Thus, Propositions 1 and 3 can be restated in terms of expected industry-adjusted earnings-to-price ratios in place of expected returns. Since firms' earnings-to-price ratios (absolute and industry-adjusted) are fairly stable over time, Propositions 1 and 3 have the following empirical implications:

Empirical implication 1

Firms' expected returns increase in industry-adjusted EPR.

Empirical implication 2

i) Expected returns of firms with relatively high industry-adjusted EPR increase in the number of firms in the industry;
ii) Expected returns of firms with relatively low industry-adjusted EPR may increase or decrease in the number of firms in the industry, depending on the strength of the relation between the equilibrium number of firms and product substitutability.

We test the model's empirical implications in Section 3.

2.4 Size, Book-to-Market, and Expected Returns

In addition to relating firms' expected returns to competition, the model sheds light on how firm characteristics may relate to expected returns in equilibrium. We define a firm's book value as the acquisition cost of capital required to produce its output:

$$BV_k \equiv \mathbf{c}_k' \mathbf{q}_k = c_k N_k q_k. \tag{34}$$

Together with Equation (8), this implies that the fixed assets are fully expensed in one period, an assumption made purely for simplicity. Then, the firm's book-to-market ratio is

$$BM_k \equiv \frac{BV_k}{MV_k} = \frac{c_k N_k q_k}{v_{0_k}}. \tag{35}$$

The following proposition relates firms' market values and book-to-market ratios to their expected returns.

Proposition 4. *(Expected returns and characteristics) Consider an industry with product homogeneity within a firm and common substitutability (Assumption 1), in which firms produce an equal number of substitute products (Assumption 2). Suppose that firm k has a higher product* *performance ratio than firm m, $PR_k > PR_m$. Then,*

(i) firm k's equilibrium size is larger than that of firm m, $MV_k > MV_m$;

(ii) firm k's equilibrium book-to-market ratio is lower than that of firm m, $BM_k < BM_m$.

To understand this result, start with symmetric firms having identical product performance ratios and consider increasing firm k's product performance ratio. Firm k's equilibrium quantity of each product and overall production would increase, leading to larger market capitalization. A higher date-0 valuation relative to the net expected payoff results in a lower book-to-market ratio.

Proposition 4 establishes the relation between a firm's product performance ratio and its size and book-to-market ratio, while Proposition 1 the relation between a firm's product performance ratio and its expected return. The combination of these two propositions raises the possibility that the size and value effects may partly originate in product markets. Specifically, Propositions 1 and 4 imply that firms with high-performance, reliable products, as indicated by their high product performance ratios, can be large growth firms that earn lower subsequent returns. Thus, the model provides an industrial organization-based motivation for the well-known empirical regularities in equity markets, such as the size and value effects. Our result points to the possibility that these effects partially originate at the industry level through competitive interactions among firms in product markets.

3. Empirical Results

3.1 Data and Methodology

We use ordinary common shares (CRSP share code 10 and 11) on NYSE, AMEX, and NASDAQ (CRSP exchange code 1, 2, and 3) that are commonly included in CRSP and Compustat. We exclude firms in financial industries (the four-digit SIC code in 6000's) because financial products and firms are unlikely to fit the framework developed here. We compute an individual firm's size ($SIZE$) as the product of its share price and the number of shares outstanding from CRSP. The book-to-market ratio (BM) is constructed following Fama and French (1993).

The first empirical implication of the model is that firms with higher earnings-to-price ratios (EPRs) should earn higher expected returns. To measure how much of such return dispersion is due to product market competition, we employ a variant of EPR that is designed to gauge individual firms' profit beta in excess of their industry average. We use operating profits, a construct of the price-cost margin that is widely used in the industrial organization literature, as a measure of earnings. Following Peress (2008), we compute operating profits by subtracting from sales (Compustat annual Xpressfeed data item $SALE$, FTP data item 12) the cost of goods sold ($COGS$, item 41) and selling general and administrative expenses ($XSGA$, item 189). If any of these three variables is missing, operating income after depreciation ($OIADP$, item 178) is substituted for operating profits. The earnings-to-price ratio, EPR, is then the ratio of operating profits to $SIZE$ (discussed below) in December of the Compustat fiscal year. Our final measure, the excess earnings-to-price ratio ($EEPR$), is the firm's EPR less the average EPR of its industry.

Choosing the most suitable industry classification is not straightforward as we need to use as narrowly defined industries as possible in order to ensure that firms in a given industry indeed compete against each other in product markets, and yet to secure a long enough sample period. While the six-digit North American Industrial Classification System (NAICS) is the most refined one, it only begins in the 80's. Thus, we employ the four-digit Standard Industry Classification (SIC), as it is sufficiently fine and available for a long period. The portfolio that is long highest $EEPR$ firms and short lowest $EEPR$ firms mimics the difference in earnings beta due to competition within the same industry. The return on this long-short portfolio is our proxy for the production risk premium.

The model's second empirical implication is that the returns of firms with high EPRs should be increasing in measures of industry competitiveness, while the returns of low EPR firms may increase or decrease. Following a large body of the industrial organization literature, we use two proxies for the degree of competition in an industry. The first one is the number of (public) firms operating in the industry. As the number of firms increases, one moves away from a monopoly toward a perfect competition. The second measure is the sales-based Herfindahl index (HI). The Herfindahl index reflects not only the number of competitors but also the relative sizes of industry rivals. A lower HI may be due to a higher number of firms or a smaller dispersion of firm sizes. Both these elements are likely to contribute to the intensity of competition in output markets.

In June of each year we form portfolios and measure value-weighted monthly returns from July through next June. We use size at the end of June and other characteristics at the end of the previous fiscal year for portfolio sorting. Only NYSE firms are used to compute the breakpoints for ranking $SIZE$ and BM, but all firms are included in portfolio formation as well as calculating breakpoints for other characteristics. The final sample of monthly returns spans the period July 1963 through December 2009.

3.2 The Excess Earnings-to-Price Ratio and Expected Return

Table 2 shows the characteristics of portfolios sorted by the excess earnings-to-price ratio ($EEPR$) and, for comparison purposes, the raw earnings-to-price ratio (EPR) as well.[9]

Insert Table 2 here

The top row of Panel A tells us that firms in the lowest quintile make operating losses on average, resulting in a negative mean EPR. The corresponding row in Panel B indicates that taking the difference from the industry average and re-sorting makes the distribution of $EEPR$ roughly symmetric around zero. The next three rows report the characteristics known to be associated with returns. $SIZE$ and BM are more evenly distributed across the quintiles in Panel B than in Panel A, suggesting that $EEPR$ is less correlated with these characteristics than raw EPR. The average number of firms, $Nstks$, implies that each portfolio is well populated on average. The remaining rows show the excess return ($EXRET$) as well as the four-factor alpha (α) and betas (β), computed from the regression of each excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors.[10] First, observe that the excess return strongly increases in EPR in Panel A, resulting in an impressive return spread of 84bp per month ($t = 3.22$) between the two extreme quintiles. However, this spread does not survive risk adjustment, nor does any of the excess quintile portfolio returns; the alphas are all insignificant along the row. The Gibbons-Ross-Shanken

[9]We form quintile portfolios because one of the decile $EEPR$ portfolios (specifically the sixth decile) turns out to be missing for some periods. This is because there is a non-trivial number of single-firm industries as defined by the four-digit SIC code at some points in time. By construction all these firms have zero $EEPR$ (mainly falling in the fifth decile) and make two consecutive decile ranking breakpoints identical at zero.

[10]The four factors are downloaded from Kenneth French's website.

(GRS) test fails to reject the hypothesis that the five alphas jointly equal zero ($F = 0.84$, $p = 0.52$). The reason is the strong association between the valueness and EPR, as indicated by β_{HML}, which monotonically increases from -0.79 for the lowest EPR quintile to 0.67 for the highest quintile. This is consistent with Fama and French's (1996, Tables II and III) finding that their three-factor model deprives the earnings-to-price ratio of its cross-sectional explanatory power.

The picture is different for the excess earnings-to-price ratio. Although the return spread between the two extreme $EEPR$ quintiles in Panel B is a modest 38bp, it is significant at 1%. Likewise while the four-factor alpha is smaller at 21bp, it remains significant. Importantly, the three highest $EEPR$ quintile portfolios have statistically significant alphas. This leads to the strong rejection of the hypothesis that the five alphas jointly equal zero (GRS $F = 3.03$, $p = 0.01$). Another striking difference is the independence of $EEPR$ from the value factor; β_{HML} is generally close to zero along the row, with the largest deviation being only -0.13.

Competition is likely fiercest among firms of similar size within an industry. Thus, it is informative to examine whether the positive association between the earnings-to-price ratio and subsequent returns in Proposition 2 becomes stronger when firm size is controlled for. We double-sort firms on size and $EEPR$ independently into quintiles and form portfolios as their intersections. Table 3 reports the characteristics of the resulting 25 portfolios.

