### Do Private Firms Learn from the Stock Market? \*

Dong Yan $^\dagger$ 

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### Abstract

This paper develops and tests the hypothesis that privately held companies learn from the stock market. Using a large panel data set for the United Kingdom, we find that private firms' investment responds positively to the valuation of public firms in the same industry. The sensitivity is stronger in industries where the stock prices are more informative or firms are more likely to face common shocks. To address the concern that unobserved factors in the managers' information set affect both private firms' investment and industry valuation and generate a spurious relationship even in the absence of learning, we further show that the investment of private firms in the industry leaders' major-segment industry reacts strongly to the valuation of industry leaders' unrelated minor-segment industries. These findings are consistent with our model in which the stock market has real effects on the private sector through an information-spillover channel: private firm managers exploit information.

**JEL Classification**: G30, G31, G14

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<sup>&</sup>lt;sup>†</sup>Department of Finance, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong; Tel: (852) 62340862; E-mail: dyan@ust.hk. All remaining errors are mine.

### 1 Introduction

Over the last decade, an extensive literature has paid attention to whether corporate managers learn from the stock market. The rationale behind such managerial learning is that, because information does not flow freely among investors and firms, diverse pieces of information that are not known to the managers can be aggregated into the stock prices through the trading activities of investors (Grossman and Stiglitz (1980), Kyle (1985)). In addition, new information about stock market listed (or "public") firms' prospects is produced and disseminated by information intermediaries who scrutinize them constantly, such as financial analysts and business media. In turn, the stock market can have real-side consequences on corporate policies if managers explore information in the public domain in the hope of making better decisions.<sup>1</sup>

Testing whether and how this mechanism works, however, is challenging, because a firm's stock price could merely be a passive indicator of the manager's knowledge about investment opportunities. Without disentangling different sources of information, the documented evidence that market valuation affects subsequent corporate investment could only suggest that the stock market is a sideshow. Furthermore, public firms, which are the objective of analysis in the majority of corporate finance studies, have long been viewed as prone to agency problems. Due to the separation of ownership and control, public firm managers' interests diverge from those of their shareholders, resulting in sub-optimal investment decisions (Jensen and Meckling (1976)). Therefore, even if there is any feedback from stock prices to investment, it is difficult to conclude that the effect is driven by managerial learning rather than other channels such as the attractiveness of equity financing (Keynes (1936), Stein (1996) and Baker, Stein and Wurgler (2003)), or catering to investors' opinions to protect the manager's livelihood (Polk and Sapienza (2009)).

In this paper, we tackle the question by examining private firms, whose shares are not publicly held and traded. Previous concerns that the stock prices of public firms passively reflect their

<sup>&</sup>lt;sup>1</sup>See Bond, Edmans and Goldstein (2012) for a comprehensive survey on the real effects of the stock markets from the informational role of market prices.

fundamentals are mitigated in our design, as the unobserved signals that are specific to the public firm and simultaneously affect the public firm's investment and stock prices are less likely to drive private firms' investment. We develop and test the hypothesis that the investment of a private firm is affected by the average market valuation of public firms in the same industry because the latter provides the private firm manager with additional information about the industry investment opportunities. We consider a simple model in which firms face demand (or productivity) uncertainty common to all public and private firms, as well as firm-specific shocks when making investment decisions. Prior to the realization of state, each firm's manager receives a noisy private signal about the combination of common and firm-specific shocks to her firm. A public firm's stock price also conveys information about the shocks as investors trade on their private information.<sup>2</sup> Private firms, on the other hand, do not have this source of information. However, by aggregating the stock prices of all public firms in their industry, private firm managers could filter out information specific to other firms and obtain a signal about the common shock from the industry average valuation, complementing thereby managers' private signals. We derive implications for private firms on their response of investment to industry valuation under two different scenarios: (i) the private firm manager ignores the stock market information ("No Learning"); and (ii) the private firm manager uses the information in the stock market ("Learning").

By utilizing a large panel of private and public firms in the United Kingdom, we find that the investment of private firms reacts positively to the industry valuation, proxied by the average Tobin's Q of all public firms in the same industry. The economic magnitude is considerable: a one standard deviation increase in the industry valuation is associated with a 1.4% increase in the capital expenditure (scaled by the beginning-of-year capital) of private firms, which is about 7% of the average investment-to-capital ratio in our sample. This effect is obtained after controlling for firm characteristics known to affect investment decisions, characteristics of both public and

 $<sup>^{2}</sup>$ We do not attempt to model the price generating process in precise and show explicitly how the investors' private firms about future shocks are reflected in the stock prices through trading activities, but rather rely on the predictions from existing models such as Kyle (1985) and Subrahmanyam and Titman (1999), among others.

private peers in the same industry, the unobserved time-varying shocks common to all firms (by using the year fixed effects), and the unobserved heterogeneity at the firm-level (by using the firm fixed effects). We also show that our results are robust and of similar economic magnitude to the baseline if we measure investment alternatively by the annual increase of capital scaled by beginning-of-year capital which also accounts for fixed assets acquired externally through mergers and acquisitions.

As shown in our model, if the private firm manager completely ignores the information in the public domain when making investment decisions (the "No Learning" scenario), there will be no relationship between the industry valuation and private firms' investment once we control for the manager's knowledge. In other words, when the manager's signal could be perfectly controlled, the positive investment-to-industry valuation relationship for private firms can be found if and only if their managers learn from the stock market. This is how we identify the "Learning" behavior in the baseline regressions. However, since we are dealing with unobservable signals to the manager, it is inevitable that biases arises in measuring the private firms' investment and industry valuation, it may generate a spurious relationship between private firms' investment and the industry valuation even in the absence of learning.

We carefully address the concern in a number of ways. Firstly, we re-estimate the baseline regressions by replacing the average Tobin's Q with the residual from regressing the average Tobin's Q on the proxy for industry common shocks. The "Learning" framework implies that, if private firm managers pay attention to stock prices and cannot separate the fundamental information from non-fundamental information, then the investment decisions will be distorted by false signals from the market.<sup>3</sup> Since we argue that the industry valuation is a refined signal of the industry common shocks, the valuation residual represents "false" signals (or noise) in industry valuation

<sup>&</sup>lt;sup>3</sup>This implication is also examined in Morck, Shleifer and Vishny (1990) in search for the impact of investor sentiment on corporate investment.

due to investor sentiment, investor inattention, or any other frictions that cannot be cancelled out when aggregating the individual stock prices. The proxy we use for industry demand (or productivity) shock is the contemporaneous industry average cash flow as suggested by Gomes (2001), Cooper and Ejarque (2003), and more recently Gala and Gomes (2013).<sup>4</sup> Consistent with the baseline results, we find that the industry valuation residual continues to explain the investment of private firms.

Secondly, we find that in industries where the stock prices are more informative about future fundamentals, private firms' investment responds more to the industry average valuation.<sup>5</sup> The economic magnitude of the investment-price sensitivity in those industries increases substantially: a one standard deviation increase in industry valuation is associated with a 3.4% increase in private firms' capital expenditure (scaled by the beginning-of-year capital), about 16% of the average investment-to-capital ratio. In addition, the sensitivity of private firms' investment to industry average Tobin's Q increases when firms in the same industry are more likely to face common demand shocks. These findings are consistent with our model's predictions and cannot be developed if the manager of private firms were not learning from the stock market.

Thirdly, to further establish the "Learning" behavior, we look at one specific type of "false" signals: the spurious cross-industry information diffusion (SCIID). Hou (2007) finds that within the same industry, leaders lead followers in stock returns. As most industry leaders have fairly complicated business segments in different industries, their stock valuation could reflect fundamentals in both major and unrelated minor segments. Cen et al. (2013) further document a strong contemporaneous and a lead-lag relation in stock returns between firms from industry leaders' unrelated minor-segment industries and pure players in the industry leaders' major segment industry,

<sup>&</sup>lt;sup>4</sup>Cash flow is widely regarded in the investment literature as capturing shocks to productivity and demand to rationalize the evidence based on misspecified investment-Q regressions. For the same reason, cash flow is considered as the primary determinant of investment in Gala and Gomes (2013) instead of Tobin's Q to improve the empirical fit of investment models.

<sup>&</sup>lt;sup>5</sup>We use (i) number of public firms in the same three-digit SIC industry, (ii) fraction of public firms in the same three-digit SIC industry, and (iii) price non-synchronocity as measures for the informativeness of industry average valuation.

which is consistent with the SCIID hypothesis that the less sophisticated investors price industry pure players based on the industry leaders' returns without being able to differentiate between the major and minor segment fundamentals. For this reason, the valuation of industry leaders' minor-segment industries is incorporated into the industry average valuation and can be regarded as "false" signals to the private firms in the industry leaders' major-segment industry because the minor-segment industries are unrelated to the fundamentals of the major-segment industry, thereby unrelated to the private firms in the major-segment industry. We exclude industry pairs where the leaders of two industries have minor segments in each other, and find that the investment of private firms in the industry leaders' major-segment industry reacts strongly to the valuation of industry leaders' unrelated minor-segment industries: a one standard deviation increase in minorsegment industry valuation is associated with a 0.5% increase in the capital expenditure (scaled by the beginning-of-year capital) of private firms in the major segments, about 2.3% of the average investment-to-capital ratio. The relationship cannot be replicated if we replace the minor segments by random industries that are irrelevant to the industry leaders, and is robust when we exclude private firms that potentially share some economic links with the minor-segment industries, or exclude minor-segment industries that are likely to have supplier or customer relationships with the major-segment industry. These results suggest that private firm mangers exhibit "Learning" behavior and cannot completely filter out irrelevant information from the industry valuation.

Our results contribute to a few strands of literature. The idea that stock prices aggregate information from various participants and improve the efficiency of real economy dates back to Hayek (1945). Follow-up studies have offered important theoretical insights (Grossman and Stiglitz (1980), Kyle (1985), Subrahmanyam and Titman (1999)), and have provided some evidence that managers use the information learnt from their stock prices when they decide on investment (Durnev, Morck and Yeung (2004), Chen, Goldstein and Jiang (2007), and Bakke and Whited (2010)), mergers and acquisitions (Luo (2005)), cash savings (Fresard (2012)), and learn from peers' valuation when making investment decisions (Foucault and Fresard (2014)). Our paper is the first to look at private firms, where the advantage is that manager-specific information cannot be reflected in the firm's own stock price, and to the extent that the market prices aggregate individual pieces of information about common fundamentals, it is highly plausible that they contain information not in the individual private firm manager's information set.

We complement the literature by showing that the information content of market prices spreads to a larger part of the economy that has not received much attention. Private firms account for a substantial fraction of the United Kingdom's economy. We estimate for the period from 2000 to 2010 that private firms represent 91% of all incorporated entities in the U.K. and 60% of all corporate assets. On average, 61% of the sales, 53% of the pre-tax profits, and 68% of the aggregate capital expenditure were from private firms.<sup>6</sup> Therefore, extending our attention to private firms helps us more properly evaluate the real effects of the stock market, which also has important policy implications.

Moreover, we contribute to the empirical literature that compares various policies of public and private firms. Using the same data set as in our paper, Brav (2009) finds that private firms rely mostly on debt financing; Michaely and Roberts (2012) find that private firms smooth dividends less than public firms. Using Sageworks in the United States, Asker, Farre-Mensa and Ljungqvist (2014) find that private firms invest substantially more and are more responsive to changes in investment opportunities compared to matched public firms; Badertscher, Shroff and White (2013) find that the disclosures of financial statements of public firms affect the investment of private firms. Phillips and Sertsios (2014) find that the private firms' product introductions respond less to the change of investment opportunities. While we do not intend to make a comparison of the two types of firms, we document strong evidence that private firm managers exploit information from the stock market.

<sup>&</sup>lt;sup>6</sup>Our statistics are in large comparable to the ones reported in Brav (2009) for U.K private firms for an earlier period (1993 to 2003). Furthermore, a comparison between the public and private firms in the United States can be found in Asker, Farre-Mensa and Ljungqvist (2014). They show that private firms represent 99.94% of all U.S. firms, 59% of sales and 49% of aggregate pre-tax profits in 2010.

Our paper is also related to an extensive literature on information diffusion and asset prices. Previous papers have documented evidence such as the lead-lag effects in stock returns that supports the hypothesis that information is diffused more sluggishly to the stock prices of certain firms than do others (Lo and MacKinglay (1990), Hou (2007) and Cen et al. (2013) among others). Our paper shows that such effects affect private firm managers' ability in uncovering the industryrelevant information and have real effects on corporate investment.

The paper is organized as follows. Section 2 develops the hypothesis under a learning model. Sections 3 describes the empirical strategies and sample selection. Section 4 presents the empirical findings. Section 5 concludes.

### 2 Hypothesis Development

In this section, we describe our setup, information structure and derive hypothesis for the information conveyed in the stock prices to affect the investment behavior of private firms.

### 2.1 Model Setup

### 2.1.1 Production Technology

We consider a market with N public firms and M private firms<sup>7</sup>. At date 0, Firm *i* has constant capital  $k_0$  before making any investment. It sells product for which demand (or productivity) is uncertain, and generate cash flow at date 1. At date 0, manager need to decide whether to adjust production capacity or not. Through investing the amount of  $I_i$ , firm can adjust the level of capital to  $k_i$ , i.e.,

$$k_i = k_0 + I_i \,, \tag{1}$$

<sup>&</sup>lt;sup>7</sup>Our analysis applies to a continuum of firms in the market. The finite number N will only be useful when we understand the effect of the informativeness of the market signal, as discussed later.

