Investment and operating strategies of public and private firms: Theory and evidence*

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Abstract

We examine theoretically and empirically potential determinants of investment and operating strategies of public and private firms that are controlled by imperfectly diversified owners. In particular, we demonstrate theoretically and confirm empirically that due to arguably more severe financial constraints that private firms face, the effects on them of factors such as the diversification of controlling owners' portfolios and the uncertainty regarding demand for firms' output are dramatically different from the effects on public ones. For example, public firms' controlling shareholders' diversification is positively related to their investment and profitability ratios, while the opposite relations are observed for private firms. Our theoretical and empirical results suggest that the differences between public and private firms' external financing costs are partially responsible for the observed relations between firms' mode of incorporation and their investment and operating strategies and outcomes.

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1 Introduction

Private firms are different from public ones. A small but growing literature examines the differences between public and private firms' financial, investment, and operating strategies. Brav's (2009) and Asker, Farre-Mensa and Ljungqvist (2011b) find that private firms have higher leverage ratios than public firms, while Saunders and Steffen (2011) document that privately-held firms face higher borrowing costs than publicly-traded ones. Asker, Farre-Mensa and Ljungqvist (2011a,b) and Sheen (2009) report that private firms invest more than public ones. Brav (2009) finds that private firms have higher return on assets (ROA) than public ones, while Faccio, Marchica, McConnell and Mura (2012) document that private firms have higher return on equity (ROE) than public firms.[1] Michaely and Roberts (2012) report that public firms tend to use more dividend smoothing than private ones.

One important reason for firm owners to take their firms public is their desire to reduce financial constraints and obtain cheaper access to external funds (e.g., Pagano, Panetta and Zingales (1998), Derrien and Kecskés (2007), Hsu, Reed and Rocholl (2010) and Schenone (2010)). In this paper we examine theoretically and empirically whether the lower costs of obtaining external financing by public firms relative to those of private ones are partially responsible for the differences between public and private firms' investment and operating strategies.

One element that is crucial in an analysis of private and public firms' strategies is imperfect diversification of portfolios of firms' controlling shareholders. Faccio, Marchica and Mura (2011) report that the vast majority of controlling owners of private as well as public firms hold portfolios that are underdiversified, a finding that we corroborate in our analysis. Similarly, Moskowitz and Vissing-Jørgensen (2002) find that most owners of private firms' are not well diversified: about three-fourths of all private equity is owned by individuals for whom such investment constitutes at least half of their total net worth. In addition, according to Heaton and Lucas (2004) and Asker, Farre-Mensa and Ljungqvist (2011a,b), private firm owners hold the majority of their firms' equity, suggesting lack of diversification.

The degree of diversification of a firm's controlling owner's portfolio has important implications for the firm's investment and operating strategies (e.g., Rothschild and Stiglitz (1971), Shah and Thakor (1988), and Chod and Lyandres (2011)). The reason is that the less well diversified the controlling owner of a firm is, the more she is concerned with profit (or cash flow) variability. For example, Faccio, Marchica and Mura (2011) find that lower diversification of a firm's controlling owner's portfolio is associated with lower risk taking, as measured by the variability of the firm's

[1] There is also a large literature documenting a decline in profitability following IPOs (e.g., Jain and Kini (1994), Mikkelson, Partch and Shah (1995), and Loughran and Ritter (1997)).

ROA. Two natural ways for a firm to reduce its profit variability are to pursue a less aggressive investment strategy (i.e. curb investment) and/or to pursue a less aggressive operating and pricing strategies (i.e. reduce output and charge higher prices). In other words, firms controlled by owners whose portfolios are better diversified are expected to invest more and/or to produce higher output. Similarly, uncertainty regarding the demand for a firm's product affects the firm's optimal investment and operating strategies. In particular, firms that operate in a more uncertain environment are expected to invest less and produce lower output.

In order to examine whether financial constraints are responsible to some degree for the differences in public and private firms' operating and investment strategies, we build a simple model in which a partially financially constrained firm operates under uncertainty regarding the demand for its output and is controlled by a risk-averse and imperfectly diversified owner. The owner maximizes her utility by making two interrelated choices. The first one is the firm's investment strategy, in particular the amount to be invested in a cost-reducing technology using internal and potentially external financing. The second one is the firm's operating policy, i.e. determination of the firm's output quantity and the resulting equilibrium output price.

The model results in testable empirical implications regarding the effects of controlling owner's diversification and of demand uncertainty on two observable variables driven by a firm's investment and operating choices – investment-to-assets ratio and profit margin. Importantly, the effects on the outcomes of a firm's investment and operating choices depend crucially on the degree of financial constraints that the firm faces. In particular, investment rate and profitability of relatively unconstrained firms is shown to be increasing in their controlling owners' portfolio diversification and to be decreasing in demand uncertainty surrounding them, while these relations are reversed for relatively constrained firms. The intuition is that financial constraints alter the way in which firms can respond to changes in their owners' diversification or in demand uncertainty. Relatively unconstrained firms, controlled by well diversified owners, and firms that face low demand uncertainty choose to invest more in a cost-reducing technology than firms whose owners are not as well diversified and those that face higher uncertainty, resulting in higher investment-to-asset ratios and profit margins of the former.[2] On the other hand, relatively constrained firms, for which financing additional capital investment using external sources may be too costly, respond to higher owner's portfolio diversification or lower demand uncertainty by increasing output quantities, leading to lower equilibrium output prices and lower profit margins. In addition, increased output quantities lead to higher asset base and potentially

[2] Relatively unconstrained firms also optimally respond to higher controlling owner's diversification and lower demand uncertainty by choosing higher output, which adversely affects equilibrium profit margins. However, this effect is second-order relative to the effect of higher investment on profit margins.

lower investment-to-assets ratios.

These differences between the effects of controlling shareholder's portfolio diversification and demand uncertainty on relatively constrained and unconstrained firms' optimal investment and operating choices may be partially responsible for the differences between observed investment and operating strategies and outcomes of public and private firms. The reason is that public firms are likely to face lower information asymmetry than private ones (e.g., Benveniste and Spindt (1989), Dow and Gorton (1997), and Derrien and Kecskés (2007)), which lowers the costs of external financing (e.g., Myers and Majluf (1984) and Fazzari, Hubbard and Petersen (1988) among many others). Thus, examining the relations between controlling owner's diversification and demand uncertainty on one hand and the outcomes of firms' investment and operating strategies on the other hand, and analyzing the differences between these relations for (relatively unconstrained) public firms and (relatively constrained) private firms sheds light on how crucial the firm's mode of incorporation is for its investment and operating choices.

We examine these relations empirically using Bureau Van Dijk's Amadeus Top 250,000 database, which contains comprehensive accounting and ownership data for over half a million firm-year observations from 34 European countries over the period 1999-2010. The advantage of using European data is that most European countries require private companies to disclose their financial information on an annual basis. This allows us to exploit a very rich database that contains a large fraction of the population of European private and public firms. Further, the role played by private companies in the European market is crucial. We estimate that at the end of 2009 privately-held companies were responsible for almost 72% of the total investment in fixed assets of all European non-financial firms, and they generated almost 73% of the total revenues of all European non-financial companies.[3]

Using these data we are able to construct measures of investment and profitability for public and private firms, identify public and private firms' controlling owners, and compute measures of controlling owners' portfolio diversification and of demand uncertainty facing the firms. Our empirical results show that the effects of controlling shareholders' diversification and demand uncertainty on public firms' investment and operating strategies are vastly different from the effects on the strategies of private firms. In particular, consistent with the model's predictions, public firms' investment-to-assets ratio and profitability are increasing in their owners' portfolio diversification and are decreasing in demand uncertainty, while these relations are reversed for private firms.

[3] Asker, Farre-Mensa and Ljungqvist (2011a) document that private companies play an important role in the US market as well, accounting for almost 55% of aggregate non-residential fixed investment and almost 58% of sales. Further, Faccio, Marchica and Mura (2011) report that, worldwide, employment by non-publicly traded firms is approximately 86% of total non-government employment.

We perform a battery of tests to examine the robustness of our main results. First, we demonstrate that our empirical findings are not driven by selection of firms into public and private modes of incorporation and into disclosing accounting information. Second, our results are not driven by the possible separation of firm ownership and control. Third, we show that the results are robust to controlling for potential measurement errors in our portfolio diversification proxies.

To summarize, our theoretical and empirical results demonstrate that one of the important reasons for the observed differences between public and private firms' strategies and outcomes is the imperfect diversification of firm owners' portfolios coupled with the potential access by public firms to cheaper external financing. The remainder of the paper is organized as follows. The next section describes the model of optimal investment and operating choices of firms with varying degrees of financial constraints, and summarizes the empirical predictions following from the model. Section 3 describes the data. In Section 4 we discuss our empirical methods, tests, and results. Section 5 concludes. All proofs are found in the Appendix.

2 Model

2.1 The controlling owner

We consider a situation in which a controlling owner of a firm is imperfectly diversified. In particular, we assume that she owns a proportion η of the firm she controls and in addition, she invests an amount x in an imperfectly diversified portfolio with a normally distributed return R_p, whose mean is $\mathbb{E}R_p$ and whose standard deviation is σ_p.[4] We assume that the controlling owner is risk-averse and that she maximizes the expected utility of her terminal wealth, w. This utility is given by

$$u(w) = a^{-1} - a^{-1}\exp(-aw), \tag{1}$$

where $a = u''/u'$ is the investor's Arrow-Pratt coefficient of absolute risk aversion. Assuming that, similar to the returns of the owner's portfolio, her wealth that is due to ownership of the firm (to be discussed below) is normally distributed as well, investor's expected utility maximization simplifies into the mean-variance criterion:

$$\mathbb{E}u(w) = \mathbb{E}w - \frac{a}{2}\sigma^2(w). \tag{2}$$

[4] σ_p is clearly decreasing in the number of stocks in the investor's portfolio, n_p, and in the correlation among their returns, ρ_p. Because of these monotonic relations, we consider σ_p a deep parameter of the model, while our proxies for σ_p in the empirical tests are based on n_p and ρ_p.

2.2 The firm

The inverse demand for a firm's product is given by

$$p(q) = \alpha - \beta q, \tag{3}$$

where $p(q)$ is the product's price and q is the quantity of the product supplied. The intercept of the demand function, α, is stochastic. We assume that it is normally distributed with mean μ and standard deviation s. β determines the elasticity of the demand for the firm's product: low β corresponds to a price-taking firm, while high β corresponds to an oligopolistic competition environment.

The firm's marginal cost of production is assumed constant. The total cost of producing q units of output, $C(q)$, equals

$$C(q) = \left(c - \delta\sqrt{K}\right) q, \tag{4}$$

where c is the "benchmark" marginal cost, which can be reduced by investing capital, K, whose unit cost is assumed one without loss of generality, into a cost-reducing technology. The efficiency of the cost-reducing technology is determined by the "investment efficiency" parameter, δ.

The firm is endowed with initial capital, W. In addition, the firm can raise external funds to be used for expanding capital. We denote the proportional deadweight cost of raising one dollar of external capital as f. $f = 0$ corresponds to a completely unconstrained firm, while $f \to \infty$ corresponds to a completely constrained firm. The firm's overall capital, K, equals, thus, the sum of its endowment, W, and capital financed by externally raised funds, $I \geq 0$. Combining (3), (4), and (**??**), the firm's profit is given by

$$\pi = (\alpha - \beta q)\, q - \left(c - \delta\sqrt{W + I}\right) q - (W + I) - fI. \tag{5}$$

Assuming that the firm's investment and production decisions (i.e. the choices of I and q) are made before the realization of the demand shock, the firm's profit is normally distributed with mean, $\mathbb{E}\pi$, and standard deviation, $\sigma(\pi)$, given by

$$\mathbb{E}\pi = (\mu - \beta q)\, q - \left(c - \delta\sqrt{W + I}\right) q - (W + I) - fI, \tag{6}$$

$$\sigma(\pi) = sq. \tag{7}$$

2.3 Controlling owner's problem

The objective of the firm's controlling owner is to maximize her expected utility by choosing the level of its investment in the cost-reducing technology, I, and output, q:

$$\max_{I\geq 0, q\geq 0} \mathbb{E}u(w) = \max_{I\geq 0, q\geq 0} \left[x\mathbb{E}\left(1 + R_p\right) + \eta\mathbb{E}\pi - \frac{a}{2}\left(x^2\sigma_p^2 + \eta^2\sigma^2(\pi) + 2x\eta\rho\sigma_p\sigma_\pi\right)\right], \tag{8}$$

To solve the owner's optimization problem in (8) we need to impose the following constraints on the model's parameters:

$$\mu - c - a\rho s\sigma_p x > 0, \tag{9}$$

$$\delta < \sqrt{(1+f)\left(4\beta + 2a\eta s^2\right)}, \tag{10}$$

$$W \leq \frac{\delta(\mu - c - a\rho s\sigma_p x)^2}{\left((1+f)\left(4\beta + 2a\eta s^2\right) - \delta^2\right)^2}. \tag{11}$$

Equation (9) ensures positive output in equilibrium, equation (10) ensures finite output, and equation (11) specifies that the optimal investment of a completely unconstrained firm (whose external financing cost equals zero) is larger than the amount of available internal capital.