Insert Table 3 here

Panel A shows that the distribution of $EEPR$ is roughly symmetric around zero within each size quintile. According to Panel B, only smallest firms with lowest industry-adjusted EPRs (i.e., lowest $EEPR$) make losses on average. Panel C confirms that the size sorting leaves little variation in size along the columns, the important premise for examining the effect of product market competition. However, Panel D indicates that the average book-to-market ratio continues to be highest for highest $EEPR$ firms. Thus, it is important to control for the value factor in the analysis to follow. The disproportionately large number of firms in the smallest size quintile in Panel F implies that most NASDAQ firms fall in that quintile.

Panel G shows the excess returns. As conjectured, the excess return roughly increases with

$EEPR$ within each size quintile, producing return spreads between the two extreme $EEPR$ quintiles that are significant for all size quintiles but the largest; the return spreads for the four quintiles range between 39bp and 72bp, all of which are statistically significant at 1%. As we have seen above, $EEPR$ is correlated with BM, which raises a concern that part of the $EEPR$ spread may be the value premium in disguise. The estimated four-factor alphas in Panel H address this concern. Observe that the return spread barely changes upon risk adjustment; the alpha spread ranges between 23bp and 67bp across all quintiles but the largest one, all of which are significant at 5% or lower. The Gibbons-Ross-Shanken test strongly rejects the hypothesis that all the 25 alphas are jointly zero ($F = 4.06$, $p = 0.000$). Therefore, the production risk premium is unexplained by the most prominent existing factors.

A legitimate question is whether taking the difference from the industry average makes our excess EPR any different from the raw EPR. The answer is yes. For comparison, we perform double sort on size and the raw EPR and report the results in Panels H and I. While the excess return spreads may seem stronger than those based on the excess EPR, this is largely because of the association between raw EPR and other known characteristics. To see this, notice that, although the spread alphas for the two smallest size quintiles are significant, they are smaller in magnitude at 54bp and 33bp. The largest quintile even has a negative and significant spread in alpha. This implies that the stronger excess return patterns in Panel H are due to the close association between the raw earnings-to-price ratio and the book-to-market ratio (recall the difference in HML loadings between the two panels of Table 2). This suggests that our industry-adjusted earnings-to-price ratio captures something that the raw EPR does not, arguably the within-industry difference in the sensitivity of an individual firm's profit to the aggregate profit.

Another way to control for the value characteristic is to further sort firms on the book-to-market ratio. Table 4 summarizes the characteristics of the 27 portfolios formed as the independent intersections of $SIZE$, BM, and $EEPR$ terciles.

Insert Table 4 here

To save space, we focus on the extreme $EEPR$ portfolios. From Panels A and B we see that the triple sorting controls for size and BM fairly well, except possibly for the largest size and highest BM terciles. Panel C shows that six of the nine spread portfolio returns are significant, ranging from 15bp to 62bp. Again, the spreads barely change upon risk adjustment in Panel D; the six alphas in the smallest and mid size terciles are all statistically significant, varying between 22bp and 60bp. Thus, the returns of $EEPR$ zero-cost portfolios, or the production risk premium, cannot be fully explained by existing characteristics or factors. Unfortunately, because of the strong correlation between raw EPR and BM, three-way independent sorting on EPR, size, and BM results in missing portfolios in a substantial number of months (e.g., largest size, highest BM, and lowest EPR portfolios turned out to be especially problematic). Thus, we omit results for raw EPR under three-way independent sorting.

We further examine the robustness of our results against alternative measures of earnings. Researchers employ different earnings measures in various contexts. Below we describe several of these with our implementation in parentheses. Fama and French (1992) define earnings as income before extraordinary items (Compustat annual Xpressfeed item IB, FTP data item 18), plus income-statement deferred taxes ($TXDI$, item 50), minus preferred dividends (DVP, item 19) to compute the earnings-to-price ratio. Kenneth French's website posts portfolios sorted on the earnings-to-price ratio based on earnings before extraordinary items (IB, item 18). Vuolteenaho (2002) uses "earnings available for common" (NI, item 172), and if it is missing the clean-surplus formula (the change in book equity defined as the sum of common equity (CEQ, item 60) and preferred stock ($PSTK$, item 130)), to calculate return on equity[11]. Two more readily available measures are worth examining. Operating income before depreciation ($OIBDP$, item 13) is closer to cash flows than any type of income after non-cash expenses like depreciation. This measure is used by Sagi, Spiegel and Watanabe (2009). Finally, net income (NI, item 172) is one of the most closely followed earnings figures. This can be viewed as Vuolteenaho's (2002) earnings without the clean-surplus correction. Dividing each of these measures by fiscal-December market equity ($SIZE$) and subtracting the industry average yields five variants of industry-adjusted earnings-to-price ratios.

We first sort firms independently on size and the industry-adjusted earnings-to-price ratio using the four-digit SIC code. If this produces a missing portfolio in any period, we perform

[11]Strictly speaking, the clean surplus formula should include dividends as Vuolteenaho does.

dependent sort on size. If this still leaves missing portfolios, we use the three-digit SIC code to recalculate the excess earnings-to-price ratio and revert to independent sort. Table 5 shows the results with the final choices of sorting and industry definition in its caption.

Insert Table 5 here

All the five panels repeat the same message: the spreads of both excess returns and the four-factor alphas between the two extreme $EEPR$ portfolios, or the production risk premia, are significantly positive within all size quintiles but the largest. In all cases, the Gibbons-Ross-Shanken test strongly rejects the joint hypothesis of zero alphas.

3.3 Expected returns and competition

Table 6 examines the relations between the number of firms operating in an industry, K, and the mean returns of firms belonging to different $EEPR$-groups. Specifically, we perform an independent double sort on $EEPR$ and the number of firms in an industry, resulting in nine $EEPR - K$ portfolios.[12]

Insert Table 6 here

Panel B demonstrates a large variation in the number of firms across the number-of-firms terciles. Panels C and D show that there is a substantial variation in mean size and BM across portfolios, suggesting that it is important to examine risk-adjusted portfolio returns and not just raw returns. Panel E confirms that there is a strong negative relation between the number of firms in an industry and the Herfindahl index. Panel F demonstrates that the nine portfolios are generally well populated.

Panels G and H provide interesting findings. First, note that the mean return of firms in the lowest-$EEPR$ tercile is monotonically decreasing in K, with the difference between the extreme K-terciles being -30bp, which is significant at 5%. This difference is not due to the different factor loadings of the high-K and low-K terciles, as the risk-adjusted difference between them is almost identical to the raw difference (-29bp, significant at 5%). This is consistent with a

[12]The sorting on $EEPR$ is global (i.e. all firms are sorted based on their EPRs adjusted for mean EPRs of their industries). Local sorting on $EEPR$ (or, equivalently, EPR) within each industry provides similar results to those reported below.

strong relation between the number of firms in the industry and product substitutability in that industry, as argued in Proposition 3. Seemingly inconsistent with Proposition 3 and with the first empirical prediction, raw returns of high-$EEPR$ portfolios do not seem to be related to K, as follows from the third row of Panel G. However, the third row of Panel H demonstrates that this is due to the large differences in size and BM across portfolios, documented in Panels C and D. In particular, the difference in mean risk-adjusted returns between high and low K portfolios in the high $EEPR$ tercile is 21bp, though insignificant. However, the mean return of the high-$K-$high-$EEPR$ portfolio is statistically significant at 10%, while it is close to zero and insignificant for low-$K-$high-$EEPR$ portfolio.

Finally, note that the result for K-EPR independent sorting in Panels I and J are very different from K-$EEPR$ sorting. In particular, both raw and risk-adjusted mean portfolio returns do not seem to be related to the number of firms in an industry. If anything, the results are the opposite of what we would expect: the returns of high-K portfolios are lower than those of low-K portfolios in the high-EPR tercile. This again demonstrates that while $EEPR$ proxies for the production risk premium, EPR may be just an alternative proxy for value, as argued by Fama and French (1996).

We perform similar tests using our second measure of competition – the Herfindahl index – in Table 7.

Insert Table 7 here

Panels A-F of Table 7 are consistent with those in Table 6. Consistent with Proposition 3 and with HI being an inverse proxy for the degree of competition, the returns of high-$EEPR$ firms roughly increase as we move from high to low HI terciles (the difference is a significant 26bp for raw returns and 19bp for risk-adjusted returns, albeit statistically insignificant). The spreads in raw and risk-adjusted mean returns between high and low HI portfolios in the low $EEPR$ tercile are -29bp and -36bp, respectively, both of which are statistically significant. Panels I and J confirm that raw EPR is not a valid proxy for the production risk premium. The mean portfolio returns in all raw EPR terciles hardly vary with HI.

In Table 8, we re-examine the relation between the number of firms in the industry and mean returns of firms with different $EEPR$s, while using the five alternative earnings measures discussed in the previous subsection.

