Owners' portfolio diversification and firm investment: Evidence from private and public firms *

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Abstract

We demonstrate theoretically and empirically that firms' capital investment depends on portfolio diversification of their controlling owners. The effect of owners' portfolio diversification on firms' investment levels depends crucially on firms financial constraints: the investment-diversification relation is positive for relatively unconstrained firms and is negative for relatively constrained ones. Owner fixed-effects, a quasi-natural experiment, and instrumental variable analysis suggest that this result is not driven by potential endogeneity of owners' diversification. A matched-sample analysis, selection model, and an alternative measure of financial constraints show that our findings are also not driven by the endogeneity of our proxy for financial constraints.

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1 Introduction

The vast majority of firms are controlled by imperfectly diversified owners (e.g., Benartzi and Thaler (2001), Moskowitz and Vissing-Jørgensen (2002), Agnew, Balduzzi and Sunden (2003), Heaton and Lucas (2004), Faccio, Marchica and Mura (2011), and Thesmar and Thoenig (2011)).[1] The degree of portfolio diversification of a firm's controlling owner may influence her choice of riskiness of firm strategies. The reason is that an expected-utility-maximizing risk-averse owner takes into account the variance of her overall wealth when making decisions on behalf of the firm she controls. Higher portfolio diversification reduces the variance of owner's portfolio return and its covariance with the firm's cash flow. As a result, higher portfolio diversification of firm owner lowers her risk avoidance incentives and leads to increased risk taking by the firm.

Existing empirical evidence is generally consistent with firm owners' portfolio diversification having a positive impact on their firms' risk taking (e.g., Amihud and Lev (1981) and Faccio, Marchica and Mura (2011)). The general theme in the existing literature is that firm riskiness can be reduced primarily by means of choosing safer investments, i.e. investments that result in lower cash flow volatility or stock return volatility (e.g., Low (2009), Faccio, Marchica and Mura (2011), and Gormley, Matsa and Milbourn (2013)), or lower correlation with the rest of the firm decision makers' cash flows (e.g., Amihud and Lev (1981), Anderson and Reeb (2003), and Gormley, Matsa and Milbourn (2013)).[2] However, in addition to the mix of relatively risky and safe investment projects, a firm's riskiness depends on its *level of capital investment*. For example, substituting cash for risky capital investments and/or raising external financing and investing the proceeds in risky projects increases the firm's cash flow variability (e.g., Petersen (1994), Kothari, Laguerre and Leone (2002), and Amir, Guan and Livne (2007)).

[1]This lack of diversification may be due to corporate control (e.g., Demsetz and Lehn (1985)), costly information acquisition (e.g., Van Nieuwerburgh and Veldkamp (2010)), and/or asymmetric information (e.g., Gaspar and Massa (2007) and Goetzmann and Kumar (2008)).

[2]An additional channel through which firms' decision makers may influence the firms' equity holders' cash flow variability is capital structure and payout policy (e.g., Chen, Miao and Wang (2010), Anderson and Reeb (2003), Hayes, Lemmon and Qiu (2012), and Gormley, Matsa and Milbourn (2013)).

Our model shows that in order to understand the impact of firm owners' portfolio diversification on firms' investment strategies, it is crucial to consider simultaneous choices of both the *level* and *riskiness* of firms' investments. Our analysis, which focuses on the relation between owner's portfolio diversification and firm's investment *level*, extends and complements the existing literature that focuses on the *riskiness* of firm's investment.[3] The interaction between these two decisions results in a non-trivial and somewhat surprising relation between owner's portfolio diversification and the level of her firm's capital investment.

The model demonstrates that the relation between owner's portfolio diversification and firm investment is affected crucially by financial constraints faced by the firm. In particular, in equilibrium, capital investment of firms that are unconstrained is predicted to be increasing in their owners' portfolio diversification. Interestingly, investment of constrained firms is shown to be decreasing in their owners' portfolio diversification.

The intuition is as follows. The direct effect of higher owner's portfolio diversification on an unconstrained firm's capital investment is through the reduction in the variance of owner's wealth and the resulting decrease in her risk-avoidance incentives. A more diversified owner is less concerned with higher cash flow volatility resulting from higher operating leverage, and chooses a higher level of capital investment. The result is a positive relation between owner's portfolio diversification and firm investment for unconstrained firms.

The mechanism behind the negative relation between a constrained firm's investment and its owner's portfolio diversification is different. A constrained firm cannot increase its capital investment level in response to an increase in firm owner's portfolio diversification, as its investment is determined by the investment capacity constraint. The only channel the constrained firm can use to alter its cash flow volatility is the riskiness of its investments. Higher portfolio diversification reduces firm owner's risk avoidance incentives and leads to higher optimal investment riskiness. The resulting higher cash flow volatility further tightens the firm's investment capacity constraint,

[3]Importantly, our model's result regarding the relations between owner's portfolio diversification on one hand and constrained and unconstrained firms' cash flow volatilities on the other hand is consistent with the findings in existing empirical literature (e.g., Faccio, Marchica and Mura (2011)).

for example because of increased credit rationing (e.g., Lewellen (1971), Stiglitz and Weiss (1981), Stein (2003), and Dimitrov and Tice (2006)). As a result, the level of the firm's investment declines, while its riskiness increases, as the firm's owner becomes more diversified.