Maximizing the owner's expected utility in (8) leads to the following equilibrium capital investment and output quantity:

Lemma 1 *1) If the financing cost is lower than*

$$\overline{f} = \frac{\delta(\mu - c - a\rho s\sigma_p x) - \sqrt{W}(4\beta + 2a\eta s^2 - \delta^2)}{\sqrt{W}(4\beta + 2a\eta s^2)}, \tag{12}$$

(partially constrained scenario henceforth), equilibrium investment and output are given by

$$K^* = \left(\frac{\delta(\mu - c - a\rho s\sigma_p x)}{(1+f)\left(4\beta + 2a\eta s^2\right) - \delta^2}\right)^2, \tag{13}$$

$$q^* = \frac{2(1+f)(\mu - c - a\rho s\sigma_p x)}{(1+f)\left(4\beta + 2a\eta s^2\right) - \delta^2}, \tag{14}$$

respectively;

2) If the financing cost is equal or higher than $\overline{f}$ *in (12) (fully constrained scenario hereafter), equilibrium investment and output are given by*

$$K^* = W,$$

$$q^* = \frac{\mu - c - a\rho s\sigma_p x + \delta\sqrt{W}}{2\beta + a\eta s^2}, \tag{15}$$

respectively.

Note that the threshold financing cost in (12), above which the firm is fully constrained (i.e. the financing cost above which the firm does not raise money in the capital markets in order to invest in cost-reducing technology) is increasing in the expected demand intercept, μ and is decreasing in the baseline marginal cost of production, c. The reason is that the higher the demand and the lower the cost, the larger the optimal investment and the higher the financing cost that makes raising external capital prohibitively costly. Note also that the threshold financing cost is increasing in the efficiency of the cost-reducing technology, δ, for the same reason. Finally, the threshold financing cost is decreasing in the amount of available internal funds: the higher the internal capital available to the firm the less it is willing to resort to costly external financing.

When the firm is not fully constrained, both investment in cost-reducing technology and output are increasing in the efficiency of that technology and in the expected demand net of marginal production cost, and is decreasing in the cost of external financing. When the firm is fully constrained, equilibrium output is increasing in the available capital (all of which is invested), as well as in the expected demand net of marginal production cost.

2.4 Comparative statics and empirical predictions

The firm's decision variables are the size of the investment in cost-reducing technology and the output quantity. In this section we examine the effects of the model's parameters on the firm's optimal choices. Importantly, in order to test the model's predictions empirically, we examine the comparative statics of the outcomes of the firm's choices: investment-to-assets ratio and profit margin. In our setup, the firm's book assets are composed of investment in cost-reducing technology, K, and the cost of other inputs required for production, $\left(c - \delta\sqrt{K}\right) q$.[5] Thus, our measure of the firm's equilibrium investment-to-assets ratio, $\mathbb{I}^*$, is given by

$$\mathbb{I}^* = \frac{K^*}{K^* + \left(c - \delta\sqrt{K^*}\right) q^*}. \tag{16}$$

We can define two measures of profit margin. The first one is operating profit margin, which does not take into account the investment in cost-reducing technology:

$$\Pi^*_{op} = 1 - \frac{c - \delta\sqrt{K^*}}{\mu - \beta q^*}. \tag{17}$$

The second one is net profit margin, which incorporates the investment in cost-reducing technology:

$$\Pi^* = 1 - \frac{\left(c - \delta\sqrt{K^*}\right) q^* + K^*}{\left(\mu - \beta q^*\right) q^*}. \tag{18}$$

The measure available in the dataset that we use to test the model's predictions is net profit margin, thus we emphasize the comparative statics for Π^* in (18). Notably, all of the comparative statics derived for Π^* hold for Π^*_{op} in (17).

In what follows we examine comparative statics of $\mathbb{I}^*$ and Π^* with respect to the diversification of controlling owner's portfolio and demand uncertainty.

[5] We implicitly assume that lumpy investment has to be financed using the combination of internal and external funds, while the costs of other inputs required for production, such as inventories, can be financed from future revenues (i.e. these costs are balanced by accounts payable in the balance sheet).

2.4.1 Portfolio diversification

Two natural (inverse) proxies for controlling owner's diversification are the volatility of the return on her holdings outside of the firm, σ_p, and the correlation of her portfolio return with the demand shock, ρ. Differentiating $\mathbb{I}^*$ and Π^* with respect to measures of portfolio diversification, σ_p and ρ, leads to the following results:

Proposition 1 *1) An unconstrained or a partially constrained firm's investment-to-assets ratio is increasing in owner's portfolio diversification:* $\frac{\partial \mathbb{I}^*}{\partial \sigma_p} < 0$ *and* $\frac{\partial \mathbb{I}^*}{\partial \rho} < 0$*;*
2) A fully constrained firm's investment-to-assets ratio is decreasing in owner's portfolio diversification: $\frac{\partial \mathbb{I}^*}{\partial \sigma_p} > 0$ *and* $\frac{\partial \mathbb{I}^*}{\partial \rho} > 0$.

This result is illustrated in Figure 1 that plots the relation between investment-to-assets ratio as defined in (16), and the standard deviation of controlling owner's portfolio, σ_p, for various levels of financing constraints.[6] The inputs are as follows: $a = 0.5$, $\mu = 30$, $s = 10$, $\beta = 5$, $c = 5$, $\delta = 2$, $\mathbb{E}R_p = 0.1$, $\rho = 0.5$, $\eta = 0.5$, $x = 5$, $W = 0.2$. We vary the financing cost, f, between 0 and 3 and we vary the standard deviation of investor's portfolio, σ_p, between 0 and 0.5.[7]

Figure 1: Investment-to-assets and portfolio diversification

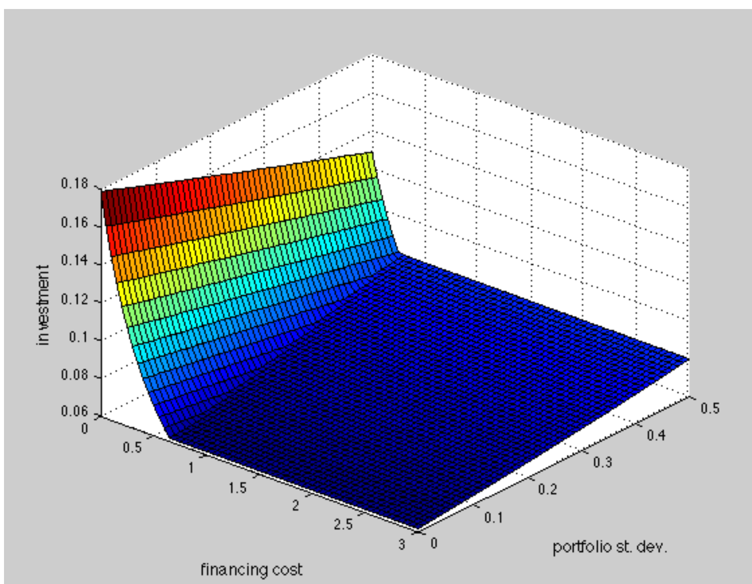


Figure 1 illustrates that for relatively unconstrained firms (f lower than approximately 0.5), investment-to-assets ratio is decreasing in the standard deviation of controlling owner's portfolio outside the firm,

[6] The results are similar when we examine the relation between equilibrium investment and the correlation between controlling owner's portfolio return and demand shock, ρ.

[7] Here and below the qualitative results hold for various parameter values, as long as the constraints in equations (9)-(11) are satisfied.

i.e. investment-to-assets ratio is increasing in portfolio diversification. For relatively constrained firms, on the contrary, investment-to-assets ratio is decreasing in portfolio diversification.

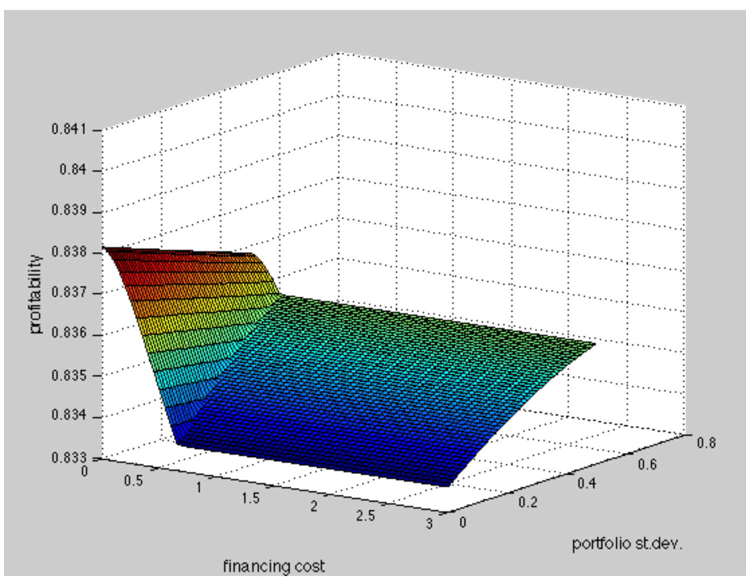
Proposition 2 *1) An unconstrained or a partially constrained firm's net profit margin is increasing in owner's portfolio diversification,* $\frac{\partial \Pi^*}{\partial \sigma_p} < 0$, $\frac{\partial \Pi^*}{\partial \rho} < 0$, *if the efficiency of the cost-reducing technology,* δ, *is higher than*

$$\overline{\delta} = \sqrt{\frac{4\beta c(1+f)^2}{\mu(1+2f)}}, \tag{19}$$

and it is decreasing in owner's portfolio diversification, $\frac{\partial \Pi^*}{\partial \sigma_p} > 0$, $\frac{\partial \Pi^*}{\partial \rho} > 0$, *if the efficiency of the cost-reducing technology is lower than* $\overline{\delta}$ *in (19);*
2) A fully constrained firm's net profit margin is decreasing in owner's diversification: $\frac{\partial \Pi^*}{\partial \sigma_p} > 0$, $\frac{\partial \Pi^*}{\partial \rho} > 0$.

Figure 2, which is based on the same parameter values as Figure 1, illustrates the result in Proposition 2. For relatively unconstrained firms ($f < 0.69$ for the chosen parameter values), $\delta > \overline{\delta}$ and the relation between owner's portfolio diversification and profit margin is positive (part 1 of Proposition 2). For relatively constrained firms, on the other hand, the relation between portfolio diversification and profit margin is negative (part 2 of Proposition 2).

Figure 2: Profit margin and portfolio diversification



The intuition for the results in Propositions 1-2 and Figures 1-2 is as follows. If the firm is not fully constrained (i.e. it finances part of the investment in cost-reducing technology externally), an increase in its owner's degree of diversification (i.e. a reduction in σ_p or ρ) lowers the importance of profit variance in the investor's expected utility and leads to higher investment level, as follows from (13). There are two forces determining the effect of owner's portfolio diversification on equilibrium profit margin. First, keeping investment (and marginal cost of production) constant, an increase in diversification raises equilibrium output and reduces profit margin. On the other hand, higher diversification raises optimal investment, which, in turn, reduces the marginal cost of production and increases profit margin. When investment efficiency is low, the indirect effect through the impact of increased investment on the marginal cost and on the resulting profit margin is small, and the negative direct effect of diversification on profit margin prevails. However, when investment efficiency is high enough, the positive effect of increased investment in cost-reducing technology on profit margin is sufficiently large to outweigh the direct negative effect on profit margin of increased output, leading to an overall positive relation between owner's diversification and profit margin.

If the firm is fully constrained (i.e. it only invests internal funds into cost-reducing technology), the higher the lever of diversification of the owner' portfolio outside the firm (i.e. the lower σ_p or ρ), the smaller the effect of volatility of firm's profit on investor's expected utility. The reason is that the interaction term between the standard deviation of firm's profit and measures of diversification in (8) affects investor's expected utility negatively. Since the firm's profit variability is increasing in output, as follows from (7), equilibrium output in (15) is decreasing in σ_p and ρ. In other words, equilibrium output is increasing in owner's portfolio diversification. Larger output leads to lower equilibrium output price and higher cost-price ratio, and to lower profit margin. In addition, since larger output requires larger production inputs other than capital investment, equilibrium investment-to-assets ratio is decreasing in output and is, therefore, decreasing in owner's diversification.