Insert Table 8 here

The results in Panels D and E, in which earnings are defined as operating income before depreciation and net income, respectively, are consistent with those in Table 6. In particular, the high-K minus low-K risk-adjusted return spread is a negative 20 to 27bp in the low-$EEPR$ tercile, while the spread is a positive 18bp in the high-$EEPR$ tercile. In both Panels D and E, the differences in the two spreads between the high and low $EEPR$ terciles (the rightmost number in the bottom row of each panel) are significant and range between 38bp and 45bp, respectively.

The results in Panels A-C are not as strong. While the differences in the K-spreads between high-$EEPR$ and low-$EEPR$ terciles are economically meaningful (they range from 19bp in the case of French's EPR definition to 33bp in the case of Fama and French's (1992) definition), none is statistically significant.

Table 9 performs similar robustness tests of the relation between mean returns and the Herfindahl index.

Insert Table 9 here

The results for various $EEPR$ measures are generally very consistent with the findings reported in Table 7. In particular, for all five alternative $EEPR$ definitions, the difference between the HI spread in the high-$EEPR$ tercile and the one in the low-$EEPR$ tercile is statistically significant, ranging between 33bp in the case of French's EPR definition to 50bp in the case of Vuolteenaho's (2002) definition.

Overall, the results in Tables 6-9 paint a picture that is quite consistent with product market competition being an important determinant of firms' expected returns. In particular, returns of firms with high product performance ratios (low-$EEPR$ firms) are generally decreasing in measures of product market competition, while the returns of low product performance ratio (high-$EEPR$) firms are increasing in competition measures. Importantly, these relations are absent in the case of raw EPRs, further highlighting the relevance of competition in product markets for equity returns.

4. Conclusions

This paper analyzes the mechanism through which product market competition can affect firms' expected returns. We propose an industry equilibrium model featuring investors, consumers, and firms that compete in an oligopolistic product market.

The model builds on the premise that firms distribute profits as dividends, which are valued by investors at the firms' market capitalization. This justifies the use of the earnings-to-price ratio as a measure of risk and hence as a predictor of future returns. We analytically show and empirically find that firms with higher earnings-to-price ratios relative to their industry rivals earn higher average returns. This production risk premium is significant and robust to controlling for factors and characteristics known to be correlated with stock returns.

In addition, the model shows that the extent of product market competition is positively related to expected returns of high earnings-to-price ratio firms, whereas expected returns of firms with low earnings-to-price ratios may be decreasing in competition. We find empirical support for this prediction. Overall, these theoretical and empirical results suggest that the intensity of competition in product markets and firms' competitive positions relative to their industry rivals are economically significant determinants of the cross-sectional variation in equity returns.

The model generates additional empirical predictions relating within-industry firm characteristics to expected returns. Specifically, it provides an industrial-organization-based motivation for the well-known empirical regularities in equity markets, such as the size and value effects. Our result points to the possibility that these effects partially originate at the industry level through competitive interactions among firms in output markets.

Our analysis leaves an interesting agenda for future research. A potential extension of our model includes an analysis of real options in product markets. In our model, a firm's scope can affect its industry rival's market value and other characteristics through competition. Thus, an option to expand or contract can have a strategic value and may be modeled as an option to alter a firm's scope. Another interesting topic is the risk analysis, for example, modeling of beta. Although we have focused on the analysis of characteristics in this paper, the model is fully rational and the pricing is purely risk-based. Characteristics merely are proxies for, and reflections of, risk. Last but not least, the flexibility of our model may allow explaining additional regularities in the equity market, such as the differences between returns of diversified and stand-alone firms.

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A. Appendix

A.1 Proofs

Proof of Theorem 1

Under Assumption 1, the element for firm k's any product in Equation (14) can be written as

$$[2(1-\rho)+\rho N_k]\sigma_k q_k + \rho\sum_{m=1}^{K} N_m\sigma_m q_m = \frac{1+\gamma}{\gamma\theta_C}PR_k, \quad k=1,\cdots,K. \tag{36}$$

Since the summation term is constant across firms, the first term must be a function of PR_k. Guess that it is linear in PR_k,

$$[2(1-\rho)+\rho N_k]\sigma_k q_k = \delta_0 + \delta_1 PR_k, \tag{37}$$

where δ_0 and δ_1 are common across firms. Substitute this into Equation (36) and take the difference between firms k and m. Eliminating the common summation term immediately requires that $\delta_1 = \frac{1+\gamma}{\gamma\theta_C}$. Substitute this back into (37) and then into (36), sum it across firms, and rearrange to obtain

$$K\delta_0 + K\rho\sum_{m=1}^{K} N_m \frac{\delta_0 + \frac{1+\gamma}{\gamma\theta_C}PR_m}{2(1-\rho)+\rho N_m} = 0.$$

Dropping K and solving for δ_0 produces the expression for δ times $\frac{1+\gamma}{\gamma\theta_C}$, which is factored out, in the theorem. It is straightforward to confirm the sufficiency. This is the solution for q in Equation (14) because it is unique as in (15). ■

Proof of Proposition 1

Pre-multiply firm k's production vector, $\mathbf{q}_k$, by its portion of the first order conditions in (14) to write

$$\mathbf{q}_k'(\mu_k - R_f\mathbf{c}_k) = \theta_C(\mathbf{q}_k'\mathbf{\Sigma}_{Ck\cdot}\mathbf{q} + \mathbf{q}_k'\mathbf{\Sigma}_{Ckk}\mathbf{q}_k) = \frac{\theta_C\gamma}{1+\gamma}(\mathbf{q}_k'\mathbf{\Sigma}_{k\cdot}\mathbf{q} + \mathbf{q}_k\mathbf{\Sigma}_{kk}\mathbf{q}_k), \tag{38}$$

where $\mathbf{\Sigma}_{Ck\cdot}$ and $\mathbf{\Sigma}_{k\cdot}$ are the rows of $\mathbf{\Sigma}_C$ and $\mathbf{\Sigma}$, respectively, for firm k, $\mathbf{\Sigma}_{kk}$ is the main diagonal block of $\mathbf{\Sigma}$ corresponding to firm k, and we have used Equation (29) in the last equality. Then using Equations (29) and (30), we can explicitly write Equation (28) as

$$
\begin{aligned}
f_k &= \frac{\theta_I}{\theta_C \gamma} \frac{\mathbf{q}_k' \mathbf{\Sigma}_{k\cdot} \mathbf{q}}{\mathbf{q}_k' \mathbf{\Sigma}_{kk} \mathbf{q}_k} = \frac{\theta_I}{\theta_C \gamma} \left[\frac{1+\gamma}{\theta_C \gamma} \frac{\mathbf{q}_k' (\mu_k - R_f \mathbf{c}_k)}{\mathbf{q}_k \mathbf{\Sigma}_{kk} \mathbf{q}_k} - 1 \right] \text{ by (38)} \\
&= \frac{\theta_I}{\theta_C \gamma} \left[\frac{1+\gamma}{\theta_C \gamma} \frac{n q_k (\mu_k - R_f c_k)}{n(1-\rho+\rho n) q_k^2 \sigma_k^2} - 1 \right] \\
&= \frac{\theta_I}{\theta_C \gamma} \left[\frac{1+\gamma}{\theta_C \gamma} \frac{PR_k}{(1-\rho+\rho n) q_k \sigma_k} - 1 \right] \\
&= \frac{\theta_I}{\theta_C \gamma} \left[\frac{PR_k}{\delta + PR_k} \frac{2(1-\rho)+\rho n}{1-\rho+\rho n} - 1 \right], \qquad (39)
\end{aligned}
$$

where

$$\delta = \frac{-\rho n K \overline{PR}}{2(1-\rho)+\rho n + \rho n K} < 0, \qquad (40)$$

and $\overline{PR} = \frac{1}{K} \sum_{m=1}^{K} PR_m$ is the average performance ratio over firms. We have used the definition of the product performance ratio in the third line and substituted Theorem 1 for q_k in the last line.

Since $\frac{2(1-\rho)n+\rho n}{1-\rho+\rho n} > 0$, it follows that $\frac{\partial \mathbb{E}(R_k)}{\partial PR_k} = \frac{\partial \mathbb{E}(R_k)}{\partial f_k} \frac{\partial f_k}{\partial PR_k} < 0$. ■

Proof of Proposition 2

Holding n and $\overline{PR}$ constant, $|\delta|$ clearly increases ($\delta < 0$ and becomes larger in magnitude) in K when $\rho > 0$. Since all elements of $\mathbf{q}$ are positive (see the paragraph following Equation (15)), $\delta + PR_k > 0$ by the expression for q_k in Theorem 1 and is decreasing in K. It follows that $\frac{PR_k}{\delta + PR_k}$ is increasing in K. Thus for any k, f_k is increasing in K. That is, the expected return of any firm is increasing in the number of firms, K.