To examine the empirical relation between firm owners' portfolio diversification and firms' capital investment, we use a sample of over 160,000 publicly-traded and privately-held firms across 34 European countries between 1999 and 2010. The key to our empirical analysis is proxies for owners' portfolio diversification. Measures of owners' diversification are impossible to obtain from standard (U.S.) data sources.[4] Thus, we turn to a data source that allows us to reconstruct significant portions of firms' controlling owners' portfolios – Bureau Van Dijk's Amadeus Top 250,000 database, which contains comprehensive accounting and ownership data for the universe of European firms satisfying certain size requirements. Amadeus data are being used by an increasing number of scholars and policy-making institutions. Previous studies verified the accuracy of Amadeus data with respect to representation of the population (e.g., Arellano, Bai, and Zhang (2012) and Bena and Ortiz-Molina (2013)) and both accounting and ownership data (e.g., Faccio, Marchica, and Mura (2011), Marchica and Mura (2013), and Michaely and Roberts (2012)). We also undertake further checks to verify the quality of the data.[5]

To build measures of firm owner's portfolio diversification, we identify all shareholders of each firm in the sample, while accounting for ownership pyramids, and define the ultimate controlling owner as the shareholder having the largest proportion of voting rights in the firm. Amadeus data allows us to reconstruct large parts of owners' equity portfolios. Using the composition of each controlling owner's portfolio, we construct three measures of portfolio diversification. The first measure is the number of companies (across the entire Amadeus database) in which the controlling shareholder holds any stake. The second one is the Herfindahl index of her portfolio holdings. The third measure, which is based on the estimated correlation between the controlled firm's equity return and controlling owner's portfolio return, captures the marginal contribution of the firm's

[4]Existing studies tend to use ownership concentration as an indirect proxy for controlling owners' diversification (e.g., Amihud and Lev (1981), Anderson and Reeb (2003), and John, Litov and Yeung (2008)).

[5]See section 3.1 for details.

cash flow variability to the volatility of owner's wealth.

Amadeus data has an additional important advantage: it covers both publicly-traded and privately-held firms. The evidence in Pagano, Panetta and Zingales (1998), Derrien and Kecskés (2007), Brav (2009), Hsu, Reed and Rocholl (2010), Schenone (2010), and Saunders and Steffen (2011) shows that public firms tend to have easier access to external funds than private ones. In addition, Farre-Mensa and Ljungqvist (2015) demonstrate that public firms behave as financially unconstrained, while private ones behave as constrained. In light of this evidence, we use firms' private/public status as our main measure of a firm's financial constraints.

Examining capital investment of privately-held firms is important in its own right because of the role private firms play in the economy. Private companies are responsible for over 70% of total investment in fixed assets and of revenues of all European firms.[6] Disclosure requirements obligate European private companies to publish both ownership and accounting information annually, therefore we are able to access these data for a very large set of firms. As a result, close to 96% of the observations in our sample correspond to privately-held companies.

We find that public (unconstrained) firms' capital investment is positively related to their owners' portfolio diversification. This relation is highly statistically significant and economically large: a one standard deviation increase in owner's diversification is associated with a 7%-8% increase in firm's capital investment rate. In contrast, the association between private (constrained) firm owners' portfolio diversification and investment is negative and significant in most cases. These findings are consistent with the predicted relation between owners' portfolio diversification and their firms' investment. An owner of an unconstrained firm, being able to modify both the riskiness and level of investment, would increase her firm's investment level in response to an increase in her portfolio diversification. In contrast, a constrained firm's owner, being able to modify only the riskiness of the firm's investment, would be ultimately forced to reduce the firm's investment level in response to an increase in her portfolio diversification because of the tightening of constraints

[6] Asker, Farre-Mensa and Ljungqvist (2015) document that private firms play an important role in the U.S. as well, accounting for over 50% of aggregate non-residential fixed investment and of sales. Further, Marchica and Mura (2013) report that worldwide, employment by private firms accounts for 86% of total non-government employment.

due to more volatile cash flows.

We subject our empirical strategy to several stress tests, as discussed in the next few paragraphs. The first set of tests, which includes estimation with owner fixed effects, a quasi-natural experiment, and instrumental variables analysis, addresses possible simultaneity of a firm's investment decision and its owner's portfolio diversification decision. The second set of tests tackles the issue of potential endogeneity of our proxy for a firm's financial constraints – the firm's mode of incorporation – by using matched sample analysis, selection model, and an alternative measure of financial constraints that is less likely to be endogenous. We find that possible endogeneity of firm owners' portfolio diversification and of firms' private/public status does not seem to drive our results.

To address the possibility that omitted unobserved owner characteristics may determine simultaneously the degree of owners' portfolio diversification and firms' investment decisions, we include owner fixed effects, which capture time-invariant owner characteristics (e.g., utility function, risk aversion). The inclusion of owner fixed effects does not impact the qualitative relation between owners' portfolio diversification and public and private firms' capital investment. However, our fixed-effects results may still be affected by self-selection: better diversified owners may select to invest in companies with higher investment rates, which better suit their risk preferences.