The literature on the implications of a firm's public/private status on the costs of obtaining external financing (e.g., Pagano, Panetta and Zingales (1998), Derrien and Kecskés (2007), and Hsu, Reed and Rocholl (2010)) suggests that private firms are likely to face costlier access to external capital, ceteris paribus. As a result, Propositions 1 and 2 lead to the following empirical predictions.

Empirical prediction 1: *Investment-to-assets ratio of public (private) firms is increasing (decreasing) in controlling owner's portfolio diversification.*

Empirical prediction 2: *Profit margin of public (private) firms may be increasing (is decreasing) in controlling owner's portfolio diversification.*

2.4.2 Demand uncertainty

The effects of diversification on a firm's optimal investment and production decisions are due to the interaction between demand uncertainty and uncertainty regarding the return on owner's portfolio outside the firm. Differentiating investment-to-assets ratio and profit margin with respect to demand uncertainty leads to the following results:

Proposition 3 *1) An unconstrained or a partially constrained firm's investment-to-assets ratio is decreasing in demand uncertainty:* $\frac{\partial \mathbb{I}^*}{\partial s} < 0$;
2) A fully constrained firm's investment-to-assets ratio is increasing in demand uncertainty: $\frac{\partial \mathbb{I}^*}{\partial s} > 0$.

Proposition 4 *1) An unconstrained or a partially constrained firm's profit margin is decreasing in demand uncertainty,* $\frac{\partial \Pi^*}{\partial s} < 0$, *if the efficiency of the cost reducing technology,* δ, *is higher than* $\overline{\delta}$ *in (19), and it is increasing in demand uncertainty,* $\frac{\partial \Pi^*}{\partial s} > 0$, *if the efficiency of the cost-reducing technology is lower than* $\overline{\delta}$;
2) A fully constrained firm's profit margin is increasing in demand uncertainty: $\frac{\partial \Pi^*}{\partial s} > 0$.

Propositions 3 and 4 are illustrated in the following two figures, in which we use the same parameter values as in Figures 1 and 2, with the only difference that the standard deviation of investor's portfolio, σ_p, is set to 0.3 and demand uncertainty, s, varies between 8 and 12.

Figure 3: Investment-to-assets and demand uncertainty

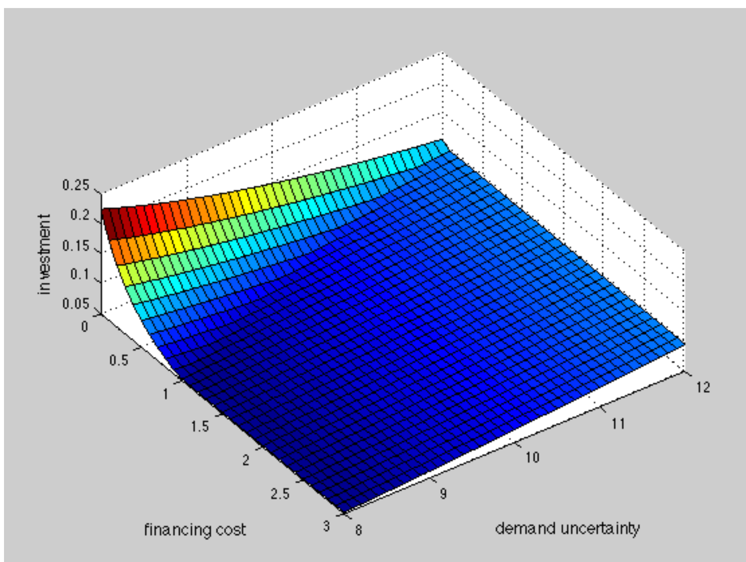
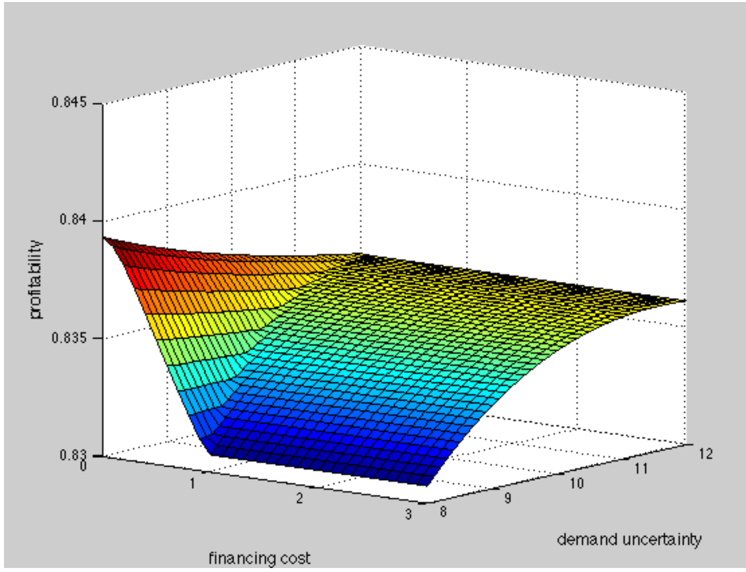


Figure 4: Profit margin and demand uncertainty



The intuition for the relations in Propositions and Figures 3-4 is as follows. Increased demand uncertainty lowers optimal output because of the positive effect that a firm's output has on its profit variance. For a fully constrained (high-f) firm, whose capital expenditure does not respond to changes in demand uncertainty, this reduction in output leads to higher output price and profit margin, and to lower amount of required non-investment inputs, resulting in higher investment-to-assets ratio. For a partially constrained or completely unconstrained (low-f) firm there is an additional effect: lower optimal output due to higher demand uncertainty reduces optimal investment, leading to a negative relation between demand uncertainty and investment-to-assets ratio. The effect of demand uncertainty on equilibrium profit margin is twofold. First, holding investment constant, higher demand uncertainty reduces optimal output and raises equilibrium profit margin. Second, higher demand uncertainty reduces optimal investment leading to lower equilibrium profit margin. If the efficiency of investment in cost-reducing technology is sufficiently high, the indirect effect through investment dominates the direct effect, and the relation between demand uncertainty and profit margin is negative. If, on the other hand, investment efficiency is low, the direct effect dominates, leading to a positive relation between demand uncertainty and profit margin.

Propositions 3 and 4 lead to the following empirical predictions.

Empirical prediction 3: *Investment-to-assets ratio of public (private) firms is decreasing (increasing) in demand uncertainty.*

Empirical prediction 4: *Profit margin of public (private) firms may be decreasing (is increasing) in demand uncertainty.*

3 Data

3.1 Sample

The data used in the paper are assembled from Amadeus Top 250,000. Amadeus is maintained by Bureau Van Dijk Publishing and covers European public and private companies. From this database we gather ownership and accounting information for every European privately-held and publicly-traded company that satisfies a minimum size threshold.[8] Disclosure requirements in Europe obligate private companies to publish annual information. Consequently, we are able to gather accounting and ownership information for a very large set of firms.[9]

We collect the data from the Amadeus Top 250,000 DVDs using the April issue of each year during the period 1999-2010. Information is typically incomplete for the year that just ended. Further, Amadeus removes firms from the database five years after they stop reporting financial data.[10] In order to avoid biases related to both survivorship and incomplete information, we skip the most recent reporting year and collect accounting data retroactively starting with the 2012 DVD and progressively moving backward in time. By doing so, no firms are dropped from the sample. We gather accounting data for all firms having data available for the variables included in the empirical tests of our model's predictions for at least one year during the period 1999-2010. Past studies found these accounting data to be reliable (e.g., Faccio, Marchica and Mura (2011)).

In addition to the accounting data, for all firm-years in our sample we collect direct ownership data. In doing so, we follow Faccio, Marchica and Mura (2011). In particular, in each DVD the information on ownership is only given as of the current year. Therefore, we collect these data one year at a time for each DVD. After cleaning the ownership information from those shareholders that are only generally defined in Amadeus, we identify the ultimate shareholder for each firm in the sample and reconstruct her equity portfolio (more details below). After combining accounting and ownership information, we end up with the final sample of 528,110 firm-year observations for 162,688 unique firms. Further, we use Datastream to gather information on weekly stock returns for all publicly-traded European firms over the 1998-2010 period to construct one of the portfolio diversification measures and a proxy for

[8] For France, Germany, Italy, Spain, and the United Kingdom, the database includes all companies that meet at least one of the following criteria: (1) revenues of at least €15m, (2) total assets of at least €30m, (3) at least 200 employees. For the other countries, the database includes all companies that meet at least one of the following criteria: (1) revenues of at least €10m, (2) total assets of at least €20m, (3) at least 150 employees.

[9] In Germany, Portugal, Bosnia, Macedonia, Serbia and Montenegro, and Switzerland not all companies comply with the filing requirements, while in Austria the disclosure of financial information covers fewer items than elsewhere.

[10] These drawbacks are also discussed in Popov and Roosenboom (2009), Faccio, Marchica, McConnell and Mura (2011), and Klapper, Leaven and Rajan (2012).

demand uncertainty.

For each company that has available ownership data, we identify first all ultimate shareholders. For each company that has available ownership data, we identify all ultimate shareholders. That is, in cases in which the direct shareholder of a firm is another firm, we identify its owners, the owners of its owners, and henceforth, i.e. we trace ownership pyramids of any length. Following Claessens, Djankov, and Lang (2000), Faccio and Lang (2002) and Faccio, Marchica and Mura (2011), our measure of ultimate ownership is the weakest link along the ownership chain. After tracing each ownership stake to its ultimate shareholders, we call the shareholder controlling the largest fraction of voting rights in each firm the firm's largest ultimate shareholder. In what follows we frequently refer to the largest ultimate shareholder as firm owner. The empirical analysis below focuses on firm owners because control of voting rights indicates power in making investment and operating decisions. However, for each shareholder, we also compute her cash flow rights in the firm's earnings. A shareholder's cash flow rights are a product of ownership stakes along the ownership chain. We exclude all firms in which a government is a shareholder, as these firms may have different incentives than other companies in the economy.

3.2 Variables

In what follows we describe the variables used in the analysis. We first describe the construction of the two main dependent variables: investment-to-assets ratio and profit margin. Then we discuss the measures of owners' portfolio diversification and demand uncertainty. Finally, we describe the control variables in the investment-to-assets and profitability regressions.

Dependent variables

Investments-to-assets ratio is defined as the year-to-year change in gross fixed assets divided by lagged total assets. Total assets are computed as the sum of fixed and current assets.

Profit margin is defined as the return on sales (ROS), i.e. the ratio of earnings before interest and taxes (EBIT) to sales.

To reduce the impact of outliers, across all analyses, most accounting variables, including ratios, such as investment-to-assets and profit margin are winsorized at the top and bottom 1% of their distribution.[11]

Measures of owner's portfolio diversification

Ln(Number of firms) is used commonly as a proxy for portfolio diversification (e.g., Barber and

[11] Some variables are winsorized differently, as discussed below.

Odean (2000) and Goetzman and Kumar (2008)). The motivation behind it is that the potential for diversification is increasing in the number of stocks in investor's portfolio. It is defined as the natural logarithm of the total number of firms in which the company's largest ultimate shareholder (e.g., the ultimate shareholder controlling the largest fraction of voting rights in the firm) holds shares, directly or indirectly, in a given year, across all countries in our sample. While this measure of portfolio diversification is admittedly crude, it has an important advantage of not requiring any information regarding the distribution of stock returns, which is particularly important in our sample consisting mostly of privately held firms.

1–Herfindahl index is used commonly as a measure of portfolio diversification (e.g., Bodnaruk, Kandel, Massa and Simonov (2008) and Goetzman and Kumar (2008)). To compute the Herfindahl index of holdings, we first calculate the dollar value of a shareholder's investment in each firm in her portfolio as the book value of the company's equity, multiplied by the shareholder's ultimate ownership stake in the firm.[12] We then compute the weight of each stock in the owner's portfolio. The Herfindahl index of portfolio holdings is the sum of these squared weights. The advantage of a value-weighted measure, such as one minus the Herfindahl index, over an equally-weighted measure based on the number of portfolio firms, is that the bias due to exclusion of small firms is less significant in the value-weighted measure.