Now using Equation (27), the spread in the production risk premium between any two firms k and m is

$$
\begin{aligned}
\mathbb{E}(R_k) - \mathbb{E}(R_m) &= \frac{1}{1/f_k - 1/R_f} - \frac{1}{1/f_m - 1/R_f} \\
&= \frac{f_k - f_m}{[1 - f_k/R_f][1 - f_m/R_f]}. \qquad (41)
\end{aligned}
$$

The denominator of (41) is decreasing in K as both f_k and f_m are increasing in K (and are smaller than R_f by assumption, see the paragraph following Equation (27)). On the other hand, using Equation (39), the numerator can be written as

$$f_k - f_m = \frac{\theta_I}{\theta_C \gamma} \frac{2(1-\rho)+\rho n}{1-\rho+\rho n} \left[\frac{PR_k}{\delta + PR_k} - \frac{PR_m}{\delta + PR_m} \right]$$
$$= \frac{\theta_I}{\theta_C \gamma} \frac{2(1-\rho)+\rho n}{1-\rho+\rho n} \frac{(-\delta)(PR_m - PR_k)}{(\delta + PR_k)(\delta + PR_m)},$$

where we note that $-\delta > 0$. From the above results, we know that, as K increases, $-\delta = |\delta|$ increases, while $\delta + PR_k$ and $\delta + PR_m$ decrease. We conclude that the production risk premium $\mathbb{E}(R_k) - \mathbb{E}(R_m)$ is positively proportional to the performance ratio spread $PR_m - PR_k$ and its proportionality constant increases in K, or, in other words, the absolute value of the difference between $\mathbb{E}(R_k)$ and $\mathbb{E}(R_m)$ increases in K. ■

Proof of Proposition 3

Let us start by examining the $\frac{\partial \mathbb{E}(R_k)}{\partial \rho}$ component of (31). Plugging δ in (40) into (39) gives:

$$f_k = \frac{\theta_I}{\theta_C \gamma} \left[\frac{PR_k[2(1-\rho)+\rho n][2(1-\rho)+\rho n+\rho nK]}{[PR_k\{2(1-\rho)+\rho n+\rho nK\} - \rho nK\overline{PR}](1-\rho+\rho n)} - 1 \right]. \tag{42}$$

Differentiating (42) with respect to ρ, we obtain:

$$\frac{\partial f_k}{\partial \rho} = \frac{\theta_I PR_k}{\theta_C \gamma [PR_k\{2(1-\rho)+\rho n+\rho nK\} - \rho nK\overline{PR}]^2 (1-\rho+\rho n)^2} \cdot \left[\begin{array}{c} \rho^2 n^3 K^2(-PR_k + \overline{PR}) - n[2(1-\rho)+\rho n]^2 PR_k \\ +[2(1-\rho)+\rho n][-2\rho n PR_k + \{2(1-\rho)+3\rho n\}\overline{PR}] \end{array} \right]. \tag{43}$$

The first (ratio) term in (43) is clearly positive. The second term in the large square bracket is linearly decreasing in PR_k from a positive number when $PR_k \approx 0$ to a negative number when PR_k is sufficiently large; for example, when $PR_k = \overline{PR}$, it equals $(1-n)[2(1-\rho)+\rho n]^2\overline{PR} < 0$, which implies that the expected return of a firm with an "average" product decreases in ρ. Thus, there exists a "threshold" $PR_k^*(< \overline{PR})$, above which $\frac{\partial f_k}{\partial \rho}$ is negative, and below which it is positive. Equating (43) to zero we obtain the threshold PR_k^*:

$$PR_k^* = \overline{PR} \frac{N[\{2(1-\rho)+\rho n\}\{2(1-\rho)+3\rho n\} + \rho^2 n^2 K]}{n[2(1-\rho)+\rho n+\rho nK]^2}.$$

It follows that $\frac{\partial \mathbb{E}(R_k)}{\partial \rho} = \frac{\partial \mathbb{E}(R_k)}{\partial f_k} \frac{\partial f_k}{\partial \rho} < 0$ for $PR_k > PR_k^*$ and $\frac{\partial \mathbb{E}(R_k)}{\partial \rho} > 0$ for $PR_k < PR_k^*$.

We established above that $\frac{\partial \mathbb{E}(R_k)}{\partial K} > 0$ for any K. Thus, from (31), $\frac{d\mathbb{E}(R_k)}{dK} > 0$ for $PR_k \leq PR_k^*$ and $\frac{d\mathbb{E}(R_k)}{dK} < 0$ for $PR_k > PR_k^*$ and $\frac{\partial \rho}{\partial K} > -\frac{\partial \mathbb{E}(R_k)/\partial K}{\partial \mathbb{E}(R_k)/\partial \rho}$. ■

Proof of Proposition 4

Firm k' maximized expected profit from (24) is

$$\mathbb{E}(\pi_k) = \frac{\theta_C}{R_f}\mathbf{q}_k'\mathbf{\Sigma}_{Ckk}\mathbf{q}_k = \frac{\theta_C}{R_f}\frac{\gamma}{1+\gamma}\sigma_k^2 q_k^2 n(1-\rho+\rho n). \tag{44}$$

The firm's market value at date 0, MV_k, is $\frac{\mathbb{E}(\pi_k)}{\mathbb{E}(R_k)}$. From Theorem 1, $\frac{\partial q_k}{\partial PR_k} > 0$, thus $\frac{\partial \mathbb{E}(\pi_k)}{\partial PR_k} > 0$. In addition, from Proposition 1, $\frac{\partial \mathbb{E}(R_k)}{\partial PR_k} < 0$. Thus, $\frac{\partial MV_k}{\partial PR_k} > 0$.

Firm k's book value, BV_k, equals the firm's cost of producing all of its products: $c_k n q_k$. Thus, from Theorem 1 and Equations (44), (33), and (39),

$$\frac{MV_k}{BV_k} \equiv MB_k = \frac{\mathbb{E}(\pi_k)/\mathbb{E}(R_k)}{c_k n q_k} = \frac{\frac{\theta_C}{R_f c}\frac{\gamma}{1+\gamma}\sigma_k^2 q_k(1-\rho+\rho n)}{\mathbb{E}(R_k)}. \tag{45}$$

The numerator of (45) is increasing in q_k and, therefore, in PR_k. From Proposition 1, the denominator of (45) is decreasing in PR_k. Thus, $\frac{\partial\left(\frac{MV_k}{BV_k}\right)}{\partial PR_k} > 0$ and $\frac{\partial\left(\frac{BV_k}{MV_k}\right)}{\partial PR_k} < 0$. ■

Table 1: **A two-industry example**

$$\mathbf{\Sigma} = \begin{bmatrix} \sigma_{11}^2 \begin{pmatrix} 1 & \rho_1 \\ \rho_1 & 1 \end{pmatrix} & \sigma_{11}\sigma_{12} \begin{pmatrix} \rho_1 & \rho_1 & \rho_1 \\ \rho_1 & \rho_1 & \rho_1 \end{pmatrix} & & \mathbf{0} & \\ \sigma_{11}\sigma_{12} \begin{pmatrix} \rho_1 & \rho_1 \\ \rho_1 & \rho_1 \\ \rho_1 & \rho_1 \end{pmatrix} & \sigma_{12}^2 \begin{pmatrix} 1 & \rho_1 & \rho_1 \\ \rho_1 & 1 & \rho_1 \\ \rho_1 & \rho_1 & 1 \end{pmatrix} & & & \\ & & \sigma_{21}^2 & \sigma_{21}\sigma_{22} \begin{pmatrix} \rho_2 & \rho_2 \end{pmatrix} & \sigma_{21}\sigma_{23} \begin{pmatrix} \rho_2 & \rho_2 & \rho_2 \end{pmatrix} \\ & & \sigma_{21}\sigma_{22} \begin{pmatrix} \rho_2 \\ \rho_2 \end{pmatrix} & \sigma_{22}^2 \begin{pmatrix} 1 & \rho_2 \\ \rho_2 & 1 \end{pmatrix} & \sigma_{22}\sigma_{23} \begin{pmatrix} \rho_2 & \rho_2 & \rho_2 \\ \rho_2 & \rho_2 & \rho_2 \end{pmatrix} \\ \mathbf{0} & & \sigma_{21}\sigma_{23} \begin{pmatrix} \rho_2 \\ \rho_2 \\ \rho_2 \end{pmatrix} & \sigma_{22}\sigma_{23} \begin{pmatrix} \rho_2 & \rho_2 \\ \rho_2 & \rho_2 \\ \rho_2 & \rho_2 \end{pmatrix} & \sigma_{23}^2 \begin{pmatrix} 1 & \rho_2 & \rho_2 \\ \rho_2 & 1 & \rho_2 \\ \rho_2 & \rho_2 & 1 \end{pmatrix} \end{bmatrix}$$

ρ_ι is the correlation between the performance of products that firms in industry ι manufacture, $\iota = 1, 2$, where product performance is measured by units of the consumption good a product delivers. $\sigma_{\iota k}$ is the volatility of the performance of a product that firm k in industry ι manufactures. There are two firms in industry 1, with the first firm producing two products and the second firm three. There are three firms in industry 2, with the first firm producing one product, the second firm two, and the third firm three.