Following the q theory literature, we further assume quadratic investment adjustment cost so that the optimal investment can be expressed as a linear function of marginal q. The project value (net present value)  $V_i$  is given by the reduced-form linear function for simplicity

$$V_i = \mathbb{E}\left[v_i \pi\left(k_i\right) - I_i - \left(a_1 I_i + \frac{a_2}{2} I_i^2\right) \mid \Omega_i\right], \qquad (2)$$

where E is the expectations operator,  $\Omega_i$  is the information set of firm i's manager at date 0,  $\pi(k_i)$  is the continuous production function,  $\pi(0) = 0$ ,  $\pi_k(k_i) > 0$ ,  $\pi_{kk}(k_i) < 0$ , and  $\lim_{k\to 0} \pi_k(k_i) = \infty$ .

The demand (or productivity) shock  $v_i$  is a linear combination of two shocks:

$$v_i = \Phi + \eta_i \,, \tag{3}$$

where  $\Phi$  is common to all the firms in the market and is normally distributed with mean  $\mu_{\Phi} > 0$ and variance  $\sigma_{\Phi}^2$ , while  $\eta_i$  is specific to firm *i* and is an i.i.d. normal variable with mean 0 and variance  $\sigma_{\eta}^2$ . Moreover, the firm-specific shock  $\eta_i$  is independent of the common shock  $\Phi$ .

The first-order condition for maximizing the firm value in Equation (2) subject to (1) is

$$E(v_i \mid \Omega_i) \pi_k(k_i^*) = 1 + a_1 + a_2(k_i^* - k_0), \qquad (4)$$

Therefore, the optimal investment can be expressed as a linear function of marginal q, which consists manager's expectation of the future productivity and the marginal contribution of new capital goods to future profit:

$$I_i^* = (k_i^* - k_0) = \frac{1}{a_2} \mathcal{E}(v_i \mid \Omega_i) \pi_k - \frac{a_1 + 1}{a_2}.$$
 (5)

Since the optimal investment  $I_i^*$  is increasing in  $E(v_i \mid \Omega_i)$ , from now on, we will focus on how managers put weight on the signals in forming their expectations of the demand shock v, which

is essentially equivalent to how they put weight on the signals in choosing  $I_i^*$ .

### 2.1.2 Information Structure

At date 0, firm *i*'s manager receives a signal  $m_i$  about *i*'s future demand (or productivity):

$$m_i = \Phi + \eta_i + \varepsilon_i \,, \tag{6}$$

where the signal noise term  $\varepsilon_i$  is normally distributed with mean 0 and variance  $\sigma_{\varepsilon}^2$ . It is assumed to be independent of  $\Phi$  and  $\eta_i$ , and is independent of  $\varepsilon_j$  for any  $j \in (1, \ldots, N + M)$  and  $j \neq i$ .

Moreover, for public firm i where  $i \in (1, ..., N)$ , with some noise  $\omega_i$ , information on future demand (or productivity) is also reflected in the stock price  $p_i$  given by

$$p_i = \Phi + \eta_i + \omega_i \,, \tag{7}$$

where  $\omega_i$  is normally distributed with mean 0 and variance  $\sigma_{\omega}^2$ . For public firm *i*,  $\omega_i$  is independent of the shocks  $\Phi$ ,  $\eta_i$  and the noise term of manager's signal  $\varepsilon_i$ . But unlike managers' signal noise term, the price noise term  $\omega_i$  could be correlated with  $\omega_j$  with some correlation  $0 \le \rho \le 1$  for any  $j \in (1, \ldots, N)$  and  $j \ne i$ . In other words, the stock price contains some "false" signal possibly due to investor sentiment, investor inattention, or any other frictions that affect a group of stocks or the entire market.

Note that we do not attempt to model the price generating process in precise and show explicitly how the shocks are linked to the stock price, but rather rely on the predictions from existing models. One could think of this link as in Kyle (1985). That is if, among the investors of the public firm i, a fraction of investors receive a perfect signal about future demand of firm i's product (i.e. they observe the true value of  $v_i$  at date 0.). The informed speculators will buy or sell shares of this stock based on the this information against the liquidity traders and the dealers. The dealers set the break-even price  $p_i$  according to the expectations of firm *i*'s value conditioning on the order flow (i.e. the sum of the net demand from speculators and liquidity traders) for stock *i*. Such mechanism provides a channel through which investors' information is incorporated into the equilibrium stock price, thereby gives the rationale for managers to learn from the market. It is followed by related papers that study the feedback effects of the firm's own stock price as well as peer firms' stock price on corporate decisions as in Subrahmanyam and Titman (1999) <sup>8</sup>, Foucault and Fresard (2014), among others.

Given the individual price structure in (7), the average of stock prices  $\bar{p}$  reveals common demand (or productivity) shock with some noise:

$$\bar{p} = \Phi + \bar{\omega} \,, \tag{8}$$

where  $\bar{\omega}$  is the average of price noise terms. In a special case that  $\omega_i$  is i.i.d.,  $\bar{\omega}$  vanishes so that the average stock price  $\bar{p}$  is a perfect signal of the common shock  $\Phi$ . In more general cases when  $\omega_i$  follows a N-dimensional joint-normal distribution,  $\bar{\omega}$  follows a normal distribution with mean of 0 and variance of  $\sigma_{\bar{\omega}}^2$ . When N goes to infinity,  $\sigma_{\bar{\omega}}^2$  converge to  $\rho \sigma_{\omega}^2$ , whereas with finite N,  $\sigma_{\bar{\omega}}^2$ is given by

$$\sigma_{\bar{\omega}}^2 = \frac{1}{N}\sigma_{\omega}^2 + \frac{N-1}{N}\rho\sigma_{\omega}^2,\tag{9}$$

<sup>&</sup>lt;sup>8</sup>Subrahmanyam and Titman (1999) do not have a common shock across firms. Therefore, firms' investment will be influenced by the stock price if they go public, and by private financier's information set if remain private. In addition, one type of the shocks (the "serendipitous information" in their paper) can only be observed by the public investors but not the private financier. Hence, unless going public, firms cannot get this piece of information, nor can they interpolate it by looking at peer firms' stock prices as there is no fundamental correlations across stocks. This sets the key difference in the the way private firms use information in stock prices between Subrahmanyam and Titman (1999) and our framework as shown in later sections.

which equals to  $\sigma_{\omega}^2$  if  $\rho = 1$  or N = 1, and have the following properties otherwise:

$$\frac{\partial \sigma_{\bar{\omega}}^2}{\partial N} = -\frac{(1-\rho)\,\sigma_{\omega}^2}{N} < 0; \tag{10}$$

and 
$$\frac{\partial \sigma_{\bar{\omega}}^2}{\partial \rho} = \frac{N-1}{N} \sigma_{\omega}^2 > 0.$$
 (11)

As  $\sigma_{\bar{\omega}}^2$  inversely measures the precision of the industry average price signal (i.e. precision  $\tau_{\bar{\omega}} = \frac{1}{\sigma_{\bar{\omega}}^2}$ ), the comparative statics show that when there are more than one public firms in the market and there exists some but not perfect correlation across the price noise terms, the industry average stock price is more informative (less volatile) if (i) the industry has a higher number of public firms; or (ii) the price noise terms are less correlated across stocks. This motivates the use of number of public firms in the industry and price-nonsynchronicity as proxies for informativeness of the industry average price.

### 2.2 Stock Prices and Private Firms' Investment

In this section, we derive the investment decision of the private firm and develop empirical implications under two scenarios: one is when the private firm manager uses the private signal  $m_i$  only, and the other one is when she relies on both the private signal  $m_i$  and the information embedded in the average industry stock price  $\bar{p}$ . According to Equation (5), the optimal investment  $I_i^*$  that maximize firm value  $V_i$  is linear and increasing in managers' expectations of the shocks. Thus, the problem here can be translated into a comparison of managers' expectation of future conditions between the circumstances of "No Learning" and "Learning".

### 2.2.1 No Learning

If private firm *i*'s manager (i = 1, ..., M) does not learn from the stock market, her expectation of future shocks will be conditional only on the private signal (i.e.,  $\Omega_i = m_i$ ) and can be expressed as a weighted average of the unconditional belief of the shock (which is a constant known to all agents by our assumption) and the managerial private signal:

$$E(v_i \mid m_i) = (1 - \lambda_{Pri}^{No}) \mu_{\Phi} + \lambda_{Pri}^{No} m_i$$
(12)

where

$$\lambda_{Pri}^{No} = \frac{\sigma_{\Phi}^2 + \sigma_{\eta}^2}{\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2} \tag{13}$$

And the manager puts a higher weight on her private signal  $(\lambda_{Pri}^{No})$  if this signal is more precise (i.e.  $\frac{\partial \lambda_{Pri}^{No}}{\partial \sigma_{\varepsilon}^2} < 0$ ). The weight to put on this signal is 1 if the manager has perfect signal on future shocks (i.e.  $\lambda_{Pri}^{No} = 1$  if  $\sigma_{\varepsilon}^2 = 0$ ).

Suppose we could control for the manager's information set, then running the regression of investment on this signal will give us a coefficient on  $\lambda_{Pri}^{No}$ . The coefficient on the average stock price  $\bar{p}$  will be zero (i.e.,  $\beta_{Pri}^{No} = 0$ ) as it was not used by the manager.

### 2.2.2 Learning from the Stock Market

If instead, private firm *i*'s manager actively utilizes the information contained in the average stock price, she will decide the optimal investment based on the expectations of shocks conditional on the average price  $\bar{p}$  as well as the private signal  $m_i$  (i.e.,  $\Omega_i = [\bar{p}, m_i]$ ) derived as

$$E(v_i \mid \bar{p}, m_i) = \left(1 - \beta_{Pri}^{Learn} - \lambda_{Pri}^{Learn}\right) \mu_{\Phi} + \beta_{Pri}^{Learn} \bar{p} + \lambda_{Pri}^{Learn} m_i$$
(14)

where

$$\beta_{Pri}^{Learn} = \frac{\sigma_{\Phi}^2 \sigma_{\varepsilon}^2}{\sigma_{\Phi}^2 \left(\sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right) + \sigma_{\bar{\omega}}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)}$$
(15)

and 
$$\lambda_{Pri}^{Learn} = \frac{\sigma_{\Phi}^2 \sigma_{\eta}^2 + \sigma_{\bar{\omega}}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2\right)}{\sigma_{\Phi}^2 \left(\sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right) + \sigma_{\bar{\omega}}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)}$$
 (16)

When the manager learns from the industry valuation as shown in Equation (14), the conditional expectations of the shocks (equivalently, the optimal investment) is a weighted average of three components: the unconditional belief of the demand shock, the signal from average stock price, and the private signal to the manager. Recall that investment will not respond to the average stock price in "No Learning" scenario <sup>9</sup>. Here, in the case of "Learning", investment response positively to average stock valuation ( $\beta_{Pri}^{Learn} > 0$ ) as long as (i) there exist uncertainty on the future common demand shock (i.e.  $\sigma_{\Phi}^2 > 0$ ), and (ii) manager's private signal is not perfect about the demand shock (i.e.  $\sigma_{\varepsilon}^2 > 0$ ). Both conditions are satisfied for the model to be non-trivial. Therefore,

*Hypothesis* 1: After controlling for manager's information set, investment of private firms responds positively to the valuation of public firms in the same industry if and only if private firm managers learn from the stock market.

If we could isolate different source of signals in  $\bar{p}$  and  $m_i$ , Equation (14) could be expressed as

$$E(v_i \mid \bar{p}, m_i) = \left(1 - \beta_{Pri}^{Learn} - \lambda_{Pri}^{Learn}\right) \mu_{\Phi} + \beta_{Pri}^{Learn} \bar{\omega} + \lambda_{Pri}^{Learn} \left(\eta_i + \varepsilon_i\right) + \left(\beta_{Pri}^{Learn} + \lambda_{Pri}^{Learn}\right) \Phi \quad (17)$$

where  $\beta_{Pri}^{Learn}$  and  $\lambda_{Pri}^{Learn}$  are derived in Equation (15) and (16). Therefore, Hypothesis 1 also applies to the residual term in industry average valuation, and we predict  $\beta_{Pri}^{Learn} > 0$  if and only if the private firm's manager learn from the stock market.

Furthermore, under the "No Learning" scenario, the variance of the noise term in average stock price  $(\sigma_{\bar{\omega}}^2)$  plays no role in the optimal investment decision, whereas under the "Learning" scenario, the magnitude of the weight on the average stock price,  $\beta_{Pri}^{Learn}$ , is decreasing in  $\sigma_{\bar{\omega}}^2$ : the more precise (the less noisy) the signal from the average stock price, the more sensitively private firms' investment responds to the average stock price. This can be seen from the following partial

<sup>&</sup>lt;sup>9</sup>This, however, relies on the assumption that we can perfectly control for the manager's information set. We will discuss in Section 3 our empirical strategy to deal with the biases raised from the violation of this assumption.

derivative:

$$\frac{\partial \beta_{Pri}^{Learn}}{\partial \sigma_{\omega}^2} = -\frac{\sigma_{\Phi}^2 \sigma_{\varepsilon}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)}{\left[\sigma_{\Phi}^2 \left(\sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right) + \sigma_{\omega}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)\right]^2} < 0$$
(18)

As shown in Equation (10) and (11), industry average stock price is more informative (the noise term in the average stock price is smaller) when the number of public firms (N) is higher, or when the correlation of stock price across firms  $(\rho)$  is lower. Using N as a proxy and  $\rho$  as an inverse proxy for the informativeness of the average industry stock price, we predict that

*Hypothesis* 2: The informativeness of industry average stock price matters for the response of investment to the average stock price only when private firm managers learn from the stock market. The sensitivity of private firms investment to the average stock price is stronger when the industry has a larger number of public firms, or when there is less co-movement of stock prices within the industry.