–Correlation is the correlation of the mean stock return of public firms in the firm's industry with the shareholder's overall portfolio returns, multiplied by -1, as in Bodnaruk, Kandel, Massa and Simonov (2008) and Faccio, Marchica and Mura (2011). This measure of diversification is higher for firm owners whose portfolio returns are less correlated with the returns in the industry in which their firm operates.[13] We use the mean industry return as a proxy for the stock return of a given firm, which is unavailable for private firms. The industry (weekly) return is defined as the weekly average return across all publicly traded European firms within a given 3-digit SIC industry. We include only firms that have stock price data available in Datastream. For each investor, the portfolio returns are computed as the weighted average of returns of individual stocks in her portfolio (or industry returns in cases in which individual stock returns are unavailable). In this calculation, we use the weights of each firm in the investor's equity portfolio at the beginning of each year.

It is important to note that despite the wide coverage of firms in Amadeus, our portfolio diversification measures are subject to some limitations. First, small equity positions as well as positions

[12] We use book equity instead of market equity because our sample consists predominantly of private firms. In the calculation of the Herfindahl index of holdings we only include firms with available data on the book value of equity.

[13] The drawback of this measure of portfolio diversification is that it is likely to understate diversification, as the returns of two stocks within the same industry are assumed perfectly correlated by construction.

in companies below the size threshold are not covered in Amadeus and, therefore, are not included in the portfolios. The exclusion of the smallest companies, though, is unlikely to have a major impact on value-weighted portfolio diversification measures discussed above. Second, we do not capture non-equity investments, such as investments in bonds and real estate, and, more importantly, we do not capture indirect equity investments, e.g., investments through mutual funds. For instance, the exclusion of investments in mutual funds and hedge funds may bias our measures of diversification downwards. To control for this potential bias, in Section 4.4 we perform a number of robustness tests that show that this issue has a very limited impact on our main empirical findings. Third, we are unable to include equity investments in firms incorporated outside Europe. Thus, we may possibly understate the diversification of investors who are well diversified across continents. However, since investors typically exhibit a home bias (e.g., French and Poterba (1991) and Coval and Moskowitz (1999)), the magnitude of this measurement error is likely to be small. To further support this argument, Faccio, Marchica and Mura (2011) find that only a tiny proportion of controlling owners of European firms hold larger-than-5% shares of equity in non-European firms.

Measure of demand uncertainty

Industry return volatility is our measure of demand uncertainty, following Leahy and Whited (1996) and Bond and Cummins (2004). Industry return volatility is calculated as follows. We compute the equally-weighted return of each 2-digit SIC industry each week across all countries. Then, we define the 2-digit SIC return volatility in a given year as the standard deviation of this equally-weighted weekly industry return computed over the previous year.

Control variables

We include the following additional variables in the investment-to-assets and profit margin regressions that were found in past literature to be related to investment and profitability.

Sales growth is used as a proxy for investment opportunities, as an available substitute for Tobin's q, which is the usual measure of investment opportunities (e.g., Kaplan and Zingales (1997) and Cleary (1999) among many others). We use sales growth instead of Tobin's q, since the latter is unavailable for private firms, which constitute the majority of our sample.[14] Sales growth is defined as the annual relative growth rate in total revenues. As sales growth exhibits large positive skewness, it is winsorized at the bottom 1% and at the top 5% of its distribution.

Cash flow, which has been shown to be related to investment (e.g., Fazzari, Hubbard and Petersen (1988), Kaplan and Zingales (1997), Erickson and Whited (2000, 2002), and Lyandres (2007)) is the

[14] In addition, Erickson and Whited (2000), Gomes (2001), and Alti (2003) show that there may be a measurement error in estimated average Tobin's q, which may bias coefficient estimates in investment regressions.

ratio of income plus depreciation to beginning-of-year total assets.

Firm age, has been shown to be related to profitability (e.g., Anderson and Reeb (2003)), since investment and profit opportunities of mature firms may be different from those of young firms. Firm age is defined as the number of years since a firm's incorporation. Because of its skewness, we winsorize age at the top 1% of its distribution and use $\ln(1 + Age)$ as the measure of age.

Total Leverage is defined as the ratio of total debt to total assets (e.g., Lang, Ofek and Stulz (1996) and Ahn, Denis and Denis (2006)) where total debt includes non-current liabilities (long term debt and other non-current liabilities) and current liabilities (loans, creditors and others).

Ln (Size) is the natural log of total assets (in thousands US$), expressed in 1999 prices.

4 Empirical tests

4.1 Univariate analysis

Table 1 reports the descriptive statistics for our sample that counts 528,110 firm-year observations from 1999 to 2010, corresponding to 162,688 unique firms across 34 different European countries. As evident from Panel A of Table 1, the most represented countries in our sample are: United Kingdom (23.36%), France (20.31%), Spain (11.37%), and Italy (8.98%). In almost all countries (with the exception of Liechtenstein, Macedonia, and Russia) we have at least 100 observations. The vast majority of firms in our sample are privately held (95.9%).

Insert Table 1 here

Panel B of Table 1 shows the differences in mean (median) of our main dependent variables across privately-held and publicly-traded companies.

On average, public companies have a significantly higher investment-to-assets ratio than private firms. Similar findings are obtained when we compare the median values of the investment-to-assets ratios of private and public firms. This result is consistent with the evidence in Mortal and Reisel (2012), obtained using a sample of Western European firms.[15] Privately-held firms have a significantly higher mean profit margin than public firms. This finding is consistent with a number of recent studies that report that privately held companies are significantly more profitable than public ones across various countries and years (e.g., Brav (2009), Asker, Farre-Mensa and Ljungqvist (2011a), and Faccio, Marchica, McConnell and Mura (2012)).[16] However, a median private firm is less profitable than a median public firm.

[15] Interestingly, this evidence differs from the results in Asker, Farre-Mensa and Ljungqvist (2011a), who show that in the U.S. publicly-traded firms invest less than matched private firms.

[16] Brav (2009) reports that the average ratio of EBIT-to-total-assets is 8.3% (4.9%) for private (public) companies

Panel C of Table 1 reports descriptive statistics at the firm level of the main independent variables and the control variables included in the regressions. The ultimate largest shareholder in our sample holds on average 21 firms in her portfolio. However, the median number of firms in the largest shareholder's portfolio is two. Thus, a typical largest shareholder is only moderately diversified. This evidence is consistent with Faccio, Marchica and Mura (2011) in a similar sample and to the evidence reported in Barber and Odean (2000), Moskowitz and Vissing-Jørgensen (2002), and Goetzman and Kumar (2008) in the US market, and Karhunen and Keloharju (2001) in the Finnish market. Portfolio diversification varies substantially across investor-year observations. For instance, 42% of our largest ultimate shareholders hold more than two companies in their portfolios, 10% of them hold at least 5 companies, and 0.5% of controlling shareholders hold at least 50 companies in their portfolios. Further, the average largest shareholder holds more than 62% of the cash flow rights and 63% of the voting rights in her company (untabulated statistics). This corroborates the presumption that the relations between portfolio diversification and investment and operating decisions are indeed a consequence of the decisions of the largest ultimate shareholder. Untabulated results are very similar to the main findings reported in the paper when we either include cash flow rights in all our regressions or when we restrict the sample to companies in which the largest shareholder owns more than 50% of the cash flow rights or she sits on the Board of Directors.

Our proxy for demand uncertainty shows variability across different sectors. In our sample sectors with the lowest volatility of returns (0.016) are generally those related to the food and retail industries (e.g., "Food and Kindred Products", "Food Stores"; "Wholesale Trade"), while those with the highest volatility (0.032) are those related to the agriculture and mining industries (e.g., "Fishing, Hunting, and Trapping", "Agricultural Production-Livestock and Animal Specialties"; "Coal Mining", "Metal Mining").

4.2 Multivariate analysis

We use OLS regressions to estimate the following two models:

$$inv\_to\_assets_{i,t} = \alpha PUB_{i,t} + \beta PRI_{i,t} + \gamma(PUB_{i,t} * MainVar_{i,t}) + \delta(PRI_{i,t} * MainVar_{i,t}) + \overline{\theta X_{i,t}} + CountryFE + IndustryFE + YearFE + u_{i,t}, \quad (20)$$

in the UK market over the period of 1993-2003. Similarly, Asker, Farre-Mensa and Ljungqvist (2011a) show that the average ROA of US private (public) companies is 7.5% (6.5%) between 2002 and 2007. Faccio, Marchica, McConnell and Mura (2012) document that the mean annual equally-weighted return on book equity (ROE) of European private companies is 25.1% versus a mean annual ROE of public firms of 10.1% over the period of 1996-2008.

$$profit\_mgn_{i,t} = \alpha PUB_{i,t} + \beta PRI_{i,t} + \gamma(PUB_{i,t} * MainVar_{i,t}) + \delta(PRI_{i,t} * MainVar_{i,t}) + \overline{\theta Z_{i,t}} + CountryFE + IndustryFE + YearFE + u_{i,t}, \tag{21}$$

$PUB_{i,t}$ is a indicator variable equalling one if company i is publicly-traded in year t, and equalling zero otherwise, while $PRI_{i,t}$ is an indicator equalling one if company i is privately-held in year t, and equalling zero otherwise. $MainVar_{i,t}$ stands for one of the three measures of controlling owner's portfolio diversification (ln(No. of firms), 1-Herfindhal Index, and -Correlation) or for the measure of demand uncertainty (industry return volatility). $\overline{X_{i,t}}$ is a vector of control variables that includes: 1) sales growth; 2) cash flow; and 3) ln(1+age). $\overline{Z_{i,t}}$ includes: 1) total leverage; 2) ln(size); and 3) ln(1+age). All regressions include country, 3-digit SIC industry, and year fixed effects. $\widehat{\gamma}$ and $\widehat{\delta}$ represent the estimated sensitivities of investment and operating strategies respectively to changes in each $MainVar_{i,t}$ for public and private firms separately. We also compute the economic impacts of these estimated coefficients when statistically significant. The economic impact is calculated as follows: $\widehat{\gamma}$ ($\widehat{\delta}$) is multiplied by one standard deviation of corresponding main variable. The product is then standardized by the mean of the corresponding main variable.

4.2.1 Controlling owner's portfolio diversification

Table 2 reports results of estimating the regressions of publicly-traded and privately-held firms' investment-to-assets ratios and profit margins on measures of their owners' portfolio diversification.

Insert Table 2 here

Panel A of Table 2 shows that controlling owners' portfolio diversification has significantly different impacts on the investment rates of public and private firms. Across all three measures of owners' portfolio diversification, the relation between portfolio diversification and investment-to-assets ratio is positive and significant for publicly-traded firms (columns 1-3), while it is negative and significant for privately held ones for two measures of diversification out of three (columns 1-2). This impact is also economically important, especially for public companies. For example, a one standard deviation increase in ln(1+No. firms) corresponds to an average increase of almost 8% in investment-to-assets ratio, ceteris paribus.

Panel B of Table 2 documents the relation between measures of portfolio diversification and return on sales of public and private companies. An increase in portfolio diversification is associated with a significant increase in average return on sales of publicly traded companies. This is in line with the model's result that for a sufficiently high investment efficiency, the positive effect of cost-reducing investment on equilibrium profitability more than offsets the negative impact on it of increased equilibrium output. For public firms, the positive relation between owner's portfolio diversification and profitability is also economically sizeable: for example, a one standard deviation increase in ln(1+No. firms) is associated with more than 31% increase in the average return on sales. When we turn to privately held firms, the relation between firms' profitability and measures of their owners' portfolio diversification is strongly negative across all diversification measures. This finding is consistent with the model's result for fully constrained firms, for which increased equilibrium output due to higher diversification of a controlling owner lowers the equilibrium profit margin of a fully constrained firm, whose capital investment is held constant.

4.2.2 Demand uncertainty

Table 3 documents that industry demand uncertainty has different impacts on the investment and operating strategies of public and private companies, in line with the predictions of the model.

Insert Table 3 here

In Panel A we observe that higher demand uncertainty in firms' industry is associated with a significant reduction in the investment-to-assets ratios of public firms, while it is associated with a marginal increase in the investment-to-assets ratios of private firms. The effect of demand uncertainty appears more pronounced for public rather than private companies. A one standard deviation increase in the measure of demand uncertainty is associated with a decrease of almost 11% in the investment-to-assets ratio of an average public firm. Turning to the return on sales regression, reported in Panel B of Table 3, demand uncertainty has a strong negative association with the return on sales of public firms, whereas the association between the return on sales of private firms and demand uncertainty is negative but statistically insignificant. Overall, the results in Table 3 are strongly consistent with the model's predictions regarding the relations between owners' diversification and demand uncertainty on one hand and public firms' investment and operating strategies, while the relations for private firms are economically and statistically insignificant.