We employ a quasi-natural experiment to address the selection issue. In particular, we analyze events in which a firm's owner invests in additional firms, thus increasing her portfolio diversification (acquisition events). While acquiring a stake in additional firms is clearly an endogenous decision of an owner, such acquisitions should not affect capital investment of the other firms in the owner's portfolio unless portfolio diversification has implications for firms' investment strategies. Empirically, we observe that acquisitions, which result in increased portfolio diversification, lead to a significant increase of about 4 percentage points in mean investment-to-assets ratio of existing public firms in owners' portfolios, which corresponds to almost 40% increase in mean investment relative to the pre-acquisition level. On the other hand, private companies controlled by owners who add a firm to their portfolios experience a reduction in mean investment-to-assets ratio of about 0.6 percentage points following acquisition events, which constitutes 8% of their mean pre-acquisition capital investment. In other words, an increase in owner's portfolio diversification leads to an increase in capital investment by public (unconstrained) firms and to a reduction in investment by private (constrained) firms.

Another potential source of endogeneity is the feedback effect from firms' investment decisions to their owners' portfolio diversification (reverse causality). In particular, owners of firms that make larger and riskier capital investments may have stronger incentives to diversify their portfolios. To control for the potential feedback effect, we use an instrumental variables approach. In particular, we instrument owner's portfolio diversification with the geographical distance between the owner and her country's stock market. This instrument is based on the findings in Goetzman and Kumar (2008) that investors' under-diversification is associated with the severity of home bias, which, in turn, is higher for investors located far from the stock markets (e.g., Zhu (2003) and Grinblatt and Keloharju (2001)). Notably, in our setting, both public and private firm owners are severely under-diversified. Our instrument is likely to satisfy the exclusion restriction, i.e. owners' proximity to stock markets is not likely to have a significant impact on firms' financial constraints, which are a primary determinant of investment. For private firms, the availability of external funds is related mostly to their proximity to local banks, not to their proximity to stock markets. Publicly-listed firms can obtain funds from the stock markets regardless of physical distance from the markets. We find that the sensitivity of firms' capital investment to their owners' proximity to a stock exchange, is significantly positive for public companies and significantly negative for private ones, consistent with the model's prediction.

An additional concern is that a firm's mode of incorporation (public versus private) is not random. To address the endogeneity of firms' public/private status, we adopt three strategies. First, we document that our results hold in a matched sample, in which we use propensity score matching procedure to find, for each public firm, a private counterpart along multiple dimensions. Second, we employ a Heckman-type two-stage selection model, in which we first model firms' decision to be publicly-traded or privately-held and then re-estimate the relations between owners' portfolio diversification and firms' capital investment, while controlling for the self-selection of firms' mode of incorporation. The results remain consistent with our baseline findings.

Third, we use an alternative proxy for financial constraints. While we expect private firms to be on average more financially constrained than public ones, the two types of firms may be different along dimensions other than financial constraints. Therefore, we use an alternative measure of constraints that we can construct for both publicly-traded and privately-held European firms, which is based on several firm characteristics other than the mode of incorporation, and is less likely to be endogenous. Our alternative financial constraints measure broadly follows Campello and Chen (2010) methodology. Consistent with the rest of our findings, the relation between firms' investment and their owners' portfolio diversification is positive for financially unconstrained firms and is negative for constrained ones.

Finally, we perform a battery of additional tests to examine the robustness of our results to potential measurement errors. Our findings are robust to using alternative measures of investment; are unlikely to be driven by owners that may not be the primary decision makers in their firms; are not due to firms partially controlled by financial owners; are not driven by possible separation of firm ownership and control; are unlikely to be due to potential measurement errors in our portfolio diversification proxies; and are not driven by potentially subpar accounting and reporting standards in some countries.

Our paper contributes to several strands of literature. First, we extend the literature that examines the effects of firm owners' portfolio diversification on firm strategies by demonstrating theoretically and empirically how owners' diversification impacts firms' capital investment decisions. We show that the relation between a firm's investment and its owner's portfolio diversification depends crucially on the firm's degree of financial constraints: owners' diversification has a significantly positive impact on unconstrained firms' capital investment and a significantly negative impact on constrained firms' investment.

In addition, our paper contributes to a small but growing empirical literature that examines differences between public and private firms' strategies. In particular, previous studies that investigate differences between public and private firms' capital investment find contrasting results. Similar to us, Mortal and Reisel (2013) document that European public firms tend to invest more than private ones. On the other hand, Asker, Farre-Mensa and Ljungqvist (2015) report that private firms in the U.S. invest more than public ones and attribute this finding to more severe agency costs within public firms. Our findings suggest that owners' portfolio diversification is an important and so far overlooked driver of firms' capital investment.

2 Model

2.1 The controlling owner

We consider a situation in which a firm's controlling owner is entitled to a proportion λ of the firm's cash flow. In addition, the firm's owner is endowed with initial wealth x outside of the controlled firm, which is invested in an imperfectly diversified portfolio with a normally distributed return, whose mean is R and whose standard deviation is s. Our model abstracts from the reasons for imperfect diversification of the firm's owner, which is a feature consistent with the data.[7] Our focus is on the effects of imperfect diversification of owners' portfolios on controlled firms' investment strategies.