Finally, the rationale behind the benefit of learning from the average stock price is that as firmspecific shock vanishes when we take the average of the individual stock prices, the average price provides managers with useful piece of information about the common demand shock. Therefore, when firms are more likely to face the common demand shock, this additional piece of information is more valuable. To see this, define f as the fraction of the variance of common shock to the variance of total shocks such (i.e.,  $f = \frac{\sigma_{\Phi}^2}{\sigma_{\Phi}^2 + \sigma_{\eta}^2}$  and 0 < f < 1), taking the partial derivative of  $\beta_{Pri}^{Learn}$  with respect to f yields

$$\frac{\partial \beta_{Pri}^{Learn}}{\partial f} = \frac{\sigma_{\eta}^2 \sigma_{\varepsilon}^2 \sigma_{\bar{\omega}}^2 \left(\sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)}{\left(1 - f\right) \left[\sigma_{\Phi}^2 \left(\sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right) + \sigma_{\bar{\omega}}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)\right]^2} > 0$$
(19)

As the f increases, uncertainty are more likely to come from the common demand shock rather than the firm-specific shock, firms put more weight on the average stock price when deciding on the optimal investment. Therefore,

Hypothesis 3: The sensitivity of private firms' investment to the average stock price is

stronger when the industry common demand shock is more important relative to the firm-specific shock.

### 2.3 Comparison between Public and Private Firms

In this section, we derive the optimal investment responses of public firms to the industry valuation when they do learn from their own stock prices as well as the industry prices and have no other incentives to react on the stock prices. We do not aim to find consistent evidence when comparing the investment behavior of private firms to that of public firms in the actual data since, as discussed earlier, there are other reasons for public firms to respond to the stock valuation than what have been suggested by the learning hypothesis.

Under the null hypothesis that managers does not learn from the stock market, public firms will follow the same decision rule as private firms in Equation (12) and set the optimal investment level based on the expected shock conditioning soly on  $m_i$ . Appendix A derives public firms' investment policies under two scenarios: (i) the public firm's manager uses information conveyed in the firm's own stock price  $p_i$ ; and (ii) the public firm's manager utilizes all the information possible including the information embedded in the industry average stock price, information in the firm's own stock price, and the manager's private signal. The results we are interested in is the case where the public firm manager utilize all the information possible (case (ii)). Not surprisingly, the optimal investment is a function of the weighted average of the three signals.

However, as shown in Equation (34) of Appendix A, the weight on the industry average stock price  $(\beta_{Pub}^{Learn})$  may not always be positive for public firms. With more volatile firm-specific shock as oppose to common shock ( $0 < \rho < 1$  and  $f = \frac{\sigma_{\Phi}^2}{\sigma_{\Phi}^2 + \sigma_{\eta}^2} < \rho$ ) or with almost perfectly correlated price noise terms ( $\rho = 1$ ), the investment of public firms responds *negatively* to the industry stock price. The rationale for the result is as follows: when the industry average stock price has the same noise as the individual stock price, public firms' manager could subtract the average stock price from its own stock price to obtain the firm-specific shock  $(\eta_i)$ . Conditioning on the firm's own stock price, the higher the industry average, the lower the estimate of  $\eta_i$ . In such case, the optimal investment responds *negatively* to the average price. This is in line with recent papers by Brown and Wu (2014) studying the cross-fund learning within mutual fund families, and Ozdenoren and Yuan (2014) studying the risk-taking behavior under common and firm-specific uncertainty when agents have incentives to match the industry average effort. For the response of private firms' investment, the sign is not sensitive to the model specifications, thereby putting less challenge when drawing inference from empirical results.

Furthermore, given any value of  $\rho$ , if we assume the distribution of managers' signal does not differ across private and public firms, the difference in their investment-to-industry stock price sensitivity is given by

$$\beta_{Pri}^{Learn} - \beta_{Pub}^{Learn} = \frac{\left(\sigma_{\Phi}^2 + \rho\sigma_{\omega}^2\right) \left[\sigma_{\Phi}^2 \sigma_{\varepsilon}^2 + \rho\sigma_{\omega} \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)\right]}{\Lambda \left[\sigma_{\Phi}^2 \left(\sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right) + \rho\sigma_{\omega}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)\right]}$$
(20)

where  $\beta_{Pri}^{Learn}$  is private firm's weight on industry average stock price under the "Learning" scenario,  $\beta_{Pub}^{Learn}$  is public firms' weight on industry average stock price when the manager learn from its own stock price and the industry average price, and  $\Lambda$  is in Equation (37) of Appendix A. It can be show that  $\beta_{Pri}^{Learn} - \beta_{Pub}^{Learn} > 0$  if (i) there is uncertainty to the common demand or productivity (i.e.  $\sigma_{\Phi}^2 > 0$ ), and (ii) managers do not receive perfect signal about future shocks (i.e.  $\sigma_{\varepsilon}^2 > 0$ ), meaning private firms always have higher sensitivity to the industry average stock price than that of public firms. Therefore,

*Hypothesis* 4: When both private firms and public firms learn from the stock market, private firms respond more to the average stock price than do public firms.

### 2.4 Remarks

The intuition behind this framework is that the expected value of the project NPV is an increasing function of the expected demand (or productivity) shocks conditioning on the information set managers utilize when making the investment decisions. Averaging the stock prices in the industry provides managers with an additional signal about the common shock in the industry. This is the reason why managers make better investment decisions, thereby create greater value if they learn from the stock market.

We will address the concern that private firms' investment may be mechanically correlated with public firms' stock prices due to our imperfect measures of managers' private signals in Section 3. Moreover, only under the "Learning" senario do private firms' investment-average price sensitivity be affected by the informativeness of the market signal. This results cannot be obtained under the null hypothesis of "No Learning".

### **3** Data and Empirical Strategies

Our sample starts with all private and public firms in the United Kingdom for the period 1993 to 2010. The primary data source is the Financial Analysis Made Easy (FAME) database provided by Bureau Van Dijk (BvD) which contains accounting variables in the balance sheet, profit & loss account, and statement of cash flow for all private and public companies (approximately 2.9 million) in the United Kingdom. For public firms, the financial data are cross-checked with the Worldscope database provided by Thomson Reuters. Moreover, we obtain from Worldscope the stock prices to calculate the industry market-to-book valuations, the product segment industry codes and product segment financials. All pound values are converted to 2005 constant million pounds using the U.K. consumer price index from the World Development Indicators (WDI).

The primary advantage of using the FAME database is that the 1967 Companies Act in the

U.K. requires all limited liability companies, private and public, file their financial statements annually with the U.K. Companies House.<sup>10</sup> Moreover, the 1981 Companies Act requires all companies submit full statements, except for the "small" and "medium"-sized firms which meet two of the three criteria: (i) sales less than £1.4 million, (ii) book assets less than £1.4 million; (iii) number of employee less than 50. <sup>11</sup> Thus, the mandatory disclosure policy avoids the selection issues associated with some other databases for private firms.

The second advantage is that private and public firms in the U.K. face equivalent accounting standards. All the statements of public and private firms must be audited if annual sales exceed £0.35 million before June 2000 and £1 million after. Moreover, the U.K. tax laws do not discriminate between public and private firms.<sup>12</sup>

FAME does not remove historical information if a firm stops reporting financial data. But it only keeps information for up to 10 years in the web version or one particular disk. Due to the short period, the sample will be dominated by firms incorporated in more recent years and surviving firms. To avoid this "survivorship" bias, we obtain the archived disks from BvD to expand the time-series from 10 years in previous studies to 18 years and collect the financial data backward in time <sup>13</sup>.

### 3.1 Private and Public Status

Static ("header") information such as listing status, and ownership structures in each disk only reports the last year's value. To obtain this type of information at annual frequency, we append the archived disks from the earliest (release 90, December 1996) to the most recent ones (release 270, December 2011).

<sup>&</sup>lt;sup>10</sup>Companies House is an executive agency of the U.K Department of Trade and Industry.

<sup>&</sup>lt;sup>11</sup>Medium firms are allowed to file abbreviated financial statement, while small firms are allowed to submit only an abridged balance sheet without a profit & loss account.

<sup>&</sup>lt;sup>12</sup>See Brav (2009) and Michaely and Roberts (2012) for more detailed discussions about the FAME database.

<sup>&</sup>lt;sup>13</sup>Our sample period starts from 1993 since the 1996 disk is the earliest archived disk in BvD and it kept financial data for the past three years.

Following Brav (2009) and Michaely and Roberts (2012) that utilized the same database, we classify firms as public if they are quoted on the London Stock Exchange, OFEX or AIM, and as private if their company type in FAME is "Private", or "Public Unquoted". We only keep firms that do not change status from private to public (or public to private) over our sample period to address the concern that the transition firms may not represent the general population of private and public firms.<sup>14</sup>

### 3.2 Sample Selections

Our sample selections follow Brav (2009) and Michaely and Roberts (2012). First, we exclude the following types: assurance company, guarantee, limited liability partnership, not companies act, public investment trusts, and other. We do so to restrict our sample to limited liability companies to which the Companies Act applies. Second, we keep only the consolidated financial statements to mitigate the impact of inter-company dividends on our results, which shrinks our sample substantially. We also exclude the small firms as defined by the Companies House to prevent large number of missing data, and exclude firm-year observations that do not satisfy the auditing requirements.

Following standard practice, we exclude financial, insurance, and real estate firms (US SIC code 6000-6900), utilities (US SIC code 4900-4999), and public sector firms (US SIC code above 8999). We exclude any firm-year observation that has missing book value of asset, sales, or shareholders' equity. We further require each firm have 5 consecutive years of data. Our final sample consists of 14,033 private firms and 1,761 public firms.

Our variable constructions are presented in Appendix B. Firm characteristics such as sales (scaled by lagged capital), cash flows (scaled by lagged capital) are winsorized separately for public and private firms at 1% level at both tails of the distribution to alleviate the impact of outliers.

<sup>&</sup>lt;sup>14</sup>Our results remain the same if we include those firms.

Table 1 presents summary statistics for our sample. We report firm-level and industry-level characteristics for private firms as well as public firms. Consistent with previous studies, we see that private firms are much smaller in size than public firms. They depend more on debt (have higher leverage ratio, and involve less in the equity market) than public firms. A notable comparison is that while the private firms do not have lower capital expenditures than do public firms, they have significantly lower investment in fixed assets. This is possibly due to fixed assets acquired through mergers and acquisitions which are associated much more intensively with public firms than private firms. The distributions of individual public firm's Q and the industry average Q are in large consistent with that of previous studies using the U.S sample <sup>15</sup>.

### 3.3 Empirical Strategies

Our hypothesis can be tested with the traditional linear investment regression as shown in Equation (5). Substituting  $E(v_i | \Omega_i)$  with Equation (12) under the null hypothesis of "No Learning" and with Equation (14) under the hypothesis of "Learning", we obtain the following baseline regression:

$$I_{i,t} = \alpha + \beta \times Industry_Q_{i,t} + \lambda \times CashFlow_{i,t-1} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t}$$
(21)

where the subscript *i* and *t* index firms and years, respectively;  $I_{i,t}$  is the measure of investment, which in the baseline regressions is the capital expenditure (scaled by beginning-of-period capital);  $Industry_Q_{i,t}$  is the average Tobin's Q at the beginning of period *t* of all public firms in the industry that firm *i* belongs to;  $CashFlow_{i,t-1}$  is firm *i*'s lagged cash flow (scaled by beginning-of-period total assets) which we use to measure manager's information on future productivity because it is widely regarded in the investment literature as capturing shocks to productivity and demand to rationalize the evidence based on misspecified investment-Q regressions;  $X_{i,t-1}$  is a set of control variables documented in the literature to affect investment decisions. Following previous studies,

<sup>&</sup>lt;sup>15</sup>In Foucault and Fresard (2014), while a higher mean of individual public firm's Q and the industry average Q for the U.S. public firms is reported, the median values are close to our statistics based on the U.K. firms.

we include firm *i*'s own size, the average size of all public firms and private peers and the average cash flow of all public firms and private peers in the vector of X. As predicted in our model, after controlling for *CashFlow* and X,  $\beta = 0$  if the private firm manager completely ignores the information in the public domain when making investment decisions ("No Learning"), and  $\beta > 0$ if and only if the manager learns from the stock market ("Learning").

However, since we are dealing with unobservable signals to the manager, biases may arise. It is possible that some unobserved factors affecting firm's investment behavior co-exist in the manager's private information set and the industry price signal, but are not reflected in the firm's cash flow (or cannot be controlled by other firm and industry characteristics). In this case, mismeasurement of the manager's signal by cash flow may lead to a spurious investment-to-industry valuation relationship even under the "No Learning" scenario.