4.3 Selection issues

Firms' assignment to public and private is not random. Thus, it is important to examine whether and to what extent our results are potentially affected by firms' self-selection into the public and private modes of incorporation. We address this issue in two ways. First, we estimate the regressions of investment and profitability within a sample in which we find for each public firm a matched private firm, i.e. we condition the analysis on observable public and private firms' characteristics. Second, since it is possible that the self-selection of companies into private and public is driven by characteristics that are not observable, we estimate a two-stage Heckman (1979) selection model. In the first stage we estimate the choice between public and private status using a probit regression and in the second stage we estimate our baseline regressions while including the inverse Mills ratio from the first-stage regression in order to correct for potential self-selection.

4.3.1 Matched sample

To construct a sample of private firms with characteristics similar to those of public ones, we use the propensity score matching estimator to find for each public firm a possible match within the sub-sample of private firms (e.g., Rosenbaum and Rubin (1983)). For the propensity score matching estimation of the investment model, we include: sales growth, cash flow, and firm age, along with year, country and industry (1-digit SIC code) fixed effects. For the propensity score matching estimation of the profitability model, we include: total leverage, firm size, and firm age, along with year, country and industry (1-digit SIC code) fixed effects. We require that the difference between the propensity score of a public firm and its matching peer does not exceed 0.1% in absolute value. We then re-estimate the regressions in Tables 2 and 3 using the matched sample. Results are reported in Tables 4 and 5.

Insert Tables 4 and 5 here

The results in Table 4 are qualitatively similar to the full-sample results reported in Table 2. The coefficients on the interaction between public firm indicator and owners' diversification are positive in all specifications and are statistically significant in three out of six specifications. The coefficients on the interaction between private firm indicator and diversification are negative and significant in all specifications. In fact, in some cases the results within the matched sample are stronger and more economically significant. For example, both the size of the coefficients on the interaction between private firm indicator and portfolio diversification and their economic significance increase more than threefold relative to those in Table 2 in both the investment-to-assets and return on sales regressions. When we compare the coefficient on the interaction of private firm indicator and demand uncertainty in Table 5 to the corresponding coefficient in Table 3 we discover that controlling for self-selection makes the coefficients in the investment-to-assets regression seven times larger and statistically significant. Controlling for self-selection also reverses the sign of the coefficient on the interaction between private firm dummy and demand uncertainty in the return on sales regression, although the coefficient remains statistically insignificant. Overall, the matched-sample results are stronger and more consistent with the model's predictions than the full-sample results.

4.3.2 Treatment effect model

Following Maddala (1991) the binary choice model of the mode of incorporation is represented as

$$P_{it}^{*} = \gamma' Z_{it} + u_{it}, \tag{22}$$

where Z_{it} is a vector of exogenous variables that influence the choice of firm i to be either private or public: $P_{it} = 1$ if $P_{it}^{*} > 0$ and $P_{it} = 0$ if $P_{it}^{*} \leq 0$. If a firm's decision to be private is correlated with the investment and operating decisions of that firm, then we would have a non-zero correlation between the error term $u_{it,}$ in (22) and the error terms in the investment and profitability models respectively. Therefore, estimating the latter models via a simple OLS may lead to inconsistent estimates.

Instead, in the first stage of the Heckman (1979) model we estimate (22) with a probit regression and obtain consistent estimates of γ'. These coefficient estimates are then used to compute the inverse Mills ratio, the correction for self-selection.[17] This parameter is then included in the second-stage regressions along with the indicator variable of private/public status (and all the other controls). In this way, we can explicitly test whether a firm's private/public status is still related to its investment and operating decisions after the self-selection due to unobservable factors has been controlled for.

For this model to be correctly specified, it is important to include at least one exogenous variable from the first stage choice model (e.g., Lennox, Francis, and Wang (2011)). For this purpose, we use the fraction of privately held companies in each 3-digit SIC industry in a country in which a company is headquartered in order to predict the decision of being private without otherwise affecting corporate investment and operating decisions. One may argue that private firms could be more clustered in certain industries. In this case, the exclusion restriction may be correlated, although indirectly, with the left hand side of the second-stage models. To mitigate this potential concern, we include industry, country and year fixed effects in both the first-stage and second-stage regressions. The results of the second-stage regressions of the investment and profitability models for the portfolio diversification and demand uncertainty specifications are reported in Tables 6 and 7 respectively.

Insert Tables 6 and 7 here

Augmenting the regressions by including the inverse Mills ratio to correct for self-selection does not affect the qualitative relations between portfolio diversification and demand uncertainty on one hand and investment-to-assets ratio and profit margin of private and public firms on the other hand. (The only result that is clearly inconsistent with the model is the significantly negative coefficient on the

[17] The inverse Mills ratio is equal to: $\lambda_1(\gamma' Z_{it}) = \frac{-\phi(\gamma' Z_{it})}{\Phi(\gamma' Z_{it})}$ for public firms and $\lambda_2(\gamma' Z_{it}) = \frac{\phi(\gamma' Z_{it})}{1-\Phi(\gamma' Z_{it})}$ for private firms, where ϕ represents the standard normal probability density function, and Φ represents the standard normal cumulative distribution function.

interaction between private firm indicator and demand uncertainty in the return on sales regression.) Overall, the results in Tables 4-7 demonstrate that selection issues are not likely to be responsible to the relations between investment and profitability of public and private firms on one hand and owner's portfolio diversification and demand uncertainty on the other hand.

4.4 Robustness tests

In this section we assess the robustness of our results with respect to a number of alternative specifications and subsamples. After having established that our main results are not likely to be driven by self-selection, in the robustness tests we use the full (unmatched) sample of public and private firms and estimate the regressions using OLS. In what follows, to conserve space, we only report the results using only one measure of owner's portfolio diversification (ln(1+No. firms)). The results obtained using other measure of portfolio diversification are qualitatively similar to those reported below and are available upon request.

4.4.1 Alternative dependent variables

Our model's predictions refer specifically to firms' capital expenditures and their profit margins. Nonetheless, since R&D expenditures may be as important as capital expenditures for some firms, we define an alternative variable for the investment model, which takes into account R&D expenditures in addition to capital expenditures. Following Gianetti (2003), we use the change in total intangible assets as a proxy for R&D expenditures and assign the value of zero to R&D expenditures in cases in which they are missing. We define total investment-to-assets ratio as the year-to-year change in the sum of gross fixed assets and total intangible assets divided by lagged total assets. Panel A of Table 8 shows the results of estimating the regressions using the alternative investment measure.

Insert Table 8 here

Our main findings are robust to alternative definition of investment: total-investment-to-assets ratio is increasing in owner's portfolio diversification and is decreasing in demand uncertainty for public firms, while it is decreasing in portfolio diversification and is increasing in demand uncertainty for private firms. Further, as an alterative proxy for profitability, we use the ratio of EBIT to total assets (ROA), following much of the existing literature. The results, which support the model's prediction for the case of public firms, are consistent with the base-case specification in Table 3.

4.4.2 Ultimate shareholders: Dual class shares

To trace back the ultimate shareholder of each company included in our sample we reconstruct the ownership pyramids from each direct shareholder of each firm. One limitation of this procedure is that we are unable to take into account the presence of dual class shares. The use of dual class shares, when legally allowed, is observed not only within public firms, but also in private companies. However, there are no official sources providing accurate information on the extent of dual class shares use among privately held firms. The omission of dual class shares in the calculation of both cash flow and voting rights of firms' ultimate shareholders may potentially create a measurement error in the identification of (ultimate) controlling owners and, therefore, in the construction of our proxies for portfolio diversification. However, previous studies show that dual class shares are used extensively in only a few European countries (e.g., Faccio and Lang (2002) and Nenova (2003)). Further, Pajuste (2005) documents that an increasing number of firms in continental Europe have recently unified their shares into a single class. Similar result is reported by the ECGI in their study commissioned by the European Union (2007). In particular, Pajuste (2005) shows that, at the end of 2001, after several legal reforms aimed at improving investor protection across Europe, only six countries still seem to have at least 10% of their public companies using dual class shares: Sweden (46.3%), Denmark (36.6%), Italy (34.6%), Switzerland (26.4%), Finland (23.9%) and Germany (11.5%). Therefore, we believe that this potential measurement error has a limited impact on the identification of firms' ultimate shareholders. Nevertheless, we re-examine the results in light of this potential bias. As there is no accurate information on the use of dual class shares among private firms, we conservatively assume that public firms' use of dual class shares mirrors the one by private firms. Therefore, we exclude the countries above from our sample and re-run all specifications for both investment and profitability models. The results, reported in Panels B and G of Table 8 respectively, demonstrate that dual class shares are generally not responsible for our empirical results.

4.4.3 Portfolio diversification measures

As mentioned in Section 3.1, a potential limitation of our portfolio diversification measures is that we are not able to capture indirect equity investments, such as investments through mutual funds. The exclusion of investments in mutual and hedge funds may bias our measures of diversification downwards. Further, we are not able to capture small equity positions and investment in companies that are not included in Amadeus or that are incorporated outside Europe. This may bias our portfolio measures even further if the presence of mutual and hedge funds in the European markets is as pervasive as in the US market.[18] However, the descriptive statistics of our portfolio diversification measures are similar to the estimates reported in Barber and Odean (2000), Goetzman and Kumar (2008), for US investors, and Karhunen and Keloharju (2001) for Finnish investors. In addition, a comparable level of diversification is documented by Moskowitz and Vissing-Jørgensen (2002) for US households investing in the private equity market. Further, as mentioned above, Faccio, Marchica and Mura (2011) provide evidence that European investors are affected by the well-known home bias. Nonetheless, we try to reduce the potential downward bias of our portfolio diversification measures in two ways.

First, we look at the fraction of households' total financial assets invested in "Mutual fund shares" as reported in the National Accounts. We calculate this fraction at the end of 2006 to take into account that in the first half of the decade several European countries experienced a significant increase in the holdings of mutual fund shares (e.g., Ynesta (2008)). In 6 out of 22 countries with available information this fraction is above 10%: Belgium, Austria, Spain, Sweden, Germany, and Switzerland, suggesting that in these countries the downwards bias that may potentially affect our portfolio diversification measures is larger. Therefore, we exclude these countries from our sample and re-estimate the investment and profitability models. The results, reported in Panels C and H of Table 8, are generally consistent with our baseline results, suggesting that our failure to capture investments in mutual funds and hedge funds is unlikely to drive our empirical results.

In addition, to proxy for the share of mutual fund investments in the stock markets of different countries, we examine the fraction of market capitalization in each country held by mutual funds as of 2005, reported in Ferreira and Matos (2008). The fraction of market capitalization held by institutional investors in general and by mutual funds in particular in Europe is well below the corresponding figures in the US market.[19] In only 6 countries out of 34 in our sample, the ownership of the stock market by mutual funds exceeds 5%: Sweden, Ireland, Finland, Luxembourg, Netherlands, and Switzerland. As in the previous test, we exclude these countries from our sample and re-estimate all the specifications for both investment and profitability models. Results, which are available upon request, are consistent with the full-sample findings and the results reported in Panels C and H of Table 8.

As mentioned above, our measures of portfolio diversification are based on equity positions held by each investor in our sample, and, as such, they exclude investments other than equity, such as real estate. This exclusion may bias our measures of owner diversification downwards. As we do not have information of asset allocation at the individual level, we gauge the magnitude of investments in real

[18] Gillan and Starks (2007) show that at the end of 2006 the proportion of total outstanding US equities held by institutional investors was more than 70%.

[19] The average fraction of stocks held by institutional investors (mutual funds) in Europe equals 20% (4%), while in the corresponding figures in the US are 66% (18%).

estate at the country level. We use the gross value added of the real estate industry as a fraction of the gross value added of the total economy as a proxy for the size of the real estate sector in each country. Gross value added represents the output valued at basic prices less intermediate consumption valued at purchasers' prices. We calculate this fraction at the end of 2006 using data from National Accounts at both the sector and country level. The idea is that the larger the size of the real estate sector in each country, the higher the investments in real estate of the individuals in that country and, therefore, the larger the potential downward bias of our measures of owners' portfolio diversification.[20] In 8 out of 28 countries with available information the gross value added of the real estate industry exceeds 10% of total gross value added: France, Italy, Greece, Germany, Finland, Estonia, Bulgaria, and Denmark. In order to examine the importance of the potential bias due to real estate investments by controlling owners, we exclude these countries from our sample and re-run all specifications for both investment and profitability models. Results are reported in Panels D and I of Table 8 and are in line with our main findings.