We assume that the firm's controlling owner is risk-averse and that she maximizes the expected utility of her terminal wealth, w. This utility is given by

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

where $a = u''(w)/u'(w)$ is the firm owner's Arrow-Pratt coefficient of absolute risk aversion. Assuming that the firm's cash flow (discussed below) is normally distributed, investor's expected utility maximization simplifies into the mean-variance criterion:

$$\mathbb{E}u(w) = \mathbb{E}w - \frac{a}{2}\mathbb{V}\text{ar}(w). \tag{2}$$

2.2 The firm

The firm is endowed with the following production technology. A capital investment of size K^2 produces uncertain cash flow αK, where the productivity parameter, α, is normally distributed with mean $\mu(\sigma)$ and standard deviation σ. We assume that the mean of the productivity parameter is

[7] See, for example, Benartzi and Thaler (2001), Moskowitz and Vissing-Jørgensen (2002), Agnew, Balduzzi and Sunden (2003), Heaton and Lucas (2004), Faccio, Marchica and Mura (2011), and Thesmar and Thoenig (2011).

a function of its volatility. In other words, by choosing σ, the firm trades off the riskiness of its investment against its expected return. This assumption is a reduced-form way of modeling the choice of the *riskiness* of investment, σ, in addition to the choice of the *level* of investment, K^2. To make the trade-off between the expected productivity and its volatility meaningful, we assume that expected productivity is increasing and concave in the chosen volatility of productivity: $\mu'(\sigma) > 0$ and $\mu''(\sigma) < 0$. In what follows, we sometimes refer to σ as the riskiness of investment. The product $K\sigma$ is the firm's resulting cash flow volatility. We denote the correlation between the productivity parameter, α, and the return to the owner's portfolio by ρ and assume that $\rho > 0$.

We assume that the firm may be financially constrained in equilibrium. In particular, the firm faces a tight constraint on the amount of funds it can raise for capital investment, which we refer to as the firm's investment capacity constraint, $\left(\overline{K}(f,\sigma)\right)^2$. This assumption is consistent with financial constraints taking the form of credit rationing by banks (e.g., Jaffee and Russell (1976) and Stiglitz and Weiss (1981)), which are the primary source of external financing for firms in our sample. Parameter f describes the severity of the constraint: $\frac{\partial \overline{K}(f,\sigma)}{\partial f} < 0$. Following Lewellen (1971), Stein (2003), and Dimitrov and Tice (2006), we assume that investment capacity is decreasing in the riskiness of investment: $\frac{\partial \overline{K}(f,\sigma)}{\partial \sigma} < 0$.[8,9]

2.3 Controlling owner's problem

The objective of the firm's controlling owner is to maximize her expected utility by choosing the level and riskiness of the firm's capital investment, K^2 and σ respectively.[10] While it is possible to endogenize the fraction of firm owner's initial wealth, x, invested in the risky external portfolio, the assumption of exogenous x is consistent with the data, which suggest that firms' controlling

[8]Lewellen (1971) and Stein (2003) argue that a reduction in volatility increases the availability of external financing (the "more money effect"), while Dimitrov and Tice (2006) confirm this relation empirically.

[9]To simplify the model, we do not allow for the owner's portfolio to serve as collateral that could partially mitigate the firm's binding financial constraint. The reason is that owners' portfolios tend to be comprised mostly of private firms' equity, which is difficult to collateralize. Allowing for the use of owner's portfolio as collateral mitigates but does not reverse the equilibrium relations discussed below.

[10]To simplify the algebra, we assume that the choice variable is the square root of capital investment, i.e. K.

owners' investments in other firms are largely predetermined. The qualitative comparative statics in a model with endogenous choice of the proportion of wealth invested in a risky portfolio are identical to the situation in which all of the external initial wealth is invested in the risky portfolio. To highlight the intuition, we present the more parsimonious model in which x is fully invested in the risky portfolio. The owner's objective function is:

$$\max_{K,\sigma} \mathbb{E}u(w) = \max_{K,\sigma} \left[-\lambda K^2 + \lambda\mu(\sigma)K + x(1+R) - \frac{a}{2}\left((\lambda K\sigma)^2 + (xs)^2 + 2\lambda K\sigma xs\rho\right)\right], \tag{3}$$

$$\text{subject to } K \leq \overline{K}(f,\sigma).$$

The first term on the right-hand-side of (3), $-\lambda K^2$, is the owner's share of the capital investment. The second term, $\lambda\mu(\sigma)K$, is the owner's share of the firm's expected cash flow. The third term, $x(1+R)$, is the expected value of the owner's external portfolio. The next three terms represent the reduction in expected utility due to the variance of the owner's terminal wealth. In particular, $(\lambda K\sigma)^2$ is the variance of the owner's share of the firm's cash flow, $(xs)^2$ is the variance of the value of the owner's external portfolio, and $\lambda K\sigma xs\rho$, is the covariance between the firm's cash flow and the external portfolio's value.