To address this concern, we first re-estimate the baseline regression by subtracting the industry common shocks from both the manager's signal and the industry valuation. This is because the unobserved factors that simultaneously affect manager's signal and the industry valuation are more likely from the systematic productivity shock than the private firm's idiosyncratic shock as the latter is hardly conveyed by the industry average stock price. We essentially plug Equation (17), which is a transformation of the conditional expectation under the "Learning" hypothesis (Equation (14)), into the optimal investment policy, and test whether private firm's investment responds to the noise term in the industry average stock price. Our model implies that, if private firm managers pay attention to stock prices and cannot separate the fundamental information from non-fundamental information, then investment decisions will be distorted by noise in the industry average stock price.<sup>16</sup> Therefore, in the following specification, we replace the industry average Tobin's Q in the baseline regression by the residual from regressing the average Tobin's Q on the proxy for industry common shocks, and predict  $\beta = 0$  when the manager does not learn

<sup>&</sup>lt;sup>16</sup>This implication is consistent with the "false" signal theory in Morck, Shleifer and Vishny (1990).

and  $\beta > 0$  if she learns from the stock market.

$$I_{i,t} = \alpha + \beta \times Residual\_Industry\_Q_{i,t} + \lambda \times Residual\_CashFlow_{i,t} + \varphi \times Industry\_CashFlow_{i,t} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t}$$
(22)

The proxy we use for the industry common shock is the contemporaneous industry average cash flow ( $Industry\_CashFlow_{i,t}$ ), which is widely regarded in the investment literature as capturing shocks to productivity and demand (see Gomes (2001), Cooper and Ejarque (2003), and Gala and Gomes (2013)). The valuation residual ( $Residual\_Industry\_Q_{i,t}$ ) represents "false" signals in industry valuation due to investor sentiment, investor inattention, or any other frictions that cannot be cancelled out when aggregating the individual stock prices. We also control for the residual of manager's signal ( $Residual\_CashFlow_{i,t}$ ) which we obtained by regressing firm *i*'s beginning-of-period cash flow on the proxy for common shock, and the proxy itself.

The second strategy we adopt to address the co-movement concern is to look at one specific type of "false" signal that only affects the industry average stock price but is unrelated to the fundamental shock (thereby unrelated to the private firm manager's private information): the spurious cross-industry information diffusion (SCIID). Industry leaders' returns could reflect fundamentals in both major and unrelated minor segments as most industry leaders have fairly complicated business segments in different industries. If the private firm manager learns from her industry leader's valuation or the industry average valuation<sup>17</sup>, but is not able to differentiate between the fundamentals associated with her industry with that associated with the leader's minor segment industries, then price movements in industry leaders' minor-segment industries provide relatively exogenous changes to the industry valuation of industry leaders' major-segment industry

<sup>&</sup>lt;sup>17</sup>The valuation of industry leaders' minor-segment industry affect industry average valuation because the stock returns of pure players may reflect the information of industry leaders' minor-segment industries. Hou (2007) finds that within the same industry, leaders lead followers in stock returns. Cen et al. (2013) further document a strong contemporaneous and a lead-lag relation in stock returns between firms from industry leaders' minor-segment industries and pure players in the industry leaders' major segment industry. They show that such evidence is consistent with the SCIID hypothesis that the less sophisticated investors price industry pure players based on the industry leaders' returns without being able to distinguish between the major and minor segment fundamentals.

because such changes are unlikely to be related to the fundamentals of the private firms in the major-segment industry.

Worldscope reports information on product segment for international public firms from 1980 and have sufficient coverage after 1990. We use the two-digit segment SIC code in each year to decide to which industry a product segment belongs.<sup>18</sup> When the segment SIC code is missing, we replace it by the most recent non-missing SIC code of the segment. We identify the "industry leaders" as firms whose major-segment industry sales rank in the top five among all firms in that industry, where the "major-segment industry" of a firm is defined as the two digit SIC industry in which the firm generates more than 50% of its total sales. If a firm does not have any such segment, its major-segment industry is regarded as missing. We also identify "industry pure players" as firms that are not industry leaders and generate all the sales from the major-segment industry. As industry leaders are usually larger firms, many of them have product segments in other two-digit SIC industries. These are defined as our "minor-segment industry", while their leaders are called "minor-segment industry leaders" in our paper. We require that there be five industry leaders and at least five pure players in each two-digit SIC industry.<sup>19</sup>

We use the average valuation of the "minor-segment industry leaders" as an instrument for the noise term in the industry valuation, and estimate whether the investment of private firms responds positively to this piece of variation.

$$I_{i,t} = \alpha + \beta \times Minor\_Leader\_Q_{i,t} + \sum_{k=1}^{K} \zeta_k \times Major\_Q_{i,t-k} + \lambda \times CashFlow_{i,t-1} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t}$$
(23)

To rule out the possible economic links among the major-segment and minor-segment industries, we exclude industry pairs where the leaders of two industries have minor segments in each other. Our model predicts  $\beta = 0$  when the manager does not learn and  $\beta > 0$  when she learns from the

<sup>&</sup>lt;sup>18</sup>Product segments defined by a different four-digit or three-digit SIC code may belong to the same two-digit SIC segment industry in our sample.

<sup>&</sup>lt;sup>19</sup>Our results are not sensitive to the number of industry leaders and pure players.

stock market.

In testing Hypothesis 2 and 3, we use (i) number of *public* firms in the same three-digit SIC industry, (ii) fraction of public firms in the same three-digit SIC industry, and (iii) price non-synchronocity as measures for the informativeness of industry average valuation and use (i) number of firms in the three-digit SIC industry, (ii) the (inverse of) Herfindahl-Hirschman Index of a three-digit SIC industry; and (iii) market share of the top 4 firms in a three-digit SIC industry as measures of the likelihood that firms in the same industry face common demand shocks. Our model predicts that these measures interacting with the industry average valuation, or the industry average valuation residuals will produce positive coefficients.

### 4 Empirical Results

### 4.1 Industry Valuation and Private Firms' Investment

As described in Section 3.3, we start our analysis by estimating the traditional linear investment regression for private firms. Our primary independent variable, industry valuation, is proxies by the average Tobin's Q of public firms in the three-digit SIC industry that the private firm belongs to. In Table 2, we report results corresponding to the estimation of Equation (21). The sensitivity of private firms' investment to the industry valuation is significantly positive (equals to 0.028), consistent with Hypothesis 1 of our model.

We further control for private firm's own lagged cash flow and size in Column (2), and the average value of all private peers, as well as the average value of public firms in Column (3), the sensitivity remains significantly positive. The economic magnitude is considerable: a one standard deviation increase in the industry valuation is associated with a 1.4% increase in the capital expenditure (scaled by the beginning-of-year fixed assets) of private firms ( $\beta \times SD(Ind_Q) = 0.23 \times 0.6 = 1.4\%$ ), which is about 7% of the average investment-to-fixed asset ratio in our

sample. This effect is obtained after controlling for firm characteristics known to affect investment decisions, characteristics of both public and private peers in the same industry, the unobserved time-varying shocks common to all firms (by using the year fixed effects), and the unobserved heterogeneity at the firm-level (by using the firm fixed effects).

Our results are robust to how investment is measured. We change the dependent variable from Capx/K, which is capital expenditures scaled by the beginning-of-period capital to  $\Delta K$ , which is the annual change of capital scaled by the beginning-of-period capital, the sensitivity of private firms' investment to the industry valuation is still positive (equals to 0.03). The difference between the two measures is that  $\Delta K$  accounts not only for fixed assets invested internally, but also for fixed assets acquired externally through mergers and acquisitions. But since mergers and acquisitions among private firms are not as active as that in public firms, the sensitivity of the two measures to the industry valuation do not have material difference.

### 4.2 Industry Valuation Residuals and Private Firms' Investment

Note that the baseline results have not consider the possibility that unobserved common factors affect both industry valuation and private firms' investment. In this, we will perform first test strategy that have been discussed in Section 3.3.

We estimate Equation (22) which replaces the average Tobin's Q in the baseline regressions by *Residual\_Industry\_Q<sub>i,t</sub>*, the residual from regressing the average Tobin's Q on the proxy for industry common shocks. The proxy we use for industry common shock is the contemporaneous industry average cash flow (*Industry\_CashFlow<sub>i,t</sub>*), which is widely regarded in the investment literature as capturing shocks to productivity and demand to rationalize the evidence based on misspecified investment-Q regressions, as suggested by Gomes (2001), Cooper and Ejarque (2003), and more recently Gala and Gomes (2013). Our model predict  $\beta > 0$ .

Table 3 reports the results from estimation of Equition (22). Consistent with the baseline

regressions, we find that the industry valuation residual continues to explain the investment of private firms in all the specifications we test. The economic magnitude is similar to that from the baseline estimation: a one standard deviation increase in the industry valuation is associated with a 1.4% increase in the capital expenditure (scaled by the beginning-of-year capital) of private firms  $(\beta \times SD(Ind_-Q) = 0.22 \times 0.59 = 1.3\%)$ , which is about 6.5% of the average investment-to-capital ratio in our sample.

After subtracting the systematic productivity shock, the valuation residual *Residual\_Industry\_Q<sub>i,t</sub>* represents "false" signals in industry valuation due to investor sentiment, investor inattention, or any other frictions that cannot be cancelled out when aggregating the individual stock prices. Fundamentals that affect one specific private firm's investment no longer exist in the price signal to drive our results. We also control for residuals of managers signal (which represents private firm's idiosyncratic fundamental shock as well as manager's signal noise) and the common shocks. If private firm managers pay attention to stock prices and cannot separate the fundamental information from non-fundamental information, then investment decisions will be distorted by false signals (in this context, the valuation residuals) from the market. Therefore, finding a positive sensitivity of the private firms' investment to the industry valuation strongly supported our Hypothesis 1 that private firms learn from the stock market.

### 4.3 Information Spillover from Minor-Segment Industry Leaders

### 4.3.1 Minor-Segment Industry Valuation and Private Firms' Investment

To further establish the "Learning" behavior, we look at one specific type of false signals as discuss in Section 3.3: the spurious cross-industry information diffusion (SCIID). We define the minorsegment industry leaders' valuation as the average beginning-of-period market-to-book ratio of all minor-segment industry leaders for a two-digit SIC industry. We estimate Equation (23) to see whether the investment of private firms responds to this piece of "false" signal (i.e.,  $\beta > 0$ ). To rule out the possible economic links among the major-segment and minor-segment industries, we exclude industry pairs where the leaders of two industries have minor segments in each other. As shown in Column (1) of Table 4, we find that investment of private firms in the industry leaders' major-segment industry reacts strongly to the valuation of industry leaders' unrelated minor-segment industries: a one standard deviation increase in minor-segment industry valuation is associated with a 0.5% increase in the capital expenditure (scaled by the beginning-of-year fixed assets) of private firms in the major segments ( $\beta \times SD(Minor\_Leader\_Q) = 0.0083 \times 0.61 = 0.5\%$ ), about 2.3% of the average investment-to-fixed assets ratio.

Our results are robust if we also control for firm-level and industry-level characteristics that affect investment behavior. Moreover, if we control for up to 2 lags of the industry leaders' valuation and the industry pure players' valuation, our results still remain, as shown in Column (3).<sup>20</sup> Our results are also robust to how we measure the minor-segment industry valuation. Results still stand if we replace the minor-segment industry leaders' return by the average of leaders and pure players in the industry, as shown in Column (4) to (6).

Industry valuation movements caused by SCIID are unlikely to be correlated with private firm's fundamentals because such movements are due to less sophisticated investors' lack of ability to decompose the valuation of industry leaders, who usually have fairly complicated business segments, to the part that is related to its major-segments industry and the part that is driven by the fundamentally unrelated minor-segment industries. Our evidence suggests that managers of private firms are also subject to this "limited attention" bias because otherwise, their investment would not be responsive to the spurious information driven by unrelated minor-segments of the industry leader. The findings suggest that the private firm mangers exhibit "Learning" behavior and cannot filter out irrelevant information from the industry valuation.

<sup>&</sup>lt;sup>20</sup>As suggested by Hou (2007) and Cen et al. (2013), the industry pure players' return (and thereby the industry average return) are affected by its own lagged return as well as the return of the minor-segment industry leaders. When we substitute the industry average valuation with the valuation of minor-segment industry leaders, we also control for the lagged return of the industry average valuation as robustness test.

### 4.3.2 Placebo Tests: Irrelevant Industry Valuation and Private Firms' Investment

The information spillover effect documented here may simply reflect common factors in the stock prices of all industries. To further address this concern, we conduct placebo tests by constructing average valuation measures of random irrelevant industries. We replace each minor segment of the industry leaders by a randomly selected "irrelevant" industry, that is, an two-digit SIC industry that does not belong to the minor-segment industries nor share any minor-segment industries with the major-segment industry leaders. We randomly choose the "irrelevant" industries for 500 times and estimate Equation (24) as follows:

$$I_{i,t} = \alpha + \beta \times Random\_Leader\_Q_{i,t} + \sum_{k=1}^{K} \zeta_k \times Major\_Q_{i,t-k} + \lambda \times CashFlow_{i,t-1} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t}$$

$$(24)$$

where  $Random\_Leader\_Q_{i,t}$  is the average beginning-of-period market-to-book of all leaders in the "random irrelevant" industries that are selected for the private firm. If the results only captures a spurious relationship driven by common factors in prices of all the industries, we expect that the investment of private firms continues to respond to the valuation of the "irrelevant" industries.

However, as shown in Table 5, this is not the case. Once we substitute the minor-segment industry leaders' average valuation with the "irrelevant" industry leaders' valuation, the relationship between private firms' investment and the market-to-book of the minor-segment industries vanishes completely. This result suggests that the mechanism is through the information spillover from minor-segment industries to the major-segment industry leaders' stock prices because the valuation of "irrelevant" industries do not affect the major-segment industry leaders' valuation, thereby are not learnt by the private firms' managers. We obtain the same results (with a negative coefficient of small magnitude) when we use the industry average market-to-book of the "irrelevant" industries instead of the leaders' average market-to-book.

### 4.3.3 Robustness Tests: Economically Unlinked Private Firms

Another concern with our analysis is that private firms may also have minor segments in the same set of industries as the public industry leaders in the major-segment industry. If this is the case, then the average valuation of the minor-segment industries may simply reflect the fundamentals in minor-segment industries within which private firms' also have minor segments, and the investment-to-valuation of minor segments is essentially caused by the economic links rather than the information spillovers. In addition, it is possible that the industry leaders' minor-segment industries have supplier or customer relationships with private firms in the industry leaders' major-segment industry, thereby have correlated fundamentals with the private firms in the major-segment industry. In this section, we establish our results by excluding the possible economic links in a number of ways.