4.4.4 Disclosure requirements and accounting standards

Although most of the countries in our sample require companies to file financial statements (albeit sometimes in reduced form), in some countries the regulations (and/or filing practices) are different. For instance, in Bosnia, Romania, Russia, and Switzerland private firms are not required to publish financial statements. In Portugal and Germany, few companies comply with the filing requirements. Additionally, in Liechtenstein, Malta, Monaco, and the Slovak Republic the criteria for publication of financial statements are undefined in Amadeus. Further, in some countries, firms that are not required to file financial reports choose to file them.[21] This could lead to a potential selection bias towards successful (private) companies that choose to file their financial reports. While in all our models we include country fixed effects, which should control for different levels of disclosure requirements in various countries and/or differences in filing practices, we try to further mitigate this potential bias by excluding private firms incorporated in the countries listed above and in other countries in which private firms are not required to file. The results, reported in Panels E and J of Table 8, mirror our previous findings.

A further potential concern relates to the quality of accounting information across the countries

[20] The results are similar when we use an employment-based proxy for the importance of the real estate sector. Specifically, we calculate the total employment of the real estate industry as a fraction of the total employment of the economy. Total employment is measured as the number of persons employed in a particular sector.

[21] See Faccio, Marchica, McConnell and Mura (2012) for a more detailed analysis of the disclosure requirements in European countries.

in our sample. Although all our countries have either adopted the International Financial Reporting Standards (IFRS) during the 2000s or decided to adopt them at some point in the near future (e.g., Russia), there could be still differences in reporting standards. This may potentially affect our findings, in particular those related to firms' operating strategies. We follow Porter and Schwab (2008) and use the Executive Opinion Survey conducted by the World Economic Forum between 2007 and 2008 to gauge the extent of these differences.[22] The Survey was completed by 2,881 top European management business leaders with an average of 88 respondents per country. The Survey asks the executives to provide their expert opinions on various aspects of the business environment in which they operate. We are interested in the question related to the strength of financial auditing and reporting standards regarding company financial performance (item 1.16). The evaluation is on a scale between 1 and 7, where 1 represents the worst possible operating condition or situation, and 7 represents the best. In our sample, the highest score is 6.2 (Austria), while the worst is 3.6 (Bosnia and Herzegovina). Countries with the lowest score (in the bottom decile of the distribution) are: Bosnia and Herzegovina, Ukraine, Russia, and Bulgaria. To control for potential misreporting bias, we exclude the above countries from our main models and obtain results similar to those reported in Panels E and J of Table 8 (available upon request).

5 Conclusions

In this paper we investigate theoretically and empirically a potential reason for the vastly different investment and operating strategies of public and private firms. We argue that one of the important consequences of the public mode of incorporation is lower costs of external finance due, for example, to lower degree of information asymmetry surrounding public firms.

External financing costs affect firms' investment and operating strategies. To examine these effects theoretically, we construct a simple model of a partially financially constrained firm that operates under uncertainty and is controlled by an imperfectly diversified owner, who maximizes her expected utility. Uncertainty and underdiversification affect (relatively financially unconstrained) public firms' investment and operating strategies in ways that are different from the effects on (relatively constrained) private firms. In particular, our model leads to clear empirical predictions regarding the relations between diversification of firms' controlling owners and uncertainties surrounding firms on one hand and public and private firms' equilibrium investment-to-asset ratios and return on sales on

[22] The World Economic Forum has conducted the annual Survey for nearly 30 years. The Executive Opinion Survey results serve as a major component of research by a number of international and national organizations, government and research bodies, and companies.

the other hand. Investment rate and profitability of (relatively unconstrained) public firms is expected to be increasing in firm owners' portfolio diversification, while the opposite relations are expected for (relatively constrained) private firms.

We test the model's predictions empirically using the Amadeus Top 250,000 database, which provides comprehensive accounting and ownership data on firms in 34 European countries over a twelve-year period and allows us to construct measures of private and public firm owners' portfolio diversification. Our empirical results are largely consistent with the model's predictions regarding the effects of owners' diversification and demand uncertainty on public and private firms' investment and operating strategies. The results are robust to potential self-selection of firms into public or private modes of incorporation and into disclosing accounting information, and to exclusion of countries in which the link between ownership and control is relatively weak or those in which our proxies for portfolio diversification may be biased.

Our theoretical and empirical results suggest that differences in the costs of raising external capital between public and private firms are partially responsible for the observed differences between their operating and investment strategies and outcomes. In this paper we purposely abstract from choices that public and private firms make other than investment and production decisions, such as firms' capital structures and payout policies, as well as the mode of incorporation decision. Examining the potential reasons for the differences between public firms' leverage ratios and dividend and share repurchase ratios and those of private firms is likely to shed additional light on the importance of the mode of incorporation for all dimensions of firms' value maximization.

Appendix

Proof of Lemma 1

Partially differentiating (8) with respect to I and q, equating these derivatives to zero and solving the resulting system of two equations results in unconstrained optimal K^* and q^* in (13) and (14) respectively. Equating I^* to zero (or K^* to W) results in $\overline{f}$ in (12). For $f > \overline{f}$, unconstrained I^* is negative. Given the constraint of $I^* \geq 0$, $I^* = 0$ for $f \geq \overline{f}$. Differentiating (8) with respect to q, while setting I to zero (or, alternatively, K^* to W), equating the derivative to zero and solving the resulting equation with respect to q results in q^* in (15).

Proof of Proposition 1

Dividing the optimal capital investment in the unconstrained case in (13) by assets, as in (16), results in an unconstrained firm's investment-to-assets ratio:

$$\mathbb{I}^*_{unconst} = \frac{\delta^2(\mu - c - a\rho s\sigma_p x)}{(1+f)^2(4\alpha s^2\eta - 8\beta c) + (1+2f)\delta^2(\mu - a\rho s\sigma_p x) + \delta^2 c}. \tag{23}$$

Differentiating $\mathbb{I}^*_{unconst}$ in (23) with respect to σ_p results in

$$\frac{\partial \mathbb{I}^*_{unconst}}{\partial \sigma_p} = -\frac{2ac(1+f)sx\delta^2\rho((4\beta + 2as^2\eta)(1+f) - \delta^2)}{(4(2\beta c + acs^2\eta)(1+f)^2 - \delta^2 c - \delta^2\mu(1+2f) + asx\delta^2\rho\sigma_p(1+2f))^2}. \tag{24}$$

The denominator of (24) is clearly positive. The numerator of (24) is positive due to the constraint in (10). Thus, $\frac{\partial \mathbb{I}^*_{unconst}}{\partial \sigma_p}$ in (24) is negative.

Differentiating $\mathbb{I}^*_{unconst}$ in (23)with respect to ρ results in

$$\frac{\partial \mathbb{I}^*_{unconst}}{\partial \rho} = -\frac{2ac(1+f)sx\delta^2\sigma_p((4\beta + 2as^2\eta)(1+f) - \delta^2)}{(4(2\beta c + acs^2\eta)(1+f)^2 - \delta^2 c - \delta^2\mu(1+2f) + asx\delta^2\rho\sigma_p(1+2f))^2}. \tag{25}$$

$\frac{\partial \mathbb{I}^*_{unconst}}{\partial \rho}$ in (25) is negative for the same reason as $\frac{\partial \mathbb{I}^*_{unconst}}{\partial \sigma_p}$ in (24).

Dividing the capital investment in the constrained case, W, by assets, as in (16), results in a constrained firm's investment-to-assets ratio:

$$\mathbb{I}^*_{const} = \frac{W}{W + \frac{(c - \sqrt{W}\delta)(\mu - c - a\rho s\sigma_p x + \sqrt{W}\delta)}{2\beta + as^2\eta}}. \tag{26}$$

Differentiating $\mathbb{I}^*_{const}$ in (26) with respect to σ_p results in

$$\frac{\partial \mathbb{I}^*_{const}}{\partial \sigma_p} = \frac{asWx\rho(c - \sqrt{W}\delta)(2\beta + as^2\eta)}{(W(2\beta - \delta^2 + as^2\eta) + \sqrt{W}(2c\delta - \mu\delta + asx\delta\rho\sigma_p) - c^2 + c\mu - acsx\rho\sigma_p)^2}. \tag{27}$$

$c-\sqrt{W}\delta$ has to be positive to ensure positive marginal cost of production, therefore $\frac{\partial \mathbb{I}^*_{const}}{\partial \sigma_p}$ in (27) is positive as well.

Differentiating $\mathbb{I}^*_{const}$ in (26) with respect to ρ results in

$$\frac{\partial \mathbb{I}^*_{const}}{\partial \rho} = \frac{asWx\sigma_p(c-\sqrt{W}\delta)(2\beta+as^2\eta)}{(W(2\beta-\delta^2+as^2\eta)+\sqrt{W}(2c\delta-\mu\delta+asx\delta\rho\sigma_p)-c^2+c\mu-acsx\rho\sigma_p)^2}, \tag{28}$$

which is positive for the same reason as $\frac{\partial \mathbb{I}^*_{const}}{\partial \sigma_p}$ in (27).

Proof of Proposition 2

Plugging in equilibrium K^* and q^* in (13) and (14) respectively into the net profit margin in (18) results in unconstrained equilibrium profit margin:

$$\Pi^*_{unconst} = \frac{(1+f)^2(-4\beta c-4acs^2\eta+4\beta\mu+4as^2\mu\eta+4asx\beta\rho\sigma_p)-(1+2f)asx\delta^2\rho\sigma_p-\delta^2\mu+\delta^2 c}{2(1+f)(2(1+f)(\beta c+\beta\mu+as^2\mu\eta asx\beta\rho\sigma_p)-\delta^2\mu)}. \tag{29}$$

Differentiating $\Pi^*_{unconst}$ in (29) with respect to σ_p results in

$$\frac{\partial \Pi^*_{unconst}}{\partial \sigma_p} = -\frac{2asx\rho((4\beta+2as^2\eta)(1+f)-\delta^2)(4\beta c(1+f)^2-\delta^2\mu(1+2f))}{2(1+f)(2(1+f)(\beta c+\beta\mu+as^2\mu\eta+asx\beta\sigma_p\rho)-\delta^2\mu)^2}. \tag{30}$$

The denominator of (30) is positive. $(4\beta+2as^2\eta)(1+f)-\delta^2$ in the numerator of (30) is positive as well, due to the constraint in (10). The sign of (30), thus, depends on the sign of $4\beta c(1+f)^2-\delta^2\mu(1+2f)$ in the numerator. This expression is positive (negative), as is $\frac{\partial \Pi^*_{unconst}}{\partial \sigma_p}$ in (30), when $\delta < \sqrt{\frac{4\beta c(1+f)^2}{\mu(1+2f)}}$ ($\delta > \sqrt{\frac{4\beta c(1+f)^2}{\mu(1+2f)}}$).

Differentiating (29) with respect to ρ results in

$$\frac{\partial \Pi^*_{unconst}}{\partial \rho} = -\frac{2asx\sigma_p((4\beta+2as^2\eta)(1+f)-\delta^2)(4\beta c(1+f)^2-\delta^2\mu(1+2f))}{2(1+f)(2(1+f)(\beta c+\beta\mu+as^2\mu\eta+asx\beta\sigma_p\rho)-\delta^2\mu)^2}. \tag{31}$$

$\frac{\partial \Pi^*_{unconst}}{\partial \rho}$ in (31) is positive (negative) in the same range of δ as (30).

Plugging in equilibrium q^* in the constrained case in (15) and $K=W$ into (18) results in constrained equilibrium profit margin:

$$\Pi^*_{const} = 1-\frac{(2\beta+as^2\eta)(W+\frac{(c-\sqrt{W}\delta)(\mu-c-a\rho s\sigma_p x+\sqrt{W}\delta)}{2\beta+as^2\eta})}{(\mu-c-a\rho s\sigma_p x+\sqrt{W}\delta)(\mu+\frac{\beta(\mu-c-a\rho s\sigma_p x+\sqrt{W}\delta)}{2\beta+as^2\eta})}. \tag{32}$$

Differentiating Π^*_{const} in (32) with respect to σ_p results in

$$\frac{\partial \Pi^*_{const}}{\partial \sigma_p} = \frac{asx\beta\rho(c-\sqrt{W}\delta)(2\beta+as^2\eta)}{(\beta c+\beta\mu-W\beta\delta+as^2\mu\eta+asx\beta\rho\sigma_p)^2}, \tag{33}$$

which is clearly positive.

Differentiating Π^*_{const} in (32) with respect to ρ results in

$$\frac{\partial \Pi^*_{const}}{\partial \sigma_p} = \frac{asx\beta\sigma_p(c-\sqrt{W}\delta)(2\beta+as^2\eta)}{(\beta c+\beta\mu-W\beta\delta+as^2\mu\eta+asx\beta\rho\sigma_p)^2}, \tag{34}$$

which is also positive.