Maximizing the owner's expected utility in (3) with respect to K and σ, while assuming that the investment capacity constraint is not binding in equilibrium, leads to the following result:

Lemma 1 *If the investment capacity constraint is not binding in equilibrium, then the firm's equilibrium level of capital investment and its riskiness, K_u^{*2} and σ_u^* respectively, are given by the following system of equations:*

$$K_u^* = \frac{\mu(\sigma_u^*) - a\sigma_u^* xs\rho}{2 + a\lambda\sigma_u^{*2}}, \tag{4}$$

$$\mu'(\sigma_u^*) = axs\rho + a\lambda K_u^*\sigma_u^*, \tag{5}$$

subject to $K_u^* \leq \overline{K}(f,\sigma_u^*)$.[11]

Maximizing the owner's expected utility in (3) with respect to σ, while assuming that the investment capacity constraint is binding, i.e. that $K_u^* > \overline{K}(f,\sigma_u^*)$, leads to the following result:

[11] It follows from (5) that the condition $\mu''(\sigma) < 0$ is too restrictive. Differentiating (5) with respect to σ shows that the necessary condition to ensure unique equilibrium is $\mu''(\sigma_u^*) < a\lambda K_u^*$.

Lemma 2 *If the investment capacity constraint is binding, $K_u^* > \overline{K}(f, \sigma_u^*)$, then the firm's equilibrium riskiness of investment, σ_c^*, is given by the following equation:*

$$\mu'(\sigma_c^*) = \frac{1}{\overline{K}(f,\sigma_c^*)} \left(\frac{\partial \overline{K}(f,\sigma_c^*)}{\partial \sigma} \left(2\overline{K}(f,\sigma_c^*) - \mu(\sigma_c^*)\right) + a \left(\overline{K}(f,\sigma_c^*) + \sigma_c^* \frac{\partial \overline{K}(f,\sigma_c^*)}{\partial \sigma} \right) \left(xs\rho + \lambda \overline{K}(f,\sigma_c^*)\right) \right), \tag{6}$$

and the firm's equilibrium capital investment, K_c^* is given by

$$K_c^* = \overline{K}(f, \sigma_c^*), \tag{7}$$

2.4 Comparative statics

We are interested in the effects of controlling owner's portfolio diversification on the choice of the level and riskiness of capital investment of constrained and unconstrained firms. In what follows, we present comparative statics of the firm's investment level and its riskiness with respect to the standard deviation of the owner's portfolio, s.[12] We also graphically illustrate these comparative statics using a numerical example to help explain the intuition.

Totally differentiating the unconstrained equilibrium conditions in (4) and (5) with respect to owner's portfolio standard deviation produces the following result:

Proposition 1 *For a firm whose capital investment is unconstrained in equilibrium, $K_u^* \leq \overline{K}(f, \sigma_u^*)$, equilibrium level of capital investment and its riskiness, ${K_u^*}^2$ and σ_u^* respectively, are decreasing in the standard deviation of firm owner's portfolio, s.*

Totally differentiating the equilibrium condition for the investment riskiness of a constrained firm in (6) with respect to owner's portfolio standard deviation leads to the following result:

Proposition 2 *For a firm whose capital investment is constrained, $K_u^* > \overline{K}(f, \sigma_u^*)$, equilibrium capital investment level, ${K_c^*}^2$, is increasing in the standard deviation of its owner's portfolio, s, while equilibrium riskiness of investment, σ_c^*, is decreasing in s.*

[12] Comparative statics with respect to the correlation between the firm's cash flow and owner's portfolio return are similar. These comparative statics are available upon request.

Consider an example in which we assume the following functional forms: $\mu(\sigma) = \sqrt{\sigma}$, $\overline{K}(f, \sigma) = \frac{1}{f\sqrt{\sigma}}$, and the following parameter values: $\lambda = 0.5$, $a = 1$, $x = 10$, and $\rho = 0.5$. In Figure 1 we examine the relation between equilibrium capital investment level, $(K^*(f))^2$ (Figure 1A) and investment riskiness, $\sigma^*(f)$ (Figure 1B) on one hand and firm owner's portfolio diversification on the other hand, for two values of constraint parameters: $f_l = 400$ (relatively unconstrained firm) and $f_h = 800$ (relatively constrained firm).

Insert Figure 1

Since the standard deviation of firm owner's portfolio is inversely related to her portfolio diversification, Proposition 1 implies that both the level and the riskiness of capital investment of an unconstrained firm are increasing in its owner's portfolio diversification. The intuition is as follows. There are two effects of firm owner's portfolio diversification on the firm's investment. First, higher portfolio diversification (i.e. lower portfolio volatility, s) reduces the impact of both the level of investment, K, and its riskiness, σ, on the variance of the owner's terminal wealth, as follows from the last element of (3). In other words, an increase in firm owner's portfolio diversification reduces the marginal costs of both the level and riskiness of investment. In contrast, the expected productivity of investment, $\mu(\sigma)$, is not affected directly by owner's portfolio volatility, i.e. the marginal benefits of investment level and riskiness are unrelated to portfolio diversification. As a result, higher portfolio diversification leads to both higher optimal level of capital investment and higher investment riskiness.[13] These positive effects of owner's portfolio diversification on the level and riskiness of firm's investment are illustrated by the solid lines in Figures 1A and 1B, which depict equilibrium unconstrained capital investment level, $K_u^{*^2}$, and riskiness, σ_u^*, respectively, as