We retrieve the secondary SIC code of private firms from FAME.<sup>21</sup> As firms are required to report not only the SIC codes for their business segments, but also for all the other industries that they operate, we exclude to the largest extent any common business segments shared by private firms and public industry leaders. We first exclude the firm-year observations for which a possible economic links could be found, then exclude the firms' entire data points if a possible economic links could be found in any year over the sample period. Our results are robust as reported in Panel A of Table 6. We also exclude the minor-segment industries that potentially have supplier or customer relationship with the major-segment industries. Our results still stand as reported in column (5) and (6) of Panel B. Moreover, our results are robust if we exclude minor-segment industries that potentially have supplier and customer relationships with the major-segment industries, where supplier and customer industries are defined using the 2012 U.S. Input-Output Tables provided by the Bureau of Economic Analysis. Therefore, the common minor-segment industries of private firms and public industry leaders or supplier and customer relationships cannot alone account for the documented investment responses to the valuation of minor-segment industries.

<sup>&</sup>lt;sup>21</sup>Worldscope, from which we obtain the segment SIC code of public firms, does not cover private firms

### 4.4 Cross-sectional Tests

Our model also provides cross-sectional implications to test the learning hypothesis. In this section, we first examine how the informativeness of the industry price signal affect the investment-toindustry valuation sensitivity (Hypothesis 2), and later examine the how industry competition structure affect this sensitivity.

### 4.4.1 Price Informativeness

We first test Hypothesis 2 and examine how the informativeness (precision) of the industry price signal affects the investment-to-industry valuation sensitivity. We use three measures for the industry price informativeness. The first is  $H_{-}\#Public$ , which is a dummy equals to 1 if the logarithm of 1 plus the number of public firms of the industry is above the 70th percentile, and equals to 0 if it is below the 30th percentile. As in Chemmanur, He and Nandy (2010), the more firms already listed in a industry, the easier it is for outsiders to evaluate firms in that industry. The outsides include unsophisticated investors, sophisticated investors, financial analysts and market makers. Therefore, if there are more public firms in the industry, the industry price is more precise.

For similar reason, we use is % Public, which is the fraction of number of public firms to all firms in a three-digit SIC industry, as our second measure for price informativeness. As argued in Badertscher, Shroff and White (2013), the faction of public to all firms in a industry affect the information environment, and thereby, the (price) and investment efficiency.

Our third measure is  $H_Nonsynchronisity$ , which is a dummy equals to 1 if the Nonsynchronisity of a three-digit SIC industry is above the 70th percentile, and equals to 0 if it is below the 30th percentile. As in many other papers (Durnev, Morck and Yeung (2004), Chen, Goldstein and Jiang (2007), and Foucault and Fresard (2014)), we use the price non-synchronicity (or firm-specific return variation) as the measure for individual price informativeness.<sup>22</sup> We then construct our

<sup>&</sup>lt;sup>22</sup>We regress public firm *i*'s weekly stock returns on the market portfolio returns and the industry portfolio returns, obtain the  $R_{i,t}^2$  and define firm-specific return variation as  $1 - R_{i,t}^2$ . Our weekly return data are from

dummy by from the average price non-synchronicity in an industry.

As shown in Table 7, we find that in industries where the stock prices are more informative about future fundamentals, private firms' investment responds more to the industry average valuation, consistent with Hypothesis 2.<sup>23</sup> The economic magnitude of the investment-price sensitivity in those industries increases substantially: a one standard deviation increase in industry valuation is associated with approximately 3.4% increase in private firms' capital expenditure (scaled by the beginning-of-year capital) in industries with high price informativeness, about 16% of the average investment-to-capital ratio.

### 4.4.2 Common Shocks

We then test Hypothesis 3. As predicted by our model, the sensitivity of private firms' investment to the average stock price is stronger when the common demand (or productivity) shock is more important to firms relative to the firm-specific shock. We use three measures for how likely firms are facing common demand shocks: (i)  $H_{-}\#Firms$ , which is a dummy equals to 1 if the logarithm of 1 plus the number of all firms of the industry is above the 70th percentile, and equals to 0 if it is below the 30th percentile; (ii)  $L_{-}HHI$ , which a dummy equals to 1 if HHI in a threedigit SIC industry is below the 30th percentile, and equals to 0 if it is above the 70th percentile; and (iii)  $L_{-}Top4\_Shares$ , which a dummy which equals to 1 if the market share of the top 4 firms in a three-digit SIC industry is below the 30th percentile, and equals to 0 if it is above the 70th percentile. We adopt these commonly used competition measures in the empirical industrial organization literature because in competitive industries, cost reductions and demand surges are more likely to be common across all firms (Hart (1983), Giroud and Mueller (2011)).

As shown in Table 8, we find that in industries where firms are more likely to face common shocks, private firms' investment responds more to the industry average valuation, consistent with

Worldscope.

<sup>&</sup>lt;sup>23</sup>In unreported results, we show that our results are robust if the continuous variables instead of the dummies are used. We use the dummy to ease our interpretation of the results

Hypothesis 3. The economic magnitude of the investment-price sensitivity in those industries increases substantially: a one standard deviation increase in industry valuation is associated with approximately 3.3% increase in private firms' capital expenditure (scaled by the beginning-of-year capital) in more competitive industries, about 16% of the average investment-to-capital ratio.

### 4.5 Public Firms' Investment

Our model predicts that when there is high uncertainty to future systematic productivity (or demand), and firms do not receive perfect signals, private firms always have higher sensitivity to the industry average stock price than public firms based on the learning framework. We do not aim to find supporting evidence for Hypothesis 4, as public firms' investment may be sensitive to the stock market valuation for many other reasons than "Learning". The most prominent channels documented in existing literature are the "equity financing channel" and the catering channel. The former suggests that equity issuance and capital investment of public firms be affected by stock prices because the effective cost of external equity of public firms can diverge from the cost of other forms of capital due to movements of the irrational element contained in stock prices (Keynes (1936), Morck, Shleifer and Vishny (1990), Stein (1996) and Baker, Stein and Wurgler (2003), among others). The latter, as in Polk and Sapienza (2009), argues that managers of public firms may try to boost short-run share prices by catering current sentiment, especially for managers with shorter shareholder horizon. Furthermore, Asker, Farre-Mensa and Ljungqvist (2014) suggest that public firms investment are less responsive to changes in investment opportunities due to managerial myopia. Therefore, the purpose of this section is to test the difference in investment response between public and private firms to the industry valuation, and see to what extent public firms investment deviates from the optimal investment behavior suggested by the "Learning" framework.

We use caliper-based nearest-neighbor match with replacement adapted to a panel setting

following Asker, Farre-Mensa and Ljungqvist (2014). Stating from 1993, we match private firms with public firms from the same three-digit industry and closest in size. We require that the ratio of their total assets is less than 2. If no match can be formed, we drop the observation and look for a match in the following year. Once a match is found, it is kept in subsequent years. The panel structure of the data allows us to estimate the within-firm sensitivity of investment to the industry valuation. Since one public firm could be matched to different private firms, we end up with more private observations (76,738) than public ones (8,135).

We estimate our baseline regression on investment and financing policies for matched sample of private and public firms as shown in Equation (25).

$$Y_{i,t} = \alpha + \beta \times Industry_{-}Q_{i,t} + \beta_{2} \times Industry_{-}Q_{i,t} \times Public_{i} + \lambda \times CashFlow_{i,t-1} + \theta \times X_{i,t-1} + \kappa_{i} + \delta_{t} + \epsilon_{i,t}$$

$$(25)$$

The results are presented in Table 9. The dependent variables in Column (1) and (2) are Capx/K, which is the annual capital expenditure (scaled by lagged capital), and  $\Delta K$ , which is the annual change of capital (scaled by lagged capital), respectively. A notable finding is that while the private firms have statistically insignificant difference from public firms in the response of Capx/K to industry valuation, they exhibit significantly lower sensitivity of their investment in fixed assets to the industry valuation. This difference is possibly due to fixed assets acquired through mergers and acquisitions which are associated much more with public firms since they can involve intensively in equity acquisition than can private firms.

We further turn to the comparison of financing policies. We construct *Equity Issue* and *Debt Issue* variables using balance sheet items following Dasgupta, Noe and Wang (2011). Column (3) and (4) report the results when the dependent variables are the annual change of Book Equity minus the annual change of Retained Earnings (scaled by lagged fixed assets), and the annual change of Book Debt (scaled by lagged capital), respectively. It shows that public firms' equity financing responds much more sensitively to industry valuation, which is consistent with earlier

view that public firms rely much more heavily on equity than do private firms (Brav (2009)). Surprisingly, their debt issuance not only responds less sensitively than private firms, but even *negatively* to industry valuation. This substitution of debt with equity is in line with the market timing literature that high returns trigger equity issuance(Baker, Stein and Wurgler (2003), Alti and Sulaeman (2012), among others).

### 5 Conclusion

Whether the stock market affects the real economy through its role of producing and aggregating information has long been the interests of finance studies. While previous studies have documented ample evidence on the relationship of stock prices and public firms' investment, it is challenging to attribute the effect to managerial learning.

In this paper, we examine privately held companies. Using a large panel data set for the United Kingdom, we find that investment of private firms responds positively to the valuation of public firms in the same industry. The sensitivity is stronger in industries where stock prices are more informative or firms are more likely to face common demand shocks. To rule out the possibility that unobserved factors drive both private firms' investment and the industry valuation and generate a spurious relationship even in the absence of learning, we further show that the investment of private firms in the industry leaders' major-segment industry responds strongly to the valuation of industry leaders' unrelated minor-segment industries. These findings are consistent with our model in which the stock market has real effects on the private sector through an information-spillover channel: private firm managers exploit information contained in the stock prices, but cannot completely filter out the information related to the multisegment public leaders but unrelated to themselves.

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### A Stock Prices and Public Firms' Investment

In this appendix, we derive the investment policy of a public firm under two scenarios: (i) the public firm's manager uses information conveyed in the firm's own stock price  $p_i$ ; and (ii) the public firm's manager utilizes all the information possible including the information embedded in the industry average stock price, information in the firm's own stock price, and the manager's private signal.

### A.0.1 Learning from own stock price

If public firm *i*'s manager (i = 1, ..., N) makes use of *i*'s own stock price, but ignores the average stock price (i.e.,  $\Omega_i = [p_i, m_i]$ )<sup>24</sup>, the expectations of the shocks can be derived as

$$E(v_i \mid p_i, m_i) = \left(1 - \gamma_{Pub}^{Narrow} - \lambda_{Pub}^{Narrow}\right) \mu_{\Phi} + \gamma_{Pub}^{Narrow} p_i + \lambda_{Pub}^{Narrow} m_i$$
(26)

where

$$\gamma_{Pub}^{Narrow} = \frac{\sigma_{\varepsilon}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2\right)}{\sigma_{\varepsilon}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2\right) + \sigma_{\omega}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)}$$
(27)

and 
$$\lambda_{Pub}^{Narrow} = \frac{\sigma_{\omega}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2\right)}{\sigma_{\varepsilon}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2\right) + \sigma_{\omega}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)}$$
 (28)

### A.0.2 Learning from own and average stock price

Furthermore, when *i*'s manager complements her private signal with both *i*'s own stock price and the industry average stock price (i.e.,  $\Omega_i = [\bar{p}, p_i, m_i]$ )<sup>25</sup>, the conditional expectations of the shocks can be derived as

$$E(v_i \mid \bar{p}, p_i, m_i) = \left(1 - \beta_{Pub}^{Learn} - \gamma_{Pub}^{Learn} - \lambda_{m_i}^{Learn}\right)\mu_{\Phi} + \beta_{Pub}^{Learn}\bar{p} + \gamma_{Pub}^{Learn}p_i + \lambda_{Pub}^{Learn}m_i$$
(29)

where

$$\beta_{Pub}^{Learn} = \frac{1}{\Lambda} \sigma_{\varepsilon}^2 \left[ \sigma_{\Phi}^2 \sigma_{\omega}^2 - \sigma_{\bar{\omega}}^2 \left( \sigma_{\Phi}^2 + \sigma_{\eta}^2 \right) \right]$$
(30)

$$\gamma_{Pub}^{Learn} = \frac{1}{\Lambda} \sigma_{\eta}^2 \sigma_{\varepsilon}^2 \left( \sigma_{\Phi}^2 + \sigma_{\bar{\omega}}^2 \right)$$
(31)

$$\lambda_{Pub}^{Learn} = \frac{1}{\Lambda} \left[ \sigma_{\Phi}^2 \sigma_{\eta}^2 \sigma_{\omega}^2 + \sigma_{\bar{\omega}}^2 \left( \sigma_{\omega}^2 - \sigma_{\bar{\omega}}^2 \right) \left( \sigma_{\Phi}^2 + \sigma_{\eta}^2 \right) \right]$$
(32)

and

$$\Lambda = \sigma_{\Phi}^2 \sigma_{\eta}^2 \sigma_{\varepsilon}^2 + \sigma_{\eta}^2 \left( \sigma_{\Phi}^2 \sigma_{\omega}^2 + \sigma_{\varepsilon}^2 \sigma_{\bar{\omega}}^2 \right) + \left( \sigma_{\omega}^2 - \sigma_{\bar{\omega}}^2 \right) \left[ \sigma_{\Phi}^2 \sigma_{\varepsilon}^2 + \sigma_{\bar{\omega}}^2 \left( \sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2 \right) \right]$$
(33)

 $^{24}$ Such scenario is similar to the "narrow learning" results examined in Foucault and Fresard (2014).