Proof of Proposition 3

Differentiating $\mathbb{I}^*_{unconst}$ in (23) with respect to s results in

$$\frac{\partial \mathbb{I}^*_{unconst}}{\partial s} = -\frac{2ac(1+f)(\delta^2(x\rho\sigma_p((4\beta x + 2as^2\eta\rho)(1+f) - \delta^2) + 4s\eta(\mu - c)))}{(4(2\beta c + acs^2\eta)(1+f)^2 - \delta^2 c - \delta^2\mu(1+2f) + asx\delta^2\rho\sigma_p(1+2f))^2}. \tag{35}$$

The denominator of (35) is positive. The numerator of (35) is positive as well: $4\beta x\rho\sigma_p + 2as^2x\eta\rho\sigma_p)(1+f) - \delta^2$ is positive due to the constraint in (10). In addition, $\mu > c$, resulting in (35) being negative.

Differentiating $\mathbb{I}^*_{const}$ in (26) with respect to s results in

$$\frac{\partial \mathbb{I}^*_{const}}{\partial \sigma_p} = \frac{aW(c - \sqrt{W}\delta)(s\eta(\mu - c + 2\sqrt{W}\delta) + s\eta(\mu - c - asx\delta\rho\sigma_p)}{(W(2\beta - \delta^2 + as^2\eta) + \sqrt{W}(2c\delta - \mu\delta + asx\delta\rho\sigma_p) - c^2 + c\mu - acsx\rho\sigma_p)^2}, \tag{36}$$

where both the numerator and the denominator are positive.

Proof of Proposition 4

Differentiating $\Pi^*_{unconst}$ in (29) with respect to σ_p results in

$$\frac{\partial \Pi^*_{unconst}}{\partial s} = \frac{a(\delta^2(x\rho\sigma_p((4\beta x\rho\sigma_p + 2as^2x\eta\rho\sigma_p)(1+f) - \delta^2) + 4s\eta(\mu - c)))(4\beta c(1+f)^2 - \delta^2\mu(1+2f))}{2(1+f)(2(1+f)(\beta c + \beta\mu + as^2\mu\eta + asx\beta\sigma_p\rho) - \delta^2\mu)^2}. \tag{37}$$

The denominator of (37) is positive. The sign of the numerator of (37) is the same as the sign of $4\beta c(1+f)^2 - \delta^2\mu(1+2f)$, which is positive (negative) when $\delta < \sqrt{\frac{4\beta c(1+f)^2}{\mu(1+2f)}}$ ($\delta > \sqrt{\frac{4\beta c(1+f)^2}{\mu(1+2f)}}$).

Differentiating Π^*_{const} (32) with respect to s results in

$$\frac{\partial \Pi^*_{unconst}}{\partial s} = \frac{a\beta(c - \sqrt{W}\delta)(s\eta(\mu - c + 2\sqrt{W}\delta) + s\eta(\mu - c - asx\delta\rho\sigma_p)}{(\beta c + \beta\mu - W\beta\delta + as^2\mu\eta + asx\beta\rho\sigma_p)^2}, \tag{38}$$

which is positive.

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Table 1. Summary statistics

Panel A reports some statistics of country coverage of our sample and the proportion of public and private firms in each country. Panel B reports the difference in means of the main dependent variables between public and private. Investments-to-assets ratio is defined as the year-to-year change in gross fixed assets divided by lagged total assets. Total assets are computed as the sum of fixed and current assets. Return on sales is defined as the ratio of earnings before interest and taxes (EBIT) to sales. Panel C reports descriptive statistics of all control variables for both the entire and matched samples. Private is a dummy equalling 1 if a company is privately held in a given year and equalling zero otherwise. No. firms is the total number of firms in which a companys controlling owner holds shares, directly or indirectly, in a given year, across all countries in our sample. 1-Herfindahl index is one minus the sum of the squared values of the weight that each investment has in a controlling owners portfolio. -Correlation is correlation of the mean stock return of public firms in a firm's industry with the shareholder's overall portfolio returns, multiplied by -1. Demand uncertainty is defined as the standard deviation over a given year of the equally-weighted weekly return of each 2-digit SIC industry across all countries in our sample. Demand uncertainty is taken at the beginning of each year of our sample period. Sales growth is defined as the annual relative growth rate in total revenues. Cash flow is the ratio of income plus depreciation to lagged total assets. Total leverage is defined as the ratio of total debt to total assets where total debt includes non-current liabilities (long term debt and other non-current liabilities) and current liabilities (loans, creditors and others). Ln (size) is the natural log of total assets (in thousands $ US), expressed in 1999 prices. Firm age is the number of years since incorporation.

Panel A. Number of observations by country

Country	Obs.	% Public	% Private
Austria	2,388	0.02	0.44
Belgium	29,999	0.08	5.60
Bosnia-Herzegovina	247	0.02	0.02
Bulgaria	3,338	0.09	0.54
Croatia	4,848	0.13	0.79
Czech Republic	5,776	0.02	1.08
Denmark	16,194	0.11	2.95
Estonia	1,083	0	0.20
Finland	6,894	0.08	1.23
France	107,285	0.51	19.81
Germany	21,897	0.33	3.81
Greece	14,341	0.31	2.40
Hungary	647	0.01	0.12
Iceland	130	0.01	0.02
Ireland	126	0.01	0.02
Italy	4,7401	0.17	8.80
Latvia	102	0	0.02
Liechtenstein	8	0	0
Luxembourg	354	0	0.06
Macedonia	1	0	0
Netherlands	6,980	0.08	1.24
Norway	20,338	0.11	3.74
Poland	9,426	0.02	1.76
Portugal	8,661	0.03	1.61
Romania	5,663	0.05	1.02
Russia	32	0	0
Serbia	2,736	0.22	0.30
Slovak Republic	170	0.01	0.03
Slovenia	644	0.02	0.11
Spain	60,044	0.18	11.19
Sweden	22,922	0.16	4.18
Switzerland	466	0.03	0.05
Ukraine	3,619	0.02	0.67
United Kingdom	123,350	1.3	22.06
Total	528110	4.13	95.87

Panel B. Summary statistics: Dependent variables

	Mean	Median	St. dev	No. obs
	Investment-to-assets ratio			
Public	0.1087	0.0612	0.2265	21,800
Private	0.0693	0.0313	0.1589	506,310
p-value of difference	0.0000	0.0000		
	Return on sales			
Public	0.0074	0.0505	0.3447	21,558
Private	0.0388	0.0314	0.1669	504,974
p-value of difference	0.0000	0.0000		

Panel C. Summary statistics: Main and control variables

Variable	Mean	Median	St. dev
	Main variables		
Private	0.9587	1	0.1989
No. firms	20.70	2	70.49
Ln(1+No. firms)	1.3241	0.6931	1.5286
1-Herfindhal index	0.3320	0.2733	0.3413
-Correlation	-0.8092	-1	0.2344
Demand uncertainty	0.0201	0.0186	0.0078
	Control variables		
Sales growth	0.1116	0.0512	0.5161
Cash flow	0.0875	0.0723	0.1161
Total leverage	0.6706	0.7031	0.2292
Total assets ($)	167,706	22,753	2,624,713
Ln(size)	10.2076	10.0325	1.3860
Age	25.1843	18	21.5692
Ln(1+age)	2.9777	2.9444	0.7693
Firm-year observations		528,110	
No. of firms		162,688	

Table 2. Regressions of investment and profitability on measures of diversification: Full sample

This table reports results of estimating portfolio diversification models of investment (Panel A) and profitability (Panel B) for the full sample of public and private firms during the period 1999-2010. See Table 1 for variable definitions. All regressions are estimated using OLS and include country, industry, and year fixed effects. P-values, adjusted for heteroskedasticity and clustering at the industry and country level, are reported in brackets below the coefficients. The economic significance of the portfolio diversification variables is reported beneath the p-values when the corresponding estimated coefficient is statistically significant; this number is the percentage change in the dependent variable (relative to its mean) in response to an increase in the portfolio diversification variable equal to one standard deviation.

	Panel A. Investment-to-assets ratio			Panel B. Return on sales		
	Ln(1+No. firms)	1-Herf. index	-Correlation	Ln(1+No. firms)	1-Herf. index	-Correlation
Public	0.0682***	0.0741***	0.0965***	-0.0217**	-0.0262**	0.0285***
	[0.0000]	[0.0000]	[0.0000]	[0.0381]	[0.0121]	[0.0083]
Private	0.0382***	0.0421***	0.0425***	0.0442***	0.0421***	0.0255***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0003]
Public x diver.	0.0037***	0.0145***	0.0213***	0.0077***	0.0440***	0.0525***
	[0.0000]	[0.0007]	[0.0002]	[0.0000]	[0.0000]	[0.0000]
	0.0798	0.0698	0.0704	0.3134	0.3998	0.3277
Private x diver.	-0.0003***	-0.0025***	0.0003	-0.0013***	-0.008***	-0.0155***
	[0.0093]	[0.0012]	[0.8976]	[0.0000]	[0.0000]	[0.0000]
	-0.0065	-0.0120	0.0010	-0.0529	-0.0727	-0.0967
Sales growth	0.0554***	0.0555***	0.0552***			
	[0.0000]	[0.0000]	[0.0000]			
Cash flow	0.2466***	0.2535***	0.2484***			
	[0.0000]	[0.0000]	[0.0000]			
Ln(1+age)	-0.0033***	-0.0032***	-0.0032***	-0.0004	-0.0005	-0.0005
	[0.0000]	[0.0000]	[0.0000]	[0.6746]	[0.5305]	[0.5757]
Total leverage				-0.0912***	-0.0827***	-0.0889***
				[0.0000]	[0.0000]	[0.0000]
Ln(size)				0.0064***	0.0061***	0.0065***
				[0.0000]	[0.0000]	[0.0000]
R-squared	0.161	0.163	0.162	0.061	0.060	0.061
Obs.	528,110	518,501	525,686	526,532	516,974	524,122

Table 3. Regressions of investment and profitability on demand uncertainty: Full sample

This table reports results of estimating demand uncertainty models of investment (Panel A) and profitability (Panel B) for the full sample of public and private firms during the period 1999-2010. See Table 1 for variable definitions. All regressions are estimated using OLS and include country, industry, and year fixed effects. P-values, adjusted for heteroskedasticity and clustering at the industry and country level, are reported in brackets below the coefficients. The economic significance of the portfolio diversification variables is reported beneath the p-values when the corresponding estimated coefficient is statistically significant; this number is the percentage change in the dependent variable (relative to its mean) in response to an increase in the portfolio diversification variable equal to one standard deviation.

	Panel A. Investment-to-assets ratio	Panel B. Return on sales
Public	0.0959***	0.0470***
	[0.0000]	[0.0000]
Private	0.0357***	0.0470***
	[0.0000]	[0.0000]
Public x demand uncertainty	-0.9600***	-2.3121***
	[0.0000]	[0.0000]
	-0.1055	-0.4796
Private x demand uncertainty	0.0456	-0.1109
	[0.5003]	[0.1705]
	–	–
Sales growth	0.0554***	
	[0.0000]	
Cash flow	0.2468***	
	[0.0000]	
Ln(1+age)	-0.0033***	-0.0004
	[0.0000]	[0.6578]
Total leverage		-0.0913***
		[0.0000]
Ln(Size)		0.0059***
		[0.0000]
R-squared	0.161	0.061
Obs.	527,600	526,026

Table 4. Regressions of investment ratio and profitability on measures of diversification: Matched sample

This table reports results of estimating portfolio diversification models of investment (Panel A) and profitability (Panel B) for the matched sample of public and private firms during the period 1999-2010. We use the propensity score matching estimator to find for each public firm a possible match in the sub-sample of private companies (Rosenbaum and Rubin, 1983). For the propensity score matching estimation of the investment model, we include: sales growth, cash flow, firm age, along with year, country and industry (1-digit US SIC code) dummies. For the propensity score matching estimation of the profitability model, we include: total leverage, firm size, firm age, along with year, country and industry (1-digit US SIC code) dummies. We require that the maximum difference between the propensity score of the public firm and its matching peer does not exceed 0.1% in absolute value. See Table 1 for variable definitions. All regressions are estimated using OLS and include country, industry, and year fixed effects. P-values, adjusted for heteroskedasticity and clustering at the industry and country level, are reported in brackets below the coefficients. The economic significance of the portfolio diversification variables is reported beneath the p-values when the corresponding estimated coefficient is statistically significant; this number is the percentage change in the dependent variable (relative to its mean) in response to an increase in the portfolio diversification variable equal to one standard deviation.