[13]There are also indirect (feedback) effects between optimal level of investment and optimal investment riskiness due to the complementary effects of investment level and riskiness on the volatility of the owner's terminal wealth. Proposition 1 shows that for a firm that is unconstrained in equilibrium, the direct positive effect of owner's portfolio diversification on firm's capital investment is always larger in magnitude than the indirect negative effect through an increase in the riskiness of investment. Thus, the overall equilibrium relation between the level of firm's capital investment and its owner's portfolio diversification is positive. Similarly, the direct positive effect of a change in portfolio diversification on firm's equilibrium investment riskiness dominates the indirect negative effect on investment riskiness through increased capital investment.

functions of owner's portfolio standard deviation, s, which ranges between 0.2 and 0.4.

The dashed line in Figure 1A depicts the equilibrium investment capacity constraint of a relatively unconstrained firm, $\left(\overline{K}(f_l, \sigma_c^*)\right)^2$. Investment capacity constraint is more binding the higher the portfolio diversification (i.e. the lower the portfolio standard deviation, s). The reason is that higher owner's portfolio diversification leads to higher optimal riskiness of the firm's investment (as shown by the solid line in Figure 1B), which, in turn, tightens the investment capacity constraint and results in lower equilibrium investment level. The thick dashed lines in Figures 1A and 1B depict equilibrium capital investment level, $(K^*(f_l))^2$, and riskiness, $\sigma^*(f_l)$, respectively of the relatively unconstrained firm.

When portfolio standard deviation is relatively low ($s < 0.25$), the unconstrained optimal capital investment is higher than the investment capacity constraint corresponding to unconstrained optimal investment riskiness, leading to lower equilibrium investment riskiness (thick dashed line in Figure 1B) and lower equilibrium capital investment level (thick dashed line in Figure 1A) than their unconstrained counterparts (solid lines in Figures 1A and 1B). When portfolio standard deviation is relatively high ($s > 0.25$), the unconstrained optimal capital investment is lower than the investment capacity constraint at unconstrained optimal investment riskiness. As a result, for $s > 0.25$, the firm is financially unconstrained in equilibrium. Assume that we would like to examine the effects of owner's portfolio diversification on firm's equilibrium capital investment and its riskiness in the vicinity of $s = 0.3$ (the vertical line in Figures 1A and 1B). At $s = 0.3$, the relation between firm's capital investment and its owner's portfolio diversification is positive for the firm that is unconstrained in equilibrium, as shown in Proposition 1.

Proposition 2, implies a negative relation between owner's portfolio diversification and capital investment of a firm that is financially constrained in equilibrium, and a positive relation between owner's diversification and the riskiness of that firm's investment. As discussed above, higher diversification of firm owner's portfolio results in a weaker effect of the riskiness of the firm's investment, σ, on the variance of owner's wealth, leading to higher optimal investment riskiness. This relation is illustrated by the thick dotted line in Figure 1B. Notably, the positive relation between firm owner's portfolio diversification and firm's riskiness for both unconstrained and constrained firms is consistent with Faccio, Marchica and Mura (2011), who find that firms' cash flow volatility is increasing in firm owners' portfolio diversification.

The intuition behind the negative relation between firm owner's portfolio diversification and the firm's investment is different for a constrained firm than for an unconstrained one. Because the investment capacity constraint is binding, the constrained firm's investment is determined by the capacity constraint effect: higher owner's portfolio diversification leads to higher optimal riskiness of the firm's investment (as shown in Figure 1B), which, in turn, tightens the investment capacity constraint and results in lower equilibrium investment level. The dotted line in Figure 1A illustrates the equilibrium investment capacity constraint of a relatively constrained firm, $\left(\overline{K}(f_h, \sigma_c^*)\right)^2$ that is decreasing in owner's portfolio diversification (i.e. increasing in owner's portfolio standard deviation, s) because of the higher riskiness of investment chosen by an owner with a more diversified portfolio. The firm with a tighter investment capacity constraint, ($f = f_h = 800$) is constrained in equilibrium over a wider range of owner's portfolio volatility: for $s < 0.35$, the firm's investment capacity (dotted line in Figure 1A) is lower than unconstrained optimal investment (dashed line in Figure 1A). In the vicinity of $s = 0.3$, capital investment is bounded by the investment capacity constraint, and the relation between equilibrium level of capital investment and portfolio diversification is determined by the effect of diversification on the tightness of the constraint. This leads to negative equilibrium relation between the level of investment of a firm that is constrained in equilibrium and its owner's portfolio diversification, illustrated by the thick dotted line in Figure 1A, as shown in Proposition 2.

3 Data and variables

3.1 Sample

The data used in our 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 publicly-traded firm and also for all privately-held companies that satisfy a minimum size threshold. 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 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. 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.[14]

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. In order to avoid biases related to both survivorship and incomplete information, we ensure that no firm-year observations are dropped from the sample because of delisting. We do so by collecting accounting data starting with the 2012 DVD and progressively moving backwards in time, each year collecting data on firms that were alive in that year. By doing so, we ensure that no firms are dropped from the sample. We gather accounting data for all firms having data available for the relevant variables for at least one year during the period 1999-2010.