 $<sup>^{25}</sup>$ This is similar to the "learning from peers" case in Foucault and Fresard (2014). However, since Foucault and Fresard (2014) do not have firm-specific shock, the implication about firms' response to industry average stock price may be different from our results.

As N goes to infinity, we have  $\sigma_{\bar{\omega}}^2 = \rho \sigma_{\omega}^2$ . Then the weights on each signal become

$$\beta_{Pub}^{Learn} = \frac{\sigma_{\varepsilon}^2 \sigma_{\omega}^2}{\Lambda} \left[ (1-\rho) \, \sigma_{\Phi}^2 - \rho \sigma_{\eta}^2 \right] \tag{34}$$

$$\gamma_{Pub}^{Learn} = \frac{\sigma_{\eta}^2 \sigma_{\varepsilon}^2}{\Lambda} \left( \sigma_{\Phi}^2 + \rho \sigma_{\omega}^2 \right)$$
(35)

$$\lambda_{Pub}^{Learn} = \frac{\sigma_{\omega}^2}{\Lambda} \left[ \sigma_{\Phi}^2 \sigma_{\eta}^2 + \rho \left( 1 - \rho \right) \sigma_{\omega}^2 \left( \sigma_{\Phi}^2 + \sigma_{\eta}^2 \right) \right]$$
(36)

where

$$\Lambda = \sigma_{\Phi}^2 \sigma_{\eta}^2 \sigma_{\varepsilon}^2 + \sigma_{\eta}^2 \sigma_{\omega}^2 \left(\sigma_{\Phi}^2 + \rho \sigma_{\varepsilon}^2\right) + (1 - \rho) \sigma_{\omega}^2 \left[\sigma_{\Phi}^2 \sigma_{\varepsilon}^2 + \rho \sigma_{\omega}^2 \left(\sigma_{\Phi}^2 + \sigma_{\eta}^2 + \sigma_{\varepsilon}^2\right)\right]$$
(37)

For all possible values of  $\rho$ , we have

$$\Lambda > 0, \quad \gamma_{Pub}^{Learn} > 0, \text{ and } \lambda_{Pub}^{Learn} > 0$$

The sign of  $\beta_{Pub}^{Learn}$ , however, depends on the value of  $\rho$  and  $f = \frac{\sigma_{\Phi}^2}{\sigma_{\Phi}^2 + \sigma_{\eta}^2}$ :

- (1) when  $\rho = 0$ , meaning that  $\bar{p}$  is a perfect signal of the common shock,  $\beta_{Pub}^{Learn} > 0$ ;
- (2) when  $0 < \rho < 1$ ,  $\beta_{Pub}^{Learn} > 0$  if  $f > \rho$ , and  $\beta_{Pub}^{Learn} <= 0$  if  $f <= \rho$ ;

(3) when  $\rho = 1$ , meaning that the noise term in the average stock price is as volatile as in the individual price,  $\beta_{Pub}^{Learn} < 0$ .

### **B** Variable Definitions

In this appendix, we discuss the definitions of main variables used in our study. All definitions coincide with line items in corporate balance sheets, profit and loss (P&L) accounts, and cash flow statement in the FAME database or other studies utilizing the FAME database.

### B.1 Firm-level variables

Total Assets is the balance sheet item Total Asset reported in 2005 constant million pounds;

 $\mathbf{K}$  (capital) is the balance sheet item Fixed Asset reported in 2005 constant million pounds, which is the sum of tangible asset and intangible asset;

Capx/K is the cash flow statement item Capital Expenditures scaled by the beginning-ofperiod capital;

 $\Delta K$  is the annual change of capital scaled by the beginning-of-period capital;

Ln(Asset) is the logarithm of Total Assets;

**CashFlow** is the cash flow of the period scaled by the beginning-of-period Total Assets, where cash flow is the sum of the profit & loss account items Profit (Loss) for the Period and Depreciation;

 $\Delta$ Sales is the annual change of sales scaled by the beginning-of-period Total Assets, where sales corresponds to the profit & loss account item Turnover;

 $\Delta Cash$  is the annual change of cash holdings scaled by the beginning-of-period Total Assets, where cash holdings is the sum of the balance sheet items Bank & Deposits and Investment;

**Tangibility** is the sum of the balance sheet items Land & Buildings, Fixtures & Fittings, and Plant & Vehicles, scaled by the beginning-of-period Total Assets;

**Leverage** is defined as the Book Debt plus Trade Creditors, scaled by the beginning-of-period Total Assets;

**Equity Issue** is the annual change of Book Equity minus the annual change of Retained Earnings, scaled by the beginning-of-period capital, where Book Equity is constructed using the balance sheet items and is the sum of Shareholders Fund and Deferred Tax, and Retained Earnings is defined as the balance sheet item profit & loss account;

**Debt Issue** is the annual change of Book Debt scaled by the beginning-of-period capital, where Book Debt is constructed using the balance sheet items and is defined as Long Term Debt plus Short Term Loans & Overdrafts minus Group Loans;

**Market-to-book** for public firms is the market-to-book ratio of assets, where the market value of assets is defined as Total Assets - Book Equity + stock price at the end of fiscal year  $\times$  number of shares outstanding;

**Own\_Q** for public firms is the beginning-of-period *Market-to-book*;

### B.2 Industry-level variables

**Industry\_Q** is the equal-weighted average of the beginning-of-period Market-to-book of public firms in a three-digit SIC industry;

**Industry\_Q\_vw** is the value-weighted average of the beginning-of-period Market-to-book of public firms in a three-digit SIC industry, where the weight is the Total Assets;

Industry\_CashFlow is the average CashFlow of all firms in a three-digit SIC industry;

**Residual\_Industry\_Q** is the residual obtained from regressing *Industry\_Q* on *Industry\_CashFlow*;

**Residual\_CashFlow** is the residual obtained from regressing *CashFlow* on *Industry\_CashFlow*;

**Minor\_Leader\_Q** is the average beginning-of-period Market-to-book of all minor-segment industry leaders for a two-digit SIC industry;

**Minor\_Industry\_Q** is the average beginning-of-period Market-to-book of all minor-segment industries for a two-digit SIC industry;

**Random\_Leader\_Q** is the average beginning-of-period *Market-to-book* of all leaders in the "random irrelevant" industries that are selected for the private firm;

**Random\_Industry\_Q** is the average beginning-of-period market-to-book of the "random irrelevant" industries that are selected for the private firm;

**#Public** is the logarithm of 1 plus the number of public firms in a industry;

 $\mathbf{H}_{-}$ #**Public** is a dummy which equals to 1 if #*Public* of the industry is above the 70th percentile, and equals to 0 if it is below the 30th percentile;

%Public is the fraction of number of public firms to all firms in a three-digit SIC industry;

**Nonsynchronisity** is estimated by the  $1 - R^2$  from running weekly firm return on the market return and three-digit SIC industry return;

**H\_Nonsynchronisity** is a dummy which equals to 1 if the *Nonsynchronisity* of a three-digit SIC industry is above the 70th percentile, and equals to 0 if it is below the 30th percentile;

**#Firms** is the logarithm of 1 plus the number of all firms in a three-digit SIC industry;

 $\mathbf{H}_{-}$ #**Firms** is a dummy which equals to 1 if the #*Firms* of a three-digit SIC industry is above the 70th percentile, and equals to 0 if it is below the 30th percentile;

**HHI** is the Herfindahl-Hirschman Index of a three-digit SIC industry calculated as the sum of squared market shares;

 $L_HHI$  is a dummy which equals to 1 if HHI in a three-digit SIC industry is below the 30th percentile, and equals to 0 if it is above the 70th percentile;

**Top4\_Share** is the market share of the top 4 firms in a three-digit SIC industry;

**L\_Top4\_Share** is a dummy which equals to 1 if the *Top4\_Share* in a three-digit SIC industry is below the 30th percentile, and equals to 0 if it is above the 70th percentile;

### Table 1: Summary Statistics

This table reports the descriptive statistics of the main variables used in our analysis. Our sample period is from 1993 to 2010. All variables are defined in Appendix B. The accounting variables for public and private firms are from the FAME database. The stock prices used to the consolidated financial statements to mitigate the impact of inter-company dividends on our results. We also exclude the small firms as equity. We further require each firm have 5 consecutive years of data. All pound values are converted to 2005 constant million pounds using calculate the industry market-to-book valuations are from the Worldscope database. The product segment industry codes and product segment financials are also from Worldscope. We restrict our sample to limited liability companies to which the Companies Act applies, and keep only defined by the Companies House to prevent large number of missing data, and exclude firm-year observations that do not satisfy the auditing requirements. We also exclude financial, insurance, and real estate firms (US SIC code 6000-6900), utilities (US SIC code 4900-4999), and public sector firms (US SIC code above 8999), and any firm-year observation that has missing book value of asset, sales, or shareholders' the U.K consumer price index from the WDI. Firm characteristics are winterized separately for public and private firms at 1% level at both tails. Firm-level variables are presented in Panel A. Industry characteristics (firm-year average) are presented in Panel B. Reported statistics include number of observations (Obs.), mean, median and standard deviation (SD).

Panel A. Firm	Characteristi	cs						
		Private	Firms			Public	: Firms	
	Obs.	Mean	Median	SD	Obs.	Mean	Median	SD
Capx/K	69,962	0.216	0.095	0.453	12,177	0.174	0.100	0.242
$\Delta K$	109,154	0.119	-0.018	0.676	12,177	0.267	0.025	0.978
Ln(Asset)	110,292	2.720	2.506	1.487	12,178	4.563	4.313	2.053
CashFlow	110, 114	0.055	0.051	0.134	12,177	0.074	0.081	0.149
$\Delta Sales$	110,294	0.114	0.045	0.570	12,178	0.132	0.059	0.425
$\Delta Cash$	99,573	0.013	0.000	0.110	12,146	0.019	0.001	0.139
Tangibility	108,722	0.276	0.215	0.237	12,178	0.277	0.228	0.232
Leverage	106, 295	0.392	0.371	0.266	12,158	0.322	0.305	0.198
$Equity\ Issue$	109,454	0.046	-0.003	0.513	12,177	0.280	-0.001	1.558
$Debt \ Issue$	109,512	0.058	0.000	1.500	12, 177	0.084	0.000	0.587
$Omn_O$					11.480	1.809	1.425	1.245

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		Private	Firms			Public	Firms	
	Obs.	Mean	Median	SD	Obs.	Mean	Median	SD
$Industrt_Q$	110,294	1.674	1.566	0.596	12,178	1.804	1.655	0.668
$Industry\_Q\_vw$	110,294	1.619	1.511	0.602	12,178	1.767	1.584	0.743
$Residual\_Industry\_Q$	110,294	0.007	-0.110	0.591	12,178	0.120	-0.017	0.668
$Residual\_CashFlow$	110, 114	-0.001	-0.004	0.131	12,177	0.012	0.019	0.140
$Industry\_CashFlow$	110,294	0.056	0.058	0.031	12,178	0.062	0.062	0.045
$Minor\_Leader\_Q$	77,565	1.816	1.652	0.609	8,356	1.840	1.706	0.603
$Minor\_Industry\_Q$	79,853	1.758	1.698	0.393	8,498	1.725	1.685	0.383
#Public	110,294	2.225	1.946	0.917	12,178	2.427	2.197	0.997
% Public	110,294	0.101	0.063	0.094	12,178	0.310	0.212	0.291
Non synchronic ity	110,294	0.705	0.724	0.145	12,178	0.727	0.766	0.154
#Firms	110,294	4.797	4.700	1.057	12,178	3.918	3.932	1.374
IHH	110,294	0.131	0.072	0.144	12,178	0.241	0.165	0.217
$Top4\_Share$	110,294	0.483	0.449	0.225	12,178	0.648	0.657	0.248

Panel B. Industry Characteristics

## Table 2: Industry Valuation and Private Firms' Investment

This table presents the results from estimating Equation (21) for private firms as shown below:

$$I_{i,t} = \alpha + \beta \times Industry_{-}Q_{i,t} + \lambda \times CashFlow_{i,t-1} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t}$$

and in model (4) to (6) is  $\Delta K$ , which is the annual change of capital scaled by the beginning-of-period capital. The main independent variable with firm-fixed effects and year-fixed effects. Since our main right-hand-side variable is at the three-digit SIC industry level, t-statistics in parentheses are adjusted using the Huber-White estimator allowing within industry clusters to be conservative. Coefficients significant at the Industry- $Q_{i,t}$  is the equal-weighted average of the beginning-of-period market-to-book ratio of public firms in the three-digit SIC industry that as well as the average value of public firms. All the variable constructions are described in Appendix B. All the regression models are estimated The dependent variable investment  $I_{i,t}$  in model (1) to (3) is Capx/K, which is Capital Expenditures scaled by the beginning-of-period capital, the private firm belongs to. We also control for private firm's own lagged Ln(Asset) and CashFlow, and the average value of all private peers, 10%, 5%, and 1% levels are marked with \*, \*\*, and \*\*\*, respectively.