	Panel A. Investment-to-assets ratio			Panel B. Return on sales		
	Ln(1+No. firms)	1-Herf. index	-Correlation	Ln(1+No. firms)	1-Herf. index	-Correlation
Public	0.1804***	0.1134***	0.1240***	-0.1932***	-0.1482***	-0.1480***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Private	0.1444***	0.0744***	0.0650***	-0.1251***	-0.0766***	-0.1500***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0035]	[0.0000]
Public x diver.	0.0020**	0.0067	0.0106*	0.0024	0.0265***	0.0155
	[0.0382]	[0.1528]	[0.0873]	[0.1702]	[0.0024]	[0.1914]
	0.0376	0.0264	0.0300	–	0.3035	–
Private x diver.	-0.0020***	-0.0083**	-0.0094*	-0.0076***	-0.0275***	-0.0535***
	[0.0049]	[0.0283]	[0.0826]	[0.0000]	[0.0000]	[0.0000]
	-0.0376	-0.0327	-0.0266	-0.4233	-0.3150	-0.4456
Sales growth	0.0528***	0.0520***	0.0520***			
	[0.0000]	[0.0000]	[0.0000]			
Cash flow	0.3259***	0.3377***	0.3299***			
	[0.0000]	[0.0000]	[0.0000]			
Ln(1+age)	-0.0132***	-0.0132***	-0.0130***	0.0066**	0.0067**	0.0066**
	[0.0000]	[0.0000]	[0.0000]	[0.0362]	[0.0312]	[0.0347]
Total leverage				-0.0473***	-0.0362***	-0.0440***
				[0.0007]	[0.0085]	[0.0016]
Ln(size)				0.0176***	0.0156***	0.0175***
				[0.0000]	[0.0000]	[0.0000]
R-squared	0.183	0.185	0.183	0.085	0.084	0.085
Obs.	42,422	41,729	42,227	42,627	42,317	42,525

Table 5. Regressions of investment ratio and profitability on demand uncertainty: Matched sample

This table reports results of estimating demand uncertainty models of investment (Panel A) and profitability (Panel B) for the matched sample of public and private firms during the period 1999-2010. We use the propensity score matching estimator to find for each public firm a possible match in the sub-sample of private companies (Rosenbaum and Rubin, 1983). For the propensity score matching estimation of the investment model, we include: sales growth, cash flow, firm age, along with year, country and industry (1-digit US SIC code) dummies. For the propensity score matching estimation of the profitability model, we include: total leverage, firm size, firm age, along with year, country and industry (1-digit US SIC code) dummies. We require that the maximum difference between the propensity score of the public firm and its matching peer does not exceed 0.1% in absolute value. See Table 1 for variable definitions. All regressions are estimated using OLS and include country, industry, and year fixed effects. P-values, adjusted for heteroskedasticity and clustering at the industry and country level, are reported in brackets below the coefficients. The economic significance of the portfolio diversification variables is reported beneath the p-values when the corresponding estimated coefficient is statistically significant; this number is the percentage change in the dependent variable (relative to its mean) in response to an increase in the portfolio diversification variable equal to one standard deviation.

	Panel A. Investment-to-assets ratio	Panel B. Return on sales
Public	0.1313***	-0.1351***
	[0.0000]	[0.0000]
Private	0.0641***	-0.1345***
	[0.0000]	[0.0000]
Public x demand uncertainty	-0.7257***	-2.1742***
	[0.0094]	[0.0000]
	-0.0548	-0.4906
Private x demand uncertainty	0.3877*	0.0997
	[0.0711]	[0.7998]
	0.0432	–
Sales growth	0.0524***	
	[0.0000]	
Cash flow	0.3256***	
	[0.0000]	
Ln(1+age)	-0.0132***	0.0062**
	[0.0000]	[0.0472]
Total leverage		-0.0468***
		[0.0009]
Ln(Size)		0.0167***
		[0.0000]
R-squared	0.182	0.086
Obs.	42,477	42,579

Table 6. Regressions of investment and profitability on measures of diversification: Treatment effect model

This table reports results of estimating portfolio diversification models of investment (Panel A) and profitability (Panel B) for the matched sample of public and private firms during the period 1999-2010 using a two-stage Heckman model. All second-stage regressions are estimated using OLS and include country, industry, and year fixed effects. The independent variables in second-stage regressions are those used in Tables 2 and 4, augmented by the Inverse Mills ratio from the first-stage regressions. To conserve space, we do not report the coefficients on control variables. At the bottom of the table we include also results from the first stage probit model of the exogenous variable. The exclusion restriction is the Fraction of privately held companies in each country, 3-dgt US SIC code and year of the company of interest. In the probit model in the first stage regressions all other control variables are also included along with country, industry, and year fixed effects. The Inverse Mills ratio is calculated from the predicted values of the first stage probit regressions. P-values, adjusted for heteroskedasticity and clustering at the industry and country level, are reported in brackets below the coefficients.

	Panel A. Investment-to-assets ratio			Panel B. Return on sales		
	Ln(1+No. firms)	1-Herf. index	-Correlation	Ln(1+No. firms)	1-Herf. index	-Correlation
			Second-stage regressions			
Public	0.0181***	0.0172***	0.0458***	-0.0336***	-0.0390***	0.0197***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0002]
Private	0.0131***	0.0112***	0.0128***	0.0357***	0.0335***	0.0177***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Public x diver.	0.0044***	0.0170***	0.0279***	0.0083***	0.0457***	0.0566***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Private x diver.	-0.0005***	-0.0020***	0.0019	-0.0017***	-0.0083***	-0.0154***
	[0.0001]	[0.0000]	[0.1252]	[0.0000]	[0.0000]	[0.0000]
Inverse Mills ratio	-0.0140***	-0.0145***	-0.0144***	-0.0006	-0.0013	-0.0010
	[0.0000]	[0.0000]	[0.0000]	[0.7101]	[0.3952]	[0.5077]
			CONTROL VARIABLES			
			First-stage probit model			
Fraction of private firms	5.5042***	5.5092***	5.5139***	5.3906***	5.3897***	5.3906***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Obs.	528,110	518,501	525,686	526,532	516,974	524,122

Table 7. Regressions of investment and profitability on demand uncertainty: Treatment effect model

This table reports results of estimating demand uncertainty models of investment (Panel A) and profitability (Panel B) for the matched sample of public and private firms during the period 1999-2010 using a two-stage Heckman model. All second-stage regressions are estimated using OLS and include country, industry, and year fixed effects. The independent variables in second-stage regressions are those used in Tables 3 and 5, augmented by the Inverse Mills ratio from the first-stage regressions. To conserve space, we do not report the coefficients on control variables. At the bottom of the table we include also results from the first stage probit model of the exogenous variable. The exclusion restriction is the Fraction of privately held companies in each country, 3-dgt US SIC code and year of the company of interest. In the probit model in the first stage regressions all other control variables are also included along with country, industry, and year fixed effects. The Inverse Mills ratio is calculated from the predicted values of the first stage probit regressions. P-values, adjusted for heteroskedasticity and clustering at the industry and country level, are reported in brackets below the coefficients.

	Panel A. Investment-to-assets ratio	Panel B. Return on sales
	Second-stage regressions	
Public	0.0440***	0.0481***
	[0.0000]	[0.0000]
Private	0.0120***	0.0411***
	[0.0000]	[0.0000]
Public x demand uncertainty	-0.8496***	-2.4977***
	[0.0000]	[0.0000]
Private x demand uncertainty	0.0121	-0.0514***
	[0.7668]	[0.2510]
Inverse Mills ratio	-0.0142***	0.0026*
	[0.0000]	[0.0799]
	CONTROL VARIABLES	
	First-stage probit model	
Fraction of private firms	5.5108***	5.3879***
	[0.0000]	[0.0000]
Obs.	527,600	526,026

Table 8. Robustness checks

This table reports results of estimating portfolio diversification and demand uncertainty models of investment (Panels A-E) and profitability (Panels F-K) for the full sample of public and private firms during the period 1999-2010 using alternative variable definitions and samples. Odd columns correspond to portfolio diversification models. To conserve space, we only report results using the Ln(No. firms)-based measure of portfolio diversification. Even columns correspond to demand uncertainty models. See Table 1 for variable definitions. In Panels A and F we use alternative measures of investment and profitability. In particular, we replace investment-to-assets ratio by the sum of investment in CAPEX and investment in R&D, normalized by book assets, and we replace return on sales by return on assets. In Panels B and G we re-estimate the regressions while excluding observations from countries in which proportion of dual-class shares exceeds 10%: Sweden, Denmark, Italy, Switzerland, Finland, and Germany. In Panels C and H we re-estimate the regressions while excluding observations from countries in which the proportion of households wealth invested in mutual funds exceeds 10%: Belgium, Austria, Spain, Sweden, Germany, and Switzerland. In Panels D and I we re-estimate the regressions while excluding observations from countries in which the proportion of the gross value added of the real estate sector exceeds 10% of the total gross value added: France, Italy, Greece, Germany, Finland, Estonia, Bulgaria, and Denmark. In Panels E and J we re-estimate the regressions while excluding countries in which the disclosure of accounting information by private firm is either voluntary or not enforced or in which the disclosure criteria are undefined in the Amadeus database: Bosnia, Romania, Russia, Switzerland, Portugal, Germany, Liechtenstein, Malta, Monaco, and Slovak Republic. All regressions are estimated using OLS and include country, industry, and year fixed effects. P-values, adjusted for heteroskedasticity and clustering at the industry and country level, are reported in brackets below the coefficients.

	Panel A. Alternative dep. var.		Panel B. Dual class shares		Panel C. Household holdings		Panel D. Real estate		Panel E. Disclosure req.	
	Diver.	Uncertainty	Diver.	Uncertainty	Diver.	Uncertainty	Diver.	Uncertainty	Diver.	Uncertainty
Public	0.0795***	0.1146***	0.0549***	0.0859***	0.0672***	0.0930***	0.1273***	0.1600***	0.0364***	0.0343***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Private	0.0355***	0.0329***	0.0259***	0.0249***	0.0372***	0.0350***	0.0993***	0.0970***	0.0694***	0.0983***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]
Public x diver.	0.0057***		0.0045***		0.0040***		0.0055***		0.0035***	
	[0.0000]		[0.0000]		[0.0000]		[0.0000]		[0.0001]	
Private x diver.	-0.0003*		0.0005*		-0.0006*		-0.0009***		-0.0005*	
	[0.0519]		[0.0973]		[0.011]		[0.0057]		[0.0973]	
Public x uncertainty		-1.1219***		-1.0445***		-0.8255***		-0.9230***		-1.0077***
		[0.0000]		[0.0000]		[0.0013]		[0.0012]		[0.0000]
Private x uncertainty		0.1051		0.0221		0.0924		0.0587		0.0851
		[0.1705]		[0.7677]		[0.2543]		[0.5192]		[0.2295]
CONTROL VARIABLES										
R-squared	0.155	0.155	0.167	0.167	0.162	0.162	0.154	0.154	0.159	0.159
Obs.	528,110	527,600	434,233	433,811	390,394	390,030	309,677	309,303	493,540	493,052

	Panel F. Alternative dep. var.		Panel G. Dual class shares		Panel H. Household holdings		Panel I. Real estate		Panel J. Disclosure req.	
	Diver.	Uncertainty	Diver.	Uncertainty	Diver.	Uncertainty	Diver.	Uncertainty	Diver.	Uncertainty
Public	0.1637***	0.2024***	-0.0158	0.0539***	-0.0234*	0.0505***	-0.0609***	0.0279*	0.0429***	0.0464***
	[0.0000]	[0.0000]	[0.1719]	[0.0000]	[0.0535]	[0.0000]	[0.0002]	[0.0759]	[0.0000]	[0.0000]
Private	0.2109***	0.2076***	0.0460***	0.0479***	0.0418***	0.0445***	0.0308***	0.0325***	-0.0222*	0.0484***
	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0000]	[0.0011]	[0.0004]	[0.0503]	[0.0000]
Public x diver.	0.0097***		0.0071***		0.0074***		0.0124***		0.0075***	
	[0.0000]		[0.0000]		[0.0000]		[0.0000]		[0.0000]	
Private x diver.	0.0007		-0.0009***		-0.0016***		-0.0016***		-0.0015***	
	[0.7102]		[0.0000]		[0.0000]		[0.0000]		[0.0000]	
Public x uncertainty		-1.1722***		-2.4230***		-2.6479***		-2.6164***		-2.3848***
		[0.0000]		[0.0000]		[0.0000]		[0.0000]		[0.0000]
Private x uncertainty		-0.0484		-0.0400		-0.1383		-0.1007		-0.1045
		[0.3349]		[0.6647]		0.1641		[0.4022]		[0.6647]
					CONTROL VARIABLES					
R-squared	0.155	0.122	0.064	0.064	0.065	0.0523	0.059	0.058	0.063	0.063
Obs.	528,110	527,600	432,961	432,543	389,276	336,439	308,459	308,088	492,018	491,533