We undertake a number of steps to further confirm the quality of our data by comparing them to alternative sources. First, we randomly select 500 privately-held companies from Amadeus with available information on revenues in 2010 and we search for them in two alternative databases: Dun & Bradstreet Private Company Database (D&B) and Worldscope. We then compute the correlation between revenues as reported in Amadeus and those reported in D&B and Worldscope respectively. The correlation coefficient is 0.98 in the case of D&B and 0.99 in the case of Worldscope.

In addition to accounting data, for all firm-years in our sample we collect direct ownership data. 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. Indirect (pyramidal) ownership

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

is quite common in our sample (e.g., de Jong, DeJong, Hege and Mertens (2012)). Thus, for each company that has available ownership data, we identify first all ultimate shareholders, while removing shareholders that are only generally identified in Amadeus. That is, in cases in which a direct shareholder of a firm is another firm, we identify its owners, the owners of its owners, and henceforth until we cannot trace back any further. We trace back pyramids of any length without imposing any cut-off threshold. Following Claessens, Djankov and Lang (2000), Faccio and Lang (2002) and Faccio, Marchica and Mura (2011), we calculate cash flow rights of each ultimate shareholder as the product between the links along the ownership chain; and her control rights as the weakest link along the 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. We exclude all firms in which the government is a shareholder, as these firms may have objectives other than value maximization. After combining accounting and ownership information, we end up with the final sample of 528,110 firm-year observations for 162,688 unique firms across 34 European countries.

An important implicit assumption in our analysis is that a firm's largest ultimate shareholder is the decision maker in the firm, both for privately-held and publicly-traded firms. This assumption is more likely to be satisfied in Europe, where the ownership of both public and private firms tends to be more concentrated than in a typical U.S. public firm. In the majority of cases, non-institutional investors own controlling stakes in European public companies.[15]

To further verify the sensibility of this assumption, we provide several additional pieces of evidence. First, we observe that the average largest shareholder holds 62% of the cash flow rights and 64% of the voting rights in her company. In private (public) companies the largest shareholder holds about 64% (30%) of cash flow rights and 65% (32%) of voting rights. Second, we exploit the information on the full names of directors in each company available in Amadeus. For a random sample of 5% of public and private firms we check whether the controlling owner (or a member of

[15] In more than 88% of public firms, the largest shareholder is a non-institutional investor. This is consistent with Ferreira and Matos (2008), who show that institutional investors in Europe own on average less than 20% of market capitalization.

her family) sits on the board of the controlled company. We find that controlling owners that we identify sit on their firms' boards in more than half the cases or have their relatives (i.e. people with the same last names) sitting on firms' boards in additional 11% of the cases. Further, ultimate controlling shareholders act as their firms' CEOs in about 30% of the cases. Taken together, this evidence is consistent with our presumption that ultimate controlling shareholders have a significant say in their firms' investment decisions.

3.2 Variables

Dependent variable

The dependent variable is *Investment-to-assets* ratio. Since Amadeus does not contain information on annual capital expenditures, we estimate annual capital investment as the year-to-year change in gross fixed assets (e.g., Eckbo and Thorburn (2003), Tang (2009), Wu, Zhang and Zhang (2010), and Farre-Mensa and Ljungqvist (2015)). We then normalize estimated capital investment by beginning-of-year total assets. Total assets are computed as the sum of fixed and current assets. To reduce the impact of outliers, the investment-to-assets ratio is winsorized at the top and bottom 1% of its distribution.

Measures of owner's portfolio diversification

Our first measure of owner's portfolio diversification is *Ln(number of firms)*, defined as the natural logarithm of the total number of firms in which a firm's owner holds shares, directly or indirectly, in a given year, across all countries in our sample (e.g., Barber and Odean (2000) and Goetzman and Kumar (2008), and Faccio, Marchica and Mura (2011)). The motivation behind it is that diversification is increasing in the number of stocks in a portfolio. 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 that consists mostly of privately-held firms.

Our second measure of portfolio diversification is one minus the Herfindahl index of firm owner's portfolio holdings, *1–Herfindahl index* (e.g., Bodnaruk, Kandel, Massa and Simonov (2008), Goetzman and Kumar (2008), and Faccio, Marchica and Mura (2011)). To compute the Herfindahl index of firm owner's holdings, we first calculate the dollar value of her 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. We use book equity instead of market equity because our sample consists predominantly of private firms. 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. In the analysis, we use one minus the Herfindahl index to make the interpretation of the coefficients comparable to the number-of-firms-based measure. The advantage of using a value-weighted measure, such as one minus the Herfindahl index, over an equally-weighted measure based on the number of firms, is that it reduces the potential downward bias in a portfolio diversification measure, which follows from small holdings in non-controlled firms.

Our third measure of portfolio diversification is *–Correlation*, defined as the correlation between the mean stock return of public firms in the firm's industry and the shareholder's overall portfolio return, multiplied by -1, (e.g., 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. We use mean industry return as a proxy for stock return of a given firm, which is unavailable for private firms. The drawback of this measure is that it is likely to understate diversification, as returns of two stocks within the same industry are assumed perfectly correlated by construction. An 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 controlling owner, weekly portfolio return is 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), where the weights are based on book equity.