1

	$\begin{array}{c} (1) \ Capx/K \end{array}$	Capx/K	${(3)} Capx/K$	$\overset{(4)}{\Delta K}$	(5) $\Delta K$	(6) $\Delta K$
$Industry\_Q_{i,t}$	$0.028^{***}$ (3.33)	$0.024^{***}$ (3.22)	$0.022^{***}$ (3.11)	$0.030^{**}$ (2.59)	$0.021^{**}$ (2.07)	$0.018^{*}$ (1.91)
$CashFlow_{i,t-1}$		$0.629^{***}$ $(18.20)$	$0.625^{***}$ (18.03)		$0.665^{***}$ (19.72)	$0.656^{***}$ (19.37)
$Ln(Asset)_{i,t-1}$		$-0.156^{***}$ (-13.01)	$-0.159^{***}$ (-13.87)		$-0.269^{***}$ (-18.72)	$-0.271^{***}$ (-19.45)
Year FE Firm FE Other Controls	$\begin{array}{c} {\rm Yes} \\ {\rm Yes} \\ {\rm No} \end{array}$	$\begin{array}{c} \mathrm{Yes} \\ \mathrm{Yes} \\ \mathrm{No} \end{array}$	$\begin{array}{c} \mathrm{Yes} \\ \mathrm{Yes} \\ \mathrm{Yes} \end{array}$	$\begin{array}{c} {\rm Yes} \\ {\rm Yes} \\ {\rm No} \end{array}$	$\begin{array}{c} {\rm Yes} \\ {\rm Yes} \\ {\rm No} \end{array}$	$\begin{array}{c} {\rm Yes} \\ {\rm Yes} \\ {\rm Yes} \end{array}$
Obs. $Adj.R^2$	$69,962 \\ 0.193$	$64,748 \\ 0.220$	$64,747 \\ 0.220$	$109,154 \\ 0.021$	$97,400\ 0.052$	97,399 $0.053$

Investment
$\operatorname{Firms}$
Private
and
Residuals
Valuation
Industry
able 3:

This table presents the results from estimating Equation (22) for private firms as shown below:

 $I_{i,t} = \alpha + \beta \times Residual\_Industry\_Q_{i,t} + \lambda \times Residual\_CashFlow_{i,t} + \varphi \times Industry\_CashFlow_{i,t} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t} + \delta_t + \epsilon_{i,t} + \delta_t + \epsilon_{i,t} + \delta_t + \delta_$ 