Table 2: **Portfolios sorted on raw and excess earnings-to-price ratio**

Panel A: Raw EPR Portfolios

EPR rank	1	2	3	4	5	5-1
EPR	-0.12	0.10	0.18	0.26	0.54	
$SIZE$	261.44	1361.25	1549.25	1175.37	620.91	
BM	0.72	0.58	0.74	0.97	1.55	
$Nstks$	632.02	658.12	659.09	656.93	650.04	
$EXRET(\%)$	-0.02	0.26	0.45	0.58	0.82	0.84
	(-0.07)	(1.16)	(2.44)	(3.22)	(3.81)	(3.22)
	[0.94]	[0.25]	[0.01]	[0.00]	[0.00]	[0.00]
$\alpha(\%)$	-0.14	0.11	0.05	0.03	0.06	0.20
	(-0.90)	(1.63)	(0.88)	(0.49)	(0.77)	(1.08)
	[0.37]	[0.10]	[0.38]	[0.62]	[0.44]	[0.28]
β_{MKTRF}	1.07	1.03	0.96	0.96	1.10	0.03
	(29.10)	(63.23)	(69.89)	(64.66)	(57.86)	(0.75)
β_{SMB}	0.56	-0.04	-0.04	0.02	0.20	-0.36
	(11.42)	(-1.77)	(-2.28)	(1.24)	(7.91)	(-6.08)
β_{HML}	-0.79	-0.38	0.09	0.42	0.67	1.47
	(-14.07)	(-15.22)	(4.44)	(18.55)	(23.11)	(21.62)
β_{MOM}	-0.10	-0.08	0.01	0.00	0.01	0.11
	(-2.63)	(-4.61)	(0.90)	(0.23)	(0.46)	(2.39)
GRS-F(5, 537): 0.84 [p = 0.521]						

Panel B: Excess EPR Portfolios

$EEPR$ rank	1	2	3	4	5	5-1
$EEPR$	-0.28	-0.06	0.00	0.06	0.31	
$SIZE$	836.34	1173.17	1065.51	1128.37	811.19	
BM	0.84	0.70	0.82	0.86	1.33	
$Nstks$	636.04	655.64	643.37	671.18	649.98	
$EXRET(\%)$	0.37	0.33	0.40	0.43	0.75	0.38
	(1.86)	(1.78)	(2.11)	(2.10)	(3.25)	(3.07)
	[0.06]	[0.08]	[0.04]	[0.04]	[0.00]	[0.00]
$\alpha(\%)$	0.00	-0.01	0.08	0.13	0.21	0.21
	(0.05)	(-0.14)	(1.62)	(1.98)	(2.23)	(1.73)
	[0.96]	[0.89]	[0.10]	[0.05]	[0.03]	[0.08]
β_{MKTRF}	1.01	0.95	0.95	0.99	1.06	0.05
	(64.80)	(84.11)	(84.84)	(62.97)	(46.58)	(1.88)
β_{SMB}	-0.02	-0.07	-0.04	-0.01	0.29	0.31
	(-0.98)	(-4.67)	(-2.56)	(-0.43)	(9.55)	(8.03)
β_{HML}	0.00	-0.05	-0.08	-0.13	0.09	0.09
	(-0.07)	(-2.63)	(-4.61)	(-5.25)	(2.62)	(2.10)
β_{MOM}	0.00	0.02	0.01	-0.02	0.03	0.04
	(-0.18)	(1.54)	(0.71)	(-1.24)	(1.49)	(1.26)
GRS-F(5, 537): 3.03 [p = 0.010]						

This table shows the characteristics of quintile portfolios sorted on the raw (EPR, Panel A) and excess ($EEPR$, Panel B) earnings-to-price ratios. $EEPR$ is a firm's earnings-to-price ratio (EPR) in excess of its industry average using the four-digit SIC code as the industry definition. $SIZE$ is the average market capitalization of member firms in millions of dollars. BM is the average book-to-market ratio, constructed as in Fama and French (1993). $Nstks$ is the average number of stocks within the portfolio. $EXRET$ is the monthly excess value-weighted return. α and the four β's are the intercept and the slope coefficients from the time-series regression of the excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. "GRS-F(n,d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the five portfolio alphas jointly equal zero. The t-statistics and the p-values are in round and square parentheses, respectively. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2008.

Table 3: **25 portfolios sorted on size and excess earnings-to-price ratio**

Panel A: Excess earnings-to-price ratio

		SIZE 1	2	3	4	5
	1	-0.32	-0.24	-0.24	-0.23	-0.23
	2	-0.06	-0.06	-0.06	-0.06	-0.06
EEPR	3	0.00	0.00	0.00	0.00	0.00
	4	0.07	0.06	0.06	0.06	0.06
	5	0.34	0.26	0.27	0.24	0.26

Panel B: Earnings-to-price ratio

		SIZE 1	2	3	4	5
	1	-0.11	0.11	0.14	0.14	0.15
	2	0.11	0.15	0.16	0.16	0.16
EEPR	3	0.19	0.19	0.19	0.19	0.17
	4	0.22	0.22	0.21	0.21	0.21
	5	0.50	0.39	0.36	0.33	0.33

Panel C: Size ($ million)

		SIZE 1	2	3	4	5
	1	36	252	570	1,408	11,090
	2	53	254	578	1,419	9,616
EEPR	3	54	252	585	1,390	8,425
	4	56	250	579	1,398	11,541
	5	48	248	579	1,371	10,962

Panel D: Book-to-market ratio

		SIZE 1	2	3	4	5
	1	1.02	0.72	0.62	0.58	0.51
	2	0.82	0.64	0.62	0.63	0.59
EEPR	3	0.99	0.70	0.69	0.68	0.61
	4	0.96	0.78	0.75	0.74	0.67
	5	1.50	1.10	1.03	0.94	0.86

Panel E: Number of stocks

		SIZE 1	2	3	4	5
	1	427	66	52	48	43
	2	330	98	80	75	71
EEPR	3	334	110	77	64	59
	4	371	112	76	59	52
	5	451	84	51	34	29

Table 3: **25 portfolios sorted on size and excess earnings-to-price ratio–continued**

Panel F: Excess return (%)

		SIZE 1	2	3	4	5	1-5
$EEPR$	1	0.42	0.57**	0.53**	0.41*	0.46**	-0.05
	2	0.54*	0.58**	0.51**	0.50**	0.31*	0.23
	3	0.81***	0.59**	0.59**	0.61***	0.47**	0.34
	4	0.88***	0.80***	0.66***	0.65***	0.39*	0.48**
	5	1.11***	0.93***	0.92***	1.01***	0.63***	0.48**
	5-1	0.69***	0.36***	0.39***	0.60***	0.16	

Panel G: Four-factor alpha (%)

		SIZE 1	2	3	4	5	1-5
$EEPR$	1	-0.39***	-0.20**	-0.09	-0.14	0.11	-0.50***
	2	-0.17**	-0.06	-0.04	-0.02	-0.01	-0.16
	3	0.08	-0.11	0.01	0.07	0.18***	-0.10
	4	0.14**	0.13*	0.10	0.18**	0.11	0.04
	5	0.28***	0.16*	0.14	0.39***	0.14	0.13
	5-1	0.67***	0.36***	0.23*	0.53***	0.03	

GRS-F(25, 529): 4.06 [p = 0.000]

Panel H: Excess return (%), raw EPR

		SIZE 1	2	3	4	5	1-5
EPR	1	0.39	0.23	0.13	0.39	0.28	0.11
	2	0.35	0.52*	0.40	0.35	0.27	0.09
	3	0.71***	0.81***	0.70***	0.53***	0.41**	0.31
	4	0.99***	0.82***	0.78***	0.68***	0.39**	0.60***
	5	1.19***	0.97***	1.02***	0.89***	0.62***	0.57***
	5-1	0.80***	0.75***	0.90***	0.49**	0.34*	

Panel I: Four-factor alpha (%), raw EPR

		SIZE 1	2	3	4	5	1-5
EPR	1	-0.28	-0.27**	-0.13	0.17	0.25***	-0.54***
	2	-0.25**	0.02	-0.05	0.02	0.07	-0.33**
	3	0.03	0.11	0.14*	-0.01	0.03	0.00
	4	0.18***	0.08	0.09	0.06	-0.02	0.20*
	5	0.26***	0.05	0.15*	0.11	0.00	0.26**
	5-1	0.54***	0.33**	0.28*	-0.06	-0.25*	

GRS-F(25, 529): 2.00 [p = 0.003]

This table shows the characteristics of 25 portfolios formed as the intersection of independently sorted size ($SIZE$) and excess earnings-to-price ($EEPR$) quintiles. $EEPR$ is a firm's earnings-to-price ratio (EPR) in excess of its industry average using the four-digit SIC code as the industry definition. Panels A and B show $EEPR$ and EPR, respectively. Panel C: Size is the average market capitalization of member firms in millions of dollars. Panel D: The book-to-market ratio is constructed following Fama and French (1993). Panel E shows the average number of stocks within the portfolio. Panel F: The excess return is the excess monthly value-weighted return. Panel G: The four-factor alpha is the intercept from the time-series regression of the excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. Panels H and I repeat the analysis in Panels F and G, respectively, replacing $EEPR$ by EPR as one of the sorting keys. *, **, and *** represent significance at 10, 5, and 1%, respectively. "GRS-F(n, d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the 25 portfolio alphas jointly equal zero, with the p-value in square parentheses. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2009.