Industry- $Q_{i,t}$  on the Industry- $CashFlow_{i,t}$ , which is the contemporaneous industry average cash flow. Residual-CashFlow\_{i,t} is the residual from regressing  $CashFlow_{i,t-1}$  on  $Industry_{-}CashFlow_{i,t}$ . We also control for private firm's own lagged Ln(Asset) and CashFlow, and the The dependent variable investment  $I_{i,t}$  in model (1) to (3) is Capx/K, which is Capital Expenditures scaled by the lagged capital, and in model (4) to (6) is  $\Delta K$ , which is the annual change of capital scaled by the lagged capital. Residual Industry- $Q_{i,t}$  is residual from regressing average value of all private peers, and that of public firms. All the variable constructions are described in Appendix B. All the regression models are estimated with firm-fixed effects and year-fixed effects. t-statistics in parentheses are adjusted using the Huber-White estimator allowing within industry clusters. Coefficients significant at the 10%, 5%, and 1% levels are marked with \*, \*\*, and \*\*\*, respectively.

		~~~	101	~ ~ ~	11	
	(1)	(2)	(3)	(4)	(2)	(9)
	Capx/K	Capx/K	Capx/K	$\Delta K$	$\Delta K$	$\Delta K$
						-
$Residual\_Industry\_Q_{i,t}$	$0.025^{***}$	$0.022^{***}$	$0.022^{***}$	$0.027^{**}$	$0.019^{*}$	$0.018^{*}$
	(2.67)	(2.88)	(2.91)	(2.06)	(1.76)	(1.80)
$Residual\_CashFlow_{i,t}$	$0.481^{***}$	$0.289^{***}$	$0.288^{***}$	$0.593^{***}$	$0.330^{***}$	$0.332^{***}$
- K -	(12.62)	(9.11)	(9.05)	(13.27)	(8.99)	(9.06)
$Industry\_CashFlow_{i,t}$	$0.826^{***}$	$0.473^{***}$	$0.452^{***}$	$1.179^{***}$	$0.727^{***}$	$0.580^{***}$
•	(6.15)	(4.26)	(4.48)	(7.71)	(5.52)	(4.31)
$CashFlow_{i,t-1}$		$0.538^{***}$	$0.536^{***}$		$0.544^{***}$	$0.540^{***}$
		(16.43)	(16.39)		(16.12)	(15.93)
$Ln(Asset)_{i.t-1}$		$-0.146^{***}$	$-0.149^{***}$		$-0.259^{***}$	$-0.261^{***}$
		(-11.94)	(-12.72)		(-17.37)	(-17.93)
Year FE	Yes	$\mathbf{Yes}$	$\mathbf{Yes}$	$\mathbf{Yes}$	$\mathbf{Y}_{\mathbf{es}}$	$\mathbf{Yes}$
Firm FE	$\mathbf{Yes}$	${ m Yes}$	${ m Yes}$	$\mathbf{Yes}$	$\mathbf{Yes}$	${ m Yes}$
Other Controls	$N_{O}$	No	$\mathbf{Y}_{\mathbf{es}}$	No	No	$\mathbf{Yes}$
Obs.	69.933	64.733	64.732	108.981	97.357	97.356
$Adj.R^2$	0.203	0.223	0.223	0.030	0.054	0.055

# Table 4: Minor-Segment Industry Valuation and Private Firms' Investment

This table presents the results from estimating Equation (23) for private firms as shown below:

$$I_{i,t} = \alpha + \beta \times Minor\_Leader\_Q_{i,t} + \sum_{k=1}^{K} \zeta_k \times Major\_Q_{i,t-k} + \lambda \times CashFlow_{i,t-1} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t}$$

variable  $Minor-Leader_{Q_{i,t}}$  in model (1) to (3) is the average beginning-of-period market-to-book of all minor-segment industry leaders for the two-digit SIC industry that the private firm belongs to; in model (4) to (6) is the Minor Industry- $Q_{i,t}$ , which is the average beginning-of-period and industry pure players' valuation for up to 2 lags in column (3) and (6). All the variable constructions are described in Appendix B. All the regression models are estimated with firm-fixed effects and year-fixed effects. t-statistics in parentheses are adjusted using the Huber-White The dependent variable investment  $I_{i,t}$  is Capx/K, which is Capital Expenditures scaled by the lagged capital. The primary independent market-to-book of all minor-segment industries for a two-digit SIC industry that the private firm belongs to. We control for private firm's own lagged Ln(Asset) and CashFlow, and the average value of all private peers, and that of public firms. We also control for the industry leaders' estimator allowing within industry clusters. Coefficients significant at the 10%, 5%, and 1% levels are marked with \*, \*\*, and \*\*\*, respectively.

	$\begin{array}{c} (1) \ Capx/K \end{array}$	(2) Capx/K	$\begin{array}{c} (3) \\ Capx/K \end{array}$	$(4) \ Capx/K$	(5) Capx/K	(6) Capx/K
$Minor\_Leader\_Q_{i,t}$	$0.008^{**}$ (2.56)	$0.007^{**}$ $(2.31)$	$0.007^{**}$ (2.13)			
$Minor\_Industry\_Q_{i,t}$				$0.016^{**}$ $(2.01)$	$0.014^{*}$ (1.84)	$0.011 \\ (1.53)$
$CashFlow_{i,t-1}$	$0.637^{***}$ (16.43)	$0.627^{***}$ (16.83)	$0.626^{***}$ (16.82)	$0.630^{***}$ (16.58)	$0.620^{***}$ (16.70)	$0.619^{***}$ (16.69)
$Ln(Asset)_{i,t-1}$	$-0.146^{**}$ (-10.39)	$-0.149^{**}$ (-11.48)	$-0.149^{**}$ (-11.48)	$-0.150^{**}$ (-10.23)	$-0.153^{***}$ (-11.21)	$-0.153^{***}$ (-11.19)
Year FE Firm FE	${ m Yes}{ m Yes}$	${ m Yes}{ m Yes}$	${ m Yes}{ m Yes}$	${ m Yes}{ m Yes}$	${ m Yes}{ m Yes}$	${ m Yes}$
Other Controls $Major-Q_{i,t-k}$	No No	${ m Yes}_{ m No}$	${ m Yes}{ m Yes}$	No No	${ m Yes}_{ m No}$	${\rm Y}_{\rm es}^{\rm Y}$
Obs. $Adj.R^2$	$rac{45}{0.221}$	$rac{45}{0.222}$	$rac{45}{0.222}$	$rac{46,773}{0.219}$	46,773 0.220	$\frac{46,773}{0.220}$

Table 5:	Random Irrelev	vant Industry V	aluation and Pr	ivate Firms' In	ivestment	
This table presents the resul	ts from estimating E	quation (24) for priva	tte firms as shown be	low:		
$I_{i,t} = \alpha + \beta >$	< Random_Leader_Q	$_{i,t} + \sum_{k=1}^{K} \zeta_k \times Major_{-1}$	$Q_{i,t-k} + \lambda \times CashFl$	$ow_{i,t-1} + \theta  imes X_{i,t-1}$	$1+\kappa_i+\delta_t+\epsilon_{i,t}$	
Each minor-segment industr, industry that does not belong	y used to estimate E. g to the minor-segmen	quation (23) is replac it industries nor share	ed by a randomly sel e any minor-segment i	lected irrelevant ind industries with the n	ustry, that is, an tw aajor-segment indus	o-digit SIC try leaders.
The dependent variable invevariable $Random\_Leader\_Q_i$	sstment $I_{i,t}$ is $Capx_{/}$ $i_{,t}$ in model (1) to (3)	K, which is Capital is the average begin	Expenditures scaled ning-of-period marke	by the lagged capi t-to-book of all lead	tal. The primary in lers in the "random	adependent irrelevant" 6 · · ·
industries that are selected in market-to-book of the "rand and <i>CashFlow</i> , and the aver	tor the private hrm; om irrelevant" indust rage value of all priva	in model (4) to (6) is ries that are selected te peers, and that of i	s the <i>Kandom_Indus</i> for the private firm. <sup>1</sup> public firms. We also	$ttry_{-}Q_{i,t}$ , which is t We control for prival control for the indu	he average beginnin te firm's own lagged strv leaders' and inc	ıg-ot-perıod Ln(Asset) lustry pure
players' valuation for up to 2 with firm-fixed effects and y 95% confidence intervals are	lags in column (3) a: ear-fixed effects. The included in brackets	nd (6). All the variab reported estimates a and coefficients are n	le are described in A <sub>I</sub> are the cross-simulatic narked with *** if 95	ppendix B. All the r m average of the co % confidence interv	egression models ar efficients from 500 s als do not span zerc	e estimated imulations.
	$(1) \ Capx/K$	$(2) \ Capx/K$	$^{(3)}_{Capx/K}$	$^{(4)}_{Capx/K}$	${(5)}\ Capx/K$	(6) Capx/K
$Random\_Leader\_Q_{i,t}$	-0.0001 [-0.0007, 0.0004]	-0.0001 [-0.0006, 0.0004]	-0.00026 [-0.0008, 0.0003]			
$Random\_Industry\_Q_{i,t}$				$-0.0015^{***}$ [-0.002, -0.001]	-0.0016*** [-0.002, -0.001]	$-0.0019^{***}$ [ $-0.003, -0.001$ ]
$CashFlow_{i,t-1}$	$0.644^{***}$ [0.644, 0.645]	$0.636^{***}$ [0.636, 0.036]	$0.622^{***}$ [0.622, 0.622]	$0.645^{***}$ [0.644, 0.646]	$0.637^{***}$ [0.637, 0.638]	$0.623^{***}$ $[0.623, 0.624]$
$Ln(Asset)_{i,t-1}$	-0.147*** [-0.147, -0.147]	$-0.149^{***}$ [-0.149, -0.149]	-0.145*** [-0.145, -0.145]	$-0.147^{***}$ [-0.147, -0.147]	$-0.149^{***}$ [ $-0.149, -0.149$ ]	-0.146*** [-0.146, -0.146]
Year & Firm FE Other Controls $Major_Q_{i,t-k}$	Yes No No	Yes Yes No	Yes Yes Yes	Yes No No	Yes Yes No	$\begin{array}{c} \mathrm{Yes} \\ \mathrm{Yes} \\ \mathrm{Yes} \end{array}$
Obs. $Adj.R^2$	56,296 $0.225$	56,296 $0.225$	51,338 $0.226$	55,303 $0.225$	55,302 $0.226$	50,468 0.226

### Table 6: Robustness Tests

This table presents the results from estimating Equation (23) for private firms that are economically unlinked to the industry leaders. In panel A, we first exclude the firm-year observations if a private firm share one or more minor-segment industries with the industry leaders in that year (results are presented in column (1) and (2)), and then exclude the private firms if they share one or more minor-segment industries with the industry leaders in any time over the sample period (results are presented in column (3) and (4)). In panel B, we first exclude the minor-segment industries shared by industry leaders and the private firms in the industry leaders' majorsegment industries (results are presented in column (5) and (6)), and then exclude the minor-segment industries that potentially have supplier or customer relationship with the major-segment industries (results are presented in column (7) and (8)). We define private firms' segments as secondary SIC industries reported in the private firm's accounts. Supplier and customer industries are defined using the 2012 U.S. Input-Output Tables provided by the Bureau of Economic Analysis. The dependent variable investment  $I_{i,t}$  is Capx/K, which is Capital Expenditures scaled by the lagged capital. The primary independent variable  $Minor\_Leader\_Q_{i,t}$  in column (1), (3), (5) and (7) is the average beginning-of-period market-to-book of all minor-segment industry leaders for the two-digit SIC industry that the private firm belongs to; in column (2), (4), (6) and (8) is the Minor\_Industry\_Q<sub>i,t</sub>, which is the average beginning-of-period market-to-book of all minor-segment industries for a two-digit SIC industry that the private firm belongs to. We control for private firm's own lagged Ln(Asset) and CashFlow, and the average value of all private peers, and that of public firms. All the variable constructions are described in Appendix B. All the regression models are estimated with firm-fixed effects and year-fixed effects. t-statistics in parentheses are adjusted using the Huber-White estimator allowing within industry clusters. Coefficients significant at the 10%, 5%, and 1% levels are marked with \*, \*\*, and \*\*\*, respectively.

Fallel A. Excluding pot		linked observations		
	Excluding p	rivate firm-years	Excluding	; private firms
	sharing th	ne same minor	sharing th	e same minor
	segments with	n industry leaders	segments with	n industry leaders
	(1)	(2)	(3)	(4)
	Capx/K	Capx/K	Capx/K	Capx/K
Minor_Leader_Q <sub>i</sub> +	0.009***		$0.007^{*}$	
	(2.63)		(1.78)	
Minor Industry Q <sub>i</sub> ,		$0.015^{*}$		0.022***
<u> </u>		(1.92)		(2.66)
$CashFlow_{i t-1}$	0.634***	0.625***	0.625***	0.612***
	(15.58)	(15.51)	(14.27)	(14.36)
$Ln(Asset)_{i \ t=1}$	-0.151***	-0.155***	-0.144***	-0.149***
	(-10.87)	(-10.65)	(-10.75)	(-10.12)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes	Yes
$Major_{-}Q_{i,t-k}$	No	No	No	No
Obs.	42,275	43.802	37.183	38.491
$Adj.R^2$	0.222	0.220	0.216	0.216

Panel A. Excluding potential economic linked observation

	Excluding n	ninor-segment	Excluding n	ninor-segment
	industries	s shared by	industries i	n supplier or
	private firm	s and leaders	customer	industries
	(1)	(2)	(3)	(4)
	Capx/K	Capx/K	Capx/K	Capx/K
Minor_Leader_Q <sub>i</sub> t	0.009**		0.007**	
• • • • •	(2.47)		(2.22)	
Minor_Industry_Q; +		0.019**		0.016**
$o = v_i, v_i$		(2.23)		(2.02)
$CashFlow_{i,t-1}$	0.632***	$0.664^{***}$	0.625***	0.620***
0,0 1	(13.46)	(15.90)	(16.47)	(16.70)
$Ln(Asset)_{i \ t-1}$	-0.157***	-0.169***	-0.147***	-0.153***
( ),,,, 1	(-15.51)	(-12.65)	(-11.46)	(-11.21)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Other Controls	Yes	Yes	Yes	Yes
$Major_Q_{i,t-k}$	No	No	No	No
Obs.	42,198	36,253	45,055	46,773
$Adj.R^2$	0.228	0.228	0.221	0.220

Panel B. Excluding potential economic linked minor-segment industries

Table 7: Private Firms' Invest This table presents the results from estimating Equatio with the measures for <i>informativeness</i> of firm <i>i</i> 's ind is Capital Expenditures scaled by the beginning-of-peri of public firms in the three-digit SIC industry that the defined in Table 3. We also control for private firm's o as the average value of public firms. Measures for $Info$ number of public firms of the industry is above the 70t of number of public firms to all firms in a three-digit SI of a three-digit SIC industry is above the 70th percent described in Appendix B. All the regression models an adjusted using the Huber-White estimator allowing wi with *, **, and ***, respectively.	ment and (2) and (2) $(21)$ and (2) $(21)$ and (2) $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$ $(21)$	the Informa the Informa 2) adding an interice at the begin ndustry- $Q_{i,t}$ is the belongs to, and $J_{u}$ h(Asset) and $Ca$ , include: (i) $H_{-\#}$ and equals to 0 i and (iii) H_Nonsy and (iii) H_Nonsy ls to 0 if it is bel with firm-fixed ef- clusters. Coeffici	tiveness of 1 action term of 1 ing-of-period. ' in a verage of the <i>Residual_Indus</i> <i>shFlow</i> , and the <i>Public</i> , a dumn <i>Public</i> , a dumn <i>f</i> it is below the achronisity, a dh ow the 30th per- fects and year-f ents significant	<b>industry Sto</b> <i>industry-Q<sub>i</sub></i> , (o) The dependent v = beginning-of-pe <i>try-Q<sub>i</sub></i> , <i>t</i> is the in <i>try-Q<sub>i</sub></i> , <i>t</i> is the in = average value o ny equals to 1 if 30th percentile; immy equals to 1 intred effects. t-st ixed effects. t-st at the 10%, 5%,	ck Price r Residual_Indu ariable is Capx, ariable is Capx, dustry valuation of all private pee the logarithm of the logarithm of (ii) % Public, th (ii) % Public, th 1 if the Nonsync variable constru atistics in paren and 1% levels a	$stry-Q_{i,t}$ ) $\langle K$ , which book ratio $\iota$ residuals rs, as well 1 plus the the fraction hronisity ctions are theses are the marked
Informativeness Measures:	I#-H	$\circ_{ublic}$	% P1	ublic	H_Nonsyn	chronisity
	$\begin{array}{c} (1) \ Capx/K \end{array}$	(2) Capx/K	$^{(3)}_{Capx/K}$	$^{(4)}_{Capx/K}$	Capx/K	$^{(6)}_{Capx/K}$
$Industry_{-}Q_{i,t}$	0.011 (1.04)		0.010 (1.25)		$0.021^{*}$ (1.93)	
$Industry\_Q_{i,t} \times Informativeness_{i,t-1}$	$0.047^{***}$ (3.32)		$0.111^{**}$ (2.29)		$0.029^{**}$ (2.12)	
$Residual\_Industry\_Q_{i,t}$		0.013 (1.22)		0.010 (1.24)		$0.020^{*}$ $(1.83)$
$Residual\_Industry\_Q_{i,t} \times Informativeness_{i,t-1}$		$0.047^{***}$ (3.20)		$0.108^{**}$ (2.16)		$0.030^{**}$ $(2.24)$
Year FE Firm FE Other Controls	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	$\begin{array}{c} {\rm Yes} \\ {\rm Yes} \\ {\rm Yes} \end{array}$
Obs. $Adj.R^2$	$35,194 \\ 0.230$	$35,187 \\ 0.234$	64,696 0.220	64,681 0.223	$35,810\ 0.228$	$35,819 \\ 0.225$

This table presents the results from estimating Eq with the measures for the <i>competitiveness</i> of firm Expenditures scaled by the beginning-of-period $ci$ firms in the three-digit SIC industry that the pri- in Table 3. We also control for private firm's own average value of public firms. Measures for <i>comp</i> of 1 plus the number of all firms of the industry a dummy equals to 1 if $HHI$ in a three-digit SI and (iii) $L$ - $Top4$ - $Shares$ , a dummy which equals percentile, and equals to 0 if it is above the 70th models are estimated with firm-fixed effects and allowing within industry clusters. Coefficients sig	uation (21) an usion (21) an i's industryat vate firm belo i lagged $Ln(A)i$ lagged $Ln(A)is above the 7is above the 7is to 1 if the mi$ percentile. A vear-fixed effe nificant at the	d (22) adding an t the beginning- $ry_{Q_{i,t}}$ is the aw- ngs to, and <i>Res</i> <i>sset</i> ) and <i>Cash.</i> f the industry ii f the industry ii f the industry and <i>Cash.</i> below the 30th arket share of t will the variable of the variable of the variable of the variable of the variable of the variable of the variable of the variable of the variable of the variable of the variable of the vari	interaction terr of-period. The d srage of the beg $idual\_Industry$ . Flow, and the a and equals to 0 percentile, and ne top 4 firms i constructions ar in parentheses % levels are ma	n of $Industry-Q_i$ lependent variabl inning-of-period $Q_{i,t}$ is the indus verage value of $\varepsilon$ verage value of $\varepsilon$ if it is below th equals to 0 if ii equals to 0 if ii a three-digit S e described in A are adjusted usi urked with *, **,	(t) (or Residual.) te is $Capx/K$ , wimarket-to-book try valuation result private peers, iy equals to 1 if a 30th percentile is above the 7( is above the 7( IC industry is b ppendix B. All ng the Huber-W and ***, respect	Industry- $Q_{i,t}$ ) hich is Capital ratio of public siduals defined as well as the the logarithm the logarithm $(ii) L_{-}HHI,$ 0th percentile; below the 30th the regression hite estimator tively.
Competitive Industry Measures:	<i>H−#F</i>	irms	$L_{-}E$	IHI	$L_Top4$	Shares
	$\begin{array}{c} (1) \\ Capx/K \end{array}$	(2) Capx/K	Capx/K	Capx/K	Capx/K	(6) Capx/K
$Industry\_Q_{i,t}$	0.002 (0.18)		$0.017^{*}$ (1.81)		0.011 (1.30)	
$Industry$ - $Q_{i,t}  imes Competitive_{i,t-1}$	$0.038^{***}$ (2.90)		$0.022^{*}$ $(1.77)$		$0.027^{**}$ (2.16)	
$Residual Jndustry-Q_{i,t}$		0.001 (0.09)		$0.018^{*}$ (1.96)		0.013 (1.43)
$Residual Industry_Q_{i,t} \times Competitive_{i,t-1}$		$0.041^{***}$ (2.98)		0.021 (1.60)		$0.026^{**}$ (1.99)
Year FE Firm FE Other Controls	Yes Yes Yes	$\begin{array}{c} \mathrm{Yes} \\ \mathrm{Yes} \\ \mathrm{Yes} \end{array}$	$\begin{array}{c} {\rm Yes} \\ {\rm Yes} \\ {\rm Yes} \end{array}$	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Obs. $Adj.R^2$	35,986 $0.045$	35,977 $0.236$	40,087 0.228	40,078 0.232	39,144 $0.225$	39,136 $0.229$

Table 8: Private Firms' Investment and Industry Common Shocks

### Table 9: Comparison of Public and Private Firms on Matched Sample

This table presents the results from estimating Equation (25) for matched sample of private and public firms:

### $Y_{i,t} = \alpha + \beta \times Industry\_Q_{i,t} + \beta_2 \times Industry\_Q_{i,t} \times Public_i + \lambda \times CashFlow_{i,t-1} + \theta \times X_{i,t-1} + \kappa_i + \delta_t + \epsilon_{i,t} + \delta_t + \epsilon_{i,t} + \delta_t + \delta_t$

The dependent variable in model (1) is Capx/K, which is Capital Expenditures scaled by lagged capital, in model (2) is  $\Delta K$ , which is the annual change of capital scaled by lagged capital, in model (3) is Equity Issue, which is the annual change of Book Equity minus the annual change of Retained Earnings, scaled by lagged capital, and in model (4) is *Debt Issue*, which is the annual change of Book Debt, scaled by lagged capital. Thus, the financing variables are defined with balance sheet items. The main independent variable  $Industry_Q_{i,t}$  is the average of the beginning-of-period market-to-book ratio of public firms in the three-digit SIC industry, and its interaction with the dummy *Public* which equals to 1 if it is a public firm and 0 if private. We also control for public firm's own beginning market-to-book, private firm's own lagged Ln(Asset) and CashFlow and their interactions with Public. All the variable constructions are described in Appendix B. We use caliper-based nearest-neighbor match adapted to a panel setting following Asker, Farre-Mensa and Ljungqvist (2014). Stating from 1993, we match private firms with public firms from the same three-digit industry and closest in size. We require that the ratio of their total assets is less than 2. If no match can be formed, we drop the observation and look for a match in the following year. Once a match is found, it is kept in subsequent years to ensure the panel structure of the data. All the regression models are estimated with firm-fixed effects and year-fixed effects. t-statistics in parentheses are adjusted using the Huber-White estimator allowing within firm clusters. Coefficients significant at the 10%, 5%, and 1% levels are marked with \*, \*\*, and \*\*\*, respectively.

	Investment		Financing	
	(1)	(2)	(3)	(4)
	Capx/K	$\Delta K$	Equity Issue	Debt Issue
$Industry\_Q_{i,t}$	$0.024^{***}$ (3.87)	$0.019^{**}$ (2.30)	$0.029^{***}$ (4.33)	$0.028^{*}$ (1.66)
$Industry_Q_{i,t} \times $ Public	$\begin{array}{c} 0.001 \\ (0.08) \end{array}$	$0.094^{***}$ (3.32)	$0.083^{*}$ (1.87)	$-0.045^{**}$ (-2.19)
$Own\_Q_{i,t}$	$0.036^{***}$ (9.22)	$0.191^{***}$ (8.13)	$0.250^{***}$ (6.71)	$0.070^{***}$ (5.82)
$CashFlow_{i,t-1}$	$0.626^{***}$ (20.12)	$0.688^{***}$ (18.90)	$-0.195^{***}$ (-6.22)	$0.477^{***}$ (5.88)
$Ln(Asset)_{i,t-1}$	$-0.158^{***}$ (-17.61)	-0.305*** (-27.61)	-0.085*** (-9.89)	-0.389*** (-16.91)
$CashFlow_{i,t-1} \times$ Public	-0.396*** (-9.17)	$0.150 \\ (0.87)$	-0.257 (-0.93)	-0.082 (-0.70)
$Ln(Asset)_{i,t-1} \times $ Public	$0.089^{***}$ (8.83)	$0.018 \\ (0.62)$	$-0.253^{***}$ (-6.03)	$0.262^{***}$ (9.92)
Constant	$\begin{array}{c} 0.524^{***} \\ (19.88) \end{array}$	$\begin{array}{c} 0.777^{***} \\ (16.89) \end{array}$	$0.286^{***}$ (4.01)	$0.887^{***}$ (10.28)
Obs. $Adj.R^2$	$52,111 \\ 0.244$	$77,092 \\ 0.076$	$77,333 \\ 0.116$	$77,361 \\ 0.001$