Table 4: **27 portfolios sorted on size, B/M, and excess earnings-to-price ratio**

Panel A: Size ($ million)

(i) Low $EEPR$ portfolios

		$SIZE$		
		1	2	3
	1	64	623	8,634
BM	2	65	592	6,426
	3	44	593	4,185

(ii) High $EEPR$ portfolios

		$SIZE$		
		1	2	3
	1	86	591	9,342
BM	2	78	575	6,227
	3	55	575	5,684

Panel B: Book-to-market ratio

(i) Low $EEPR$ portfolios

		$SIZE$		
		1	2	3
	1	0.29	0.33	0.32
BM	2	0.77	0.75	0.74
	3	1.84	1.44	1.39

(ii) High $EEPR$ portfolios

		$SIZE$		
		1	2	3
	1	0.37	0.36	0.36
BM	2	0.79	0.77	0.77
	3	1.96	1.62	1.53

Panel C: Return (high - low $EEPR$)

		$SIZE$		
		1	2	3
	1	0.62***	0.26*	0.13
BM	2	0.35***	0.28***	0.00
	3	0.15*	0.35***	0.21

GRS-F(27, 527): 3.42 [p = 0.000]

Panel D: Alpha (high - low $EEPR$)

		$SIZE$		
		1	2	3
	1	0.60***	0.26**	0.16
BM	2	0.36***	0.27***	0.04
	3	0.22**	0.28**	0.28

This table shows the characteristics of 27 portfolios formed as the intersection of independently sorted size ($SIZE$), book-to-market ratio (BM), and excess earnings-to-price ($EEPR$) terciles. $EEPR$ is a firm's earnings-to-price ratio in excess of its industry average using the four-digit SIC code as the industry definition. Panel A: Size is the average market capitalization of member firms in millions of dollars. Panel B: The book-to-market ratio is constructed following Fama and French (1993). Panel C: The zero-cost portfolio return is the spread of excess monthly value-weighted returns between the high and low $EEPR$ portfolios. Panel D: The four-factor alpha is the intercept from the time-series regression of the zero-cost portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. *, **, and *** represent significance at 10, 5, and 1%, respectively. "GRS-F(n, d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the 27 portfolio alphas jointly equal zero, with the p-value in square parentheses. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2009.

Table 5: **Robustness to alternative earnings measures**

Panel A: Fama and French (1992)

(i) Excess return (%)

		SIZE 1	2	3	4	5	1-5
EEPR	1	0.62*	0.51	0.43	0.46*	0.38*	0.24
	2	0.66**	0.61**	0.54**	0.56***	0.44**	0.22
	3	0.69**	0.69**	0.51**	0.54**	0.30	0.39*
	4	0.84***	0.91***	0.84***	0.78***	0.67***	0.17
	5	0.98***	0.78***	0.86***	0.76***	0.18	0.80***
	5-1	0.36***	0.27*	0.43***	0.29**	-0.19	

(ii) Four-factor alpha (%)

		SIZE 1	2	3	4	5	1-5
EEPR	1	-0.23*	-0.30**	-0.28**	-0.15	-0.07	-0.16
	2	-0.06	-0.09	-0.04	0.00	0.11	-0.16
	3	-0.01	0.02	-0.04	0.05	0.07	-0.09
	4	0.08	0.19**	0.19**	0.20**	0.29***	-0.21**
	5	0.18**	0.09	0.16*	0.14	-0.24**	0.42***
	5-1	0.41***	0.39***	0.44***	0.29**	-0.16	

GRS-F(25, 529): 2.62 [p = 0.000]

Panel B: French

(i) Excess return (%)

		SIZE 1	2	3	4	5	1-5
EEPR	1	0.57*	0.52*	0.47*	0.46*	0.44**	0.12
	2	0.62**	0.56**	0.57**	0.53***	0.43**	0.19
	3	0.72**	0.56**	0.43*	0.46**	0.39**	0.34
	4	0.80***	0.88***	0.68***	0.81***	0.49**	0.31
	5	0.98***	0.78***	0.85***	0.74***	0.34	0.64***
	5-1	0.41***	0.26*	0.38***	0.28**	-0.10	

(ii) Four-factor alpha (%)

		SIZE 1	2	3	4	5	1-5
EEPR	1	-0.28**	-0.26**	-0.19*	-0.10	0.09	-0.37**
	2	-0.15*	-0.10	0.00	-0.03	0.10	-0.24**
	3	0.02	-0.13**	-0.13	-0.01	0.09	-0.07
	4	0.09	0.21***	0.10	0.29***	0.15**	-0.06
	5	0.20***	0.10	0.15	0.14	0.04	0.17
	5-1	0.48***	0.36***	0.34**	0.24*	-0.05	

GRS-F(25, 529): 3.00 [p = 0.000]

Panel C: Vuolteenaho (2002)

(i) Excess return (%)

		SIZE 1	2	3	4	5	1-5
EPR	1	0.75**	0.59**	0.61**	0.53**	0.43**	0.32
	2	0.52*	0.64***	0.57***	0.54***	0.38**	0.14
	3	0.74***	0.58**	0.38	0.42**	0.27	0.47**
	4	0.84***	0.78***	0.71***	0.70***	0.42**	0.42**
	5	0.94***	0.84***	0.83***	0.74***	0.41*	0.53***
	5-1	0.19	0.26**	0.22**	0.20*	-0.02	

(ii) Four-factor alpha (%)

		SIZE 1	2	3	4	5	1-5
EPR	1	-0.11	-0.15*	-0.02	-0.03	0.04	-0.15
	2	-0.19**	-0.01	0.00	0.01	0.07	-0.26**
	3	0.01	-0.13*	-0.15**	-0.02	0.03	-0.02
	4	0.09	0.13	0.14	0.20**	0.11*	-0.03
	5	0.15*	0.14*	0.16*	0.19**	0.11	0.03
	5-1	0.26**	0.29***	0.17	0.22**	0.07	

GRS-F(25, 529): 1.95 [p = 0.004]

Table 5: **Robustness to alternative earnings measures–continued**

Panel D: Operating income before depreciation

(i) Excess return (%)

		SIZE 1	2	3	4	5	1-5
	1	0.33	0.48	0.52**	0.40*	0.48**	-0.16
	2	0.56*	0.48*	0.49**	0.51**	0.28	0.28
EEPR	3	0.70**	0.66**	0.53**	0.55**	0.35*	0.35*
	4	0.93***	0.85***	0.74***	0.74***	0.52**	0.41**
	5	1.16***	0.87***	0.93***	0.90***	0.50**	0.66***
	5-1	0.83***	0.39***	0.41***	0.49***	0.02	

(ii) Four-factor alpha (%)

		SIZE 1	2	3	4	5	1-5
	1	-0.47***	-0.30***	-0.08	-0.13	0.13*	-0.60***
	2	-0.15	-0.20***	-0.11	-0.03	-0.01	-0.14
EEPR	3	0.01	0.07	0.03	0.06	0.09	-0.08
	4	0.20***	0.15**	0.17**	0.22***	0.17**	0.03
	5	0.30***	0.08	0.13	0.24**	-0.03	0.33**
	5-1	0.77***	0.38***	0.20	0.37***	-0.16	

GRS-F(25, 529): 4.44 [p = 0.000]

Panel E: Net income

(i) Excess return (%)

		SIZE 1	2	3	4	5	1-5
	1	0.73**	0.57**	0.60**	0.52**	0.42**	0.31
	2	0.52*	0.61**	0.52**	0.57***	0.38**	0.14
EEPR	3	0.74***	0.64**	0.46*	0.42*	0.34*	0.40**
	4	0.84***	0.79***	0.71***	0.68***	0.39**	0.45**
	5	0.94***	0.82***	0.80***	0.74***	0.41*	0.53***
	5-1	0.21*	0.25**	0.20*	0.22*	-0.01	

(ii) Four-factor alpha (%)

		SIZE 1	2	3	4	5	1-5
	1	-0.11	-0.15*	-0.02	-0.04	0.03	-0.14
	2	-0.23***	-0.06	-0.05	0.03	0.07	-0.29***
EEPR	3	0.02	-0.07	-0.08	-0.01	0.08	-0.06
	4	0.10	0.13	0.15*	0.18**	0.14*	-0.03
	5	0.16**	0.12	0.12	0.20**	0.08	0.07
	5-1	0.26**	0.27**	0.14	0.23**	0.05	

GRS-F(25, 529): 1.91 [p = 0.005]

This table shows the characteristics of 25 portfolios formed as the intersection of independently sorted size ($SIZE$) quintiles and either the raw or the excess ($EEPR$) earnings-to-price quintiles. $EEPR$ is a firm's earnings-to-price ratio in excess of its industry average. The following earnings measures are implemented: Panel A, Fama and French (1992); Panel B, Compustat earnings before extraordinary items as in Kenneth French's website; Panel C, Vuolteenaho (2002); Panel D, Compustat operating income before depreciation; and Panel E, Compustat net income. We first sort firms independently on size and the excess earnings-to-price ratio using the four-digit SIC code (Panel B). If this produces a missing portfolio in any period, we perform dependent sort on size (Panels C and E). If this still leaves missing portfolios, we use the three-digit SIC code to recalculate the excess earnings-to-price ratio and revert to independent sort (Panels A and D). The excess return is the excess monthly value-weighted return. The four-factor alpha is the intercept from the time-series regression of the excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. *, **, and *** represent significance at 10, 5, and 1%, respectively. "GRS-F(n, d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the 25 portfolio alphas jointly equal zero, with the p-value in square parentheses. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2009.

Table 6: **Nine portfolios sorted on number of industry-peer firms and excess earnings-to-price ratio**

Panel A: Excess earnings-to-price ratio

		K 1	2	3
	1	-0.20	-0.20	-0.21
$EEPR$	2	0.00	0.00	0.00
	3	0.23	0.25	0.19

Panel B: Number of industry-peer firms

		K 1	2	3
	1	3.9	12.8	99.0
$EEPR$	2	2.4	12.9	94.5
	3	3.9	13.0	104.4

Panel C: Size ($ million)

		K 1	2	3
	1	1,141	1,338	477
$EEPR$	2	1,068	1,350	1,250
	3	599	898	1,159

Panel D: Book-to-market ratio

		K 1	2	3
	1	0.85	0.81	0.73
$EEPR$	2	0.90	0.77	0.67
	3	1.34	1.26	0.97

Panel E: Herfindahl index of sales

		K 1	2	3
	1	0.53	0.30	0.13
$EEPR$	2	0.76	0.29	0.12
	3	0.54	0.30	0.13

Panel F: Number of stocks

		K 1	2	3
	1	341	379	353
$EEPR$	2	511	266	318
	3	306	343	437

Panel G: Excess return (%)

		K 1	2	3	3-1
	1	0.45**	0.39*	0.15	-0.30**
$EEPR$	2	0.51***	0.38*	0.40**	-0.12
	3	0.67***	0.62***	0.62**	-0.05
	3-1	0.22**	0.23*	0.47***	0.25

Panel H: Four-factor alpha (%)

		K 1	2	3	3-1
	1	0.04	0.00	-0.25**	-0.29**
$EEPR$	2	0.06	0.05	0.12	0.06
	3	0.02	0.21**	0.23*	0.21
	3-1	-0.01	0.21*	0.48***	0.49***

GRS-F(9, 545): 2.27 [p = 0.017]

Panel I: Excess return (%), raw EPR

		K 1	2	3	3-1
	1	0.13	0.09	0.20	0.07
EPR	2	0.55***	0.37*	0.49**	-0.06
	3	0.83***	0.79***	0.71***	-0.13
	3-1	0.70***	0.70***	0.50*	-0.19

Panel J: Four-factor alpha (%), raw EPR

		K 1	2	3	3-1
	1	-0.01	-0.01	0.21	0.22
EPR	2	0.06	0.05	0.15*	0.09
	3	0.07	0.06	0.01	-0.06
	3-1	0.08	0.07	-0.20	-0.29

GRS-F(9, 545): 0.89 [p = 0.529]

This table shows the characteristics of nine portfolios formed as the intersection of independently sorted number of industry-peer firms (K) and excess earnings-to-price ($EEPR$) terciles. Industries are defined by the four-digit SIC code. $EEPR$ is the firm's earnings-to-price ratio (EPR) in excess of its industry average. Panels A and B show $EEPR$ and K, respectively. Panel C: Size is the average market capitalization of member firms in millions of dollars. Panel D: The book-to-market ratio is constructed following Fama and French (1993). Panel E shows the average Herfindahl index of sales. Panel F shows the average number of stocks within the portfolio. Panel G: The excess return is the excess monthly value-weighted return. Panel H: The four-factor alpha is the intercept from the time-series regression of the excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. Panels I and J repeat the analysis in Panels G and H, respectively, replacing $EEPR$ by EPR as one of the sorting keys. *, **, and *** represent significance at 10, 5, and 1%, respectively. "GRS-F(n, d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the nine portfolio alphas jointly equal zero, with the p-value in square parentheses. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2009.

Table 7: **Nine portfolios sorted on Herfindahl index and excess earnings-to-price ratio**

Panel A: Excess earnings-to-price ratio

		HI		
		1	2	3
	1	-0.20	-0.21	-0.19
$EEPR$	2	0.00	0.00	0.00
	3	0.21	0.23	0.22

Panel B: Herfindahl index of sales

		HI		
		1	2	3
	1	0.10	0.28	0.61
$EEPR$	2	0.09	0.29	0.81
	3	0.10	0.29	0.61

Panel C: Size ($ million)

		HI		
		1	2	3
	1	578	1,143	1,359
$EEPR$	2	1,173	1,199	1,189
	3	917	888	1,021

Panel D: Book-to-market ratio

		HI		
		1	2	3
	1	0.77	0.79	0.82
$EEPR$	2	0.72	0.74	0.89
	3	1.05	1.23	1.26

Panel E: Number of industry-peer firms

		HI		
		1	2	3
	1	90.2	17.1	6.2
$EEPR$	2	87.0	18.2	3.4
	3	99.4	20.2	6.7

Panel F: Number of stocks

		HI		
		1	2	3
	1	360	400	313
$EEPR$	2	318	291	485
	3	415	375	296

Panel G: Excess return (%)

		HI			
		1	2	3	1-3
	1	0.15	0.44**	0.45**	-0.29**
$EEPR$	2	0.45**	0.40*	0.41**	0.04
	3	0.83***	0.58**	0.57***	0.26*
	3-1	0.68***	0.14	0.12	0.56***

Panel H: Four-factor alpha (%)

		HI			
		1	2	3	1-3
	1	-0.26***	0.00	0.10	-0.36***
$EEPR$	2	0.22**	-0.06	0.01	0.21*
	3	0.35***	0.11	0.16*	0.19
	3-1	0.61***	0.11	0.06	0.55***

GRS-F(9, 545): 3.44 [p = 0.000]

Panel I: Excess return (%), raw EPR

		HI			
		1	2	3	1-3
	1	0.18	0.05	0.22	-0.03
EPR	2	0.50**	0.44**	0.45**	0.06
	3	0.86***	0.66***	0.87***	0.00
	3-1	0.68**	0.61***	0.65***	0.03

Panel J: Four-factor alpha (%), raw EPR

		HI			
		1	2	3	1-3
	1	0.22	-0.08	0.11	0.10
EPR	2	0.19**	-0.02	0.10	0.09
	3	0.09	-0.04	0.11	-0.02
	3-1	-0.13	0.04	0.00	-0.13

GRS-F(9, 545): 1.32 [p = 0.224]

This table shows the characteristics of nine portfolios formed as the intersection of independently sorted Herfindahl-index (HI) and excess earnings-to-price ($EEPR$) terciles. Industries are defined by the four-digit SIC code. Panel A: $EEPR$ is the firm's earnings-to-price ratio (EPR) in excess of its industry average. Panel B: HI is the average Herfindahl index of sales. Panel C: Size is the average market capitalization of member firms in millions of dollars. Panel D: The book-to-market ratio is constructed following Fama and French (1993). Panel E shows the average number of industry peer firms. Panel F shows the average number of stocks within the portfolio. Panel G: The excess return is the excess monthly value-weighted return. Panel H: The four-factor alpha is the intercept from the time-series regression of the excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. Panels I and J repeat the analysis in Panels G and H, respectively, replacing $EEPR$ by EPR as one of the sorting keys. *, **, and *** represent significance at 10, 5, and 1%, respectively. "GRS-F(n, d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the nine portfolio alphas jointly equal zero, with the p-value in square parentheses. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2009.

Table 8: **Robustness to alternative earnings measures: K-$EEPR$ sorting**

Panel A: Fama and French (1992)

(i) Excess return (%)

		K: 1	2	3	3-1
	1	0.48**	0.46**	0.32	-0.16
$EEPR$	2	0.49**	0.38*	0.47**	-0.02
	3	0.63***	0.52**	0.68***	0.04
	3-1	0.16	0.06	0.36*	0.20

(ii) Four-factor alpha (%)

		K: 1	2	3	3-1
	1	0.01	0.03	-0.21	-0.22
$EEPR$	2	0.02	0.08	0.24**	0.22*
	3	0.08	0.08	0.19	0.10
	3-1	0.07	0.05	0.40**	0.33

GRS-F(9, 545): 2.24 [p = 0.018]

Panel B: French

(i) Excess return (%)

		K: 1	2	3	3-1
	1	0.42**	0.47**	0.29	-0.13
$EEPR$	2	0.53***	0.40**	0.42**	-0.12
	3	0.62***	0.49**	0.62**	0.01
	3-1	0.20*	0.02	0.34*	0.14

(ii) Four-factor alpha (%)

		K: 1	2	3	3-1
	1	-0.03	0.05	-0.14	-0.11
$EEPR$	2	0.05	0.06	0.22**	0.18
	3	0.10	0.08	0.18	0.08
	3-1	0.13	0.03	0.32	0.19

GRS-F(9, 545): 2.13 [p = 0.025]

Panel C: Vuolteenaho (2002)

(i) Excess return (%)

		K: 1	2	3	3-1
	1	0.43**	0.50**	0.39	-0.05
$EEPR$	2	0.54***	0.41**	0.40**	-0.14
	3	0.56**	0.49**	0.59**	0.03
	3-1	0.12	-0.01	0.20	0.08

(ii) Four-factor alpha (%)

		K: 1	2	3	3-1
	1	-0.01	0.05	-0.09	-0.08
$EEPR$	2	0.04	0.08	0.13	0.08
	3	0.05	0.09	0.26**	0.21
	3-1	0.06	0.04	0.35*	0.29

GRS-F(9, 545): 2.04 [p = 0.033]

Panel D: Operating income before depreciation

(i) Excess return (%)

		K: 1	2	3	3-1
	1	0.42**	0.34*	0.16	-0.26*
$EEPR$	2	0.52***	0.40**	0.45**	-0.07
	3	0.73***	0.74***	0.68***	-0.05
	3-1	0.31***	0.40***	0.52***	0.21

(ii) Four-factor alpha (%)

		K: 1	2	3	3-1
	1	0.02	-0.02	-0.25**	-0.27*
$EEPR$	2	0.06	0.05	0.18**	0.12
	3	0.04	0.26**	0.22*	0.18
	3-1	0.03	0.28**	0.47***	0.45**

GRS-F(9, 545): 2.80 [p = 0.003]

Panel E: Net income

(i) Excess return (%)

		K: 1	2	3	3-1
	1	0.43**	0.52**	0.27	-0.16
$EEPR$	2	0.54***	0.39**	0.38*	-0.16
	3	0.56**	0.48**	0.66***	0.10
	3-1	0.14	-0.04	0.39**	0.26

(ii) Four-factor alpha (%)

		K: 1	2	3	3-1
	1	-0.02	0.08	-0.22	-0.20
$EEPR$	2	0.05	0.05	0.15*	0.10
	3	0.08	0.08	0.26**	0.18
	3-1	0.10	0.00	0.47**	0.38*

GRS-F(9, 545): 2.18 [p = 0.022]

This table shows the characteristics of nine portfolios formed as the intersection of independently sorted number of industry-peer firms (K) and excess earnings-to-price ($EEPR$) terciles. Industries are defined by the four-digit SIC code. $EEPR$ is the firm's earnings-to-price ratio (EPR) in excess of its industry average. The following earnings measures are implemented: Panel A, Fama and French (1992); Panel B, Compustat earnings before extraordinary items as in Kenneth French's website; Panel C, Vuolteenaho (2002); Panel D, Compustat operating income before depreciation; and Panel E, Compustat net income. The excess return is the excess monthly value-weighted return. The four-factor alpha is the intercept from the time-series regression of the excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. *, **, and *** represent significance at 10, 5, and 1%, respectively. "GRS-F(n, d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the nine portfolio alphas jointly equal zero, with the p-value in square parentheses. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2009.

Table 9: **Robustness to alternative earnings measures: HI-$EEPR$ sorting**

Panel A: Fama and French (1992)

(i) Excess return (%)

		HI 1	2	3	1-3
	1	0.32	0.48**	0.45**	-0.13
$EEPR$	2	0.54**	0.42**	0.39**	0.15
	3	0.78***	0.51**	0.56**	0.22
	3-1	0.46**	0.02	0.11	0.36*

(ii) Four-factor alpha (%)

		HI 1	2	3	1-3
	1	-0.22**	0.01	0.02	-0.25*
$EEPR$	2	0.28***	0.01	0.06	0.22*
	3	0.34***	-0.02	0.13	0.21
	3-1	0.56***	-0.03	0.11	0.45**

GRS-F(9, 545): 3.14 [p = 0.001]

Panel B: French

(i) Excess return (%)

		HI 1	2	3	1-3
	1	0.34*	0.49**	0.38*	-0.04
$EEPR$	2	0.47**	0.41**	0.46**	0.00
	3	0.71***	0.50**	0.53**	0.18
	3-1	0.37*	0.01	0.15	0.23

(ii) Four-factor alpha (%)

		HI 1	2	3	1-3
	1	-0.21*	0.05	-0.02	-0.18
$EEPR$	2	0.25***	-0.06	0.10	0.16
	3	0.28**	0.03	0.14	0.14
	3-1	0.49***	-0.02	0.16	0.33*

GRS-F(9, 545): 2.79 [p = 0.003]

Panel C: Vuolteenaho (2002)

(i) Excess return (%)

		HI 1	2	3	1-3
	1	0.31	0.51**	0.46**	-0.15
$EEPR$	2	0.47**	0.47**	0.43**	0.04
	3	0.71***	0.43*	0.48**	0.23
	3-1	0.40**	-0.08	0.02	0.38*

(ii) Four-factor alpha (%)

		HI 1	2	3	1-3
	1	-0.21**	0.06	0.03	-0.24*
$EEPR$	2	0.21**	-0.04	0.07	0.14
	3	0.35***	0.04	0.09	0.26*
	3-1	0.56***	-0.02	0.06	0.50**

GRS-F(9, 545): 2.98 [p = 0.002]

Panel D: Operating income before depreciation

(i) Excess return (%)

		HI 1	2	3	1-3
	1	0.20	0.42**	0.38*	-0.18
$EEPR$	2	0.45**	0.42**	0.46**	-0.01
	3	0.86***	0.69***	0.71***	0.14
	3-1	0.65***	0.27**	0.33***	0.32

(ii) Four-factor alpha (%)

		HI 1	2	3	1-3
	1	-0.23***	-0.03	0.07	-0.30**
$EEPR$	2	0.22**	-0.02	0.05	0.17
	3	0.36**	0.13	0.22**	0.14
	3-1	0.59***	0.16	0.15	0.45**

GRS-F(9, 545): 3.19 [p = 0.001]

Panel E: Net income

(i) Excess return (%)

		HI 1	2	3	1-3
	1	0.30	0.53***	0.44**	-0.15
$EEPR$	2	0.48**	0.39**	0.44**	0.04
	3	0.71***	0.48**	0.46**	0.25
	3-1	0.41**	-0.06	0.02	0.39*

(ii) Four-factor alpha (%)

		HI 1	2	3	1-3
	1	-0.22**	0.08	0.02	-0.24*
$EEPR$	2	0.23**	-0.06	0.07	0.15
	3	0.35***	0.01	0.10	0.25*
	3-1	0.57***	-0.07	0.07	0.49**

GRS-F(9, 545): 3.27 [p = 0.001]

This table shows the characteristics of nine portfolios formed as the intersection of independently sorted Herfindahl-index (HI) and excess earnings-to-price ($EEPR$) terciles. Industries are defined by the four-digit SIC code. $EEPR$ is the firm's earnings-to-price ratio (EPR) in excess of its industry average. HI is the Herfindahl index of sales. The following earnings measures are implemented: Panel A, Fama and French (1992); Panel B, Compustat earnings before extraordinary items as in Kenneth French's website; Panel C, Vuolteenaho (2002); Panel D, Compustat operating income before depreciation; and Panel E, Compustat net income. The excess return is the excess monthly value-weighted return. The four-factor alpha is the intercept from the time-series regression of the excess portfolio return on the excess market return ($MKTRF$) and the size (SMB), value (HML), and momentum (MOM) factors. *, **, and *** represent significance at 10, 5, and 1%, respectively. "GRS-F(n, d)" is the Gibbons-Ross-Shanken F-statistic (with the numerator and denominator degrees of freedom n and d, respectively) for the hypothesis that all the nine portfolio alphas jointly equal zero, with the p-value in square parentheses. The sample contains ordinary common shares of firms in non-financial industries traded on NYSE, AMEX, and NASDAQ. The monthly sample runs from July 1963 through December 2009.