It is important to note that despite the wide coverage of firms in Amadeus, our portfolio diversification measures may be subject to some limitations. First, small ownership stakes as well as positions in companies below the size threshold are not covered in Amadeus and, therefore, are not included in the portfolios. Second, our diversification measures do not capture non-equity investments, such as investments in bonds and real estate. This, however, should have a minor impact on our results, as real estate and fixed income investments tend to have low correlations with the firm's cash flows and are, thus, not likely to significantly affect firms' investment strategies. Third, we do not capture indirect equity investments. 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, we perform a number of robustness tests, discussed in detail below, which show that the exclusion of non-equity or indirect equity investments has only a limited impact on our findings. Fourth, 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 home bias (e.g., French and Poterba (1991) and Coval and Moskowitz (1999)), the magnitude of this measurement error is likely to be small. Only a very small proportion of European firms' controlling owners hold larger-than-5% shares of equity in non-European firms (e.g., Faccio, Marchica and Mura (2011)). In addition, Fons-Rosen, Kalemli-Ozcan, Sørensen,Villegas-Sanchez and Volosovych (2013) show that the presence of foreign ownership is not widespread worldwide: only 4% (3%) of European (U.S.) companies have non-zero foreign ownership.

Primary measure of financial constraints

Following Farre-Mensa and Ljungqvist (2015), we use *a public and private indicator* that equals one for publicly-traded and privately-held firms respectively as our primary measure of a firm's financial constraints. Farre-Mensa and Ljungqvist (2015) show that public firms appear to behave in ways consistent with being financially unconstrained, whereas private firms tend to behave as if they were constrained. They argue that traditional measures of financial constraints may fail to identify constrained firms. The use of firms' mode of incorporation as a proxy for financial constraints is also supported by a vast literature showing that public firms tend to have easier access to external funds than private ones (e.g., Pagano, Panetta and Zingales (1998), Derrien and Kecskés (2007), Brav (2009), Hsu, Reed and Rocholl (2010), Schenone (2010), and Saunders and Steffen (2011)).[16]

[16] The reason is that information asymmetry surrounding public firms is lower than that around private ones (e.g., Benveniste and Spindt (1989), Dow and Gorton (1997), and Derrien and Kecskés (2007)). Lower information

Since public and private firms may be different along dimensions other than financial constraints, we perform robustness checks in which we use an alternative measures of financial constraints that is not based on firms' public/private status. We discuss the alternative measure in Section 4.5.

Control variables

Sales growth is used as a proxy for investment opportunities, since we can construct it for all our sample firms, both publicly-traded and privately-held. This measure is commonly used in studies of private firms' strategies (e.g., Lehn and Poulsen (1989), Michaely and Roberts (2012), Mortal and Reisel (2013), and Asker, Farre-Mensa and Ljungqvist (2015)). 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 was shown to be related to investment (e.g., Fazzari, Hubbard and Petersen (1988), Kaplan and Zingales (1997), and Erickson and (2000)) is the ratio of income plus depreciation to beginning-of-year total assets.

Firm age was shown to be related to investment opportunities, as investment opportunities of mature firms may be different from those of young firms (e.g., Anderson and Reeb (2003)). 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 $\ln(1 + age)$.

3.3 Descriptive statistics

Table 1 reports the descriptive statistics for our sample that includes over half million firm-year observations from 1999 to 2010.

Insert Table 1 here

As evident from Panel A, 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

asymmetry results in weaker financial constraints (e.g., Myers and Majluf (1984) and Fazzari, Hubbard and Petersen (1988)).

majority of firms are privately-held (95.9%).

Panel B reports descriptive statistics at firm level of the dependent variable (investment-to-assets ratio), main independent variables, and control variables. The first three columns report full-sample statistics, which are followed by those for subsamples of public and private firms separately. On average, public companies have significantly higher investment-to-assets ratios than private firms: mean (median) investment rate of public firms is 10.9% (6.1%), compared with 6.9% (3.1%) for private firms. This result is consistent with the evidence in Mortal and Reisel (2013), obtained using a sample of public and private Western European firms. This evidence is also in line with the view that public firms tend to be less financially constrained than private ones.

Average (median) values of all portfolio diversification measures are significantly different between public and private firms. The ultimate largest shareholder in our sample holds on average 21 firms in her portfolio (20 for private firms and 42 for public ones).[17] However, the median number of firms in the largest shareholder's portfolio is 2 (4 for public firms). Thus, a typical largest shareholder is only moderately diversified. This evidence is consistent with Faccio, Marchica and Mura (2011) in a similar sample, with the evidence reported in Barber and Odean (2000), Moskowitz and Vissing-Jørgensen (2002), and Goetzman and Kumar (2008) in the U.S. market, and with Karhunen and Keloharju's (2001) evidence in the Finnish market. Portfolio diversification exhibits large heterogeneity. For instance, 42% of largest ultimate shareholders hold more than two companies in their portfolios, 10% of them hold at least 5 companies, and 0.5% of them hold at least 50 companies in their portfolios. Mean (median) 1-Herfindahl index of holdings of private firms is 33% (26%), compared with 42% (46%) for public firms, consistent with public firm owners being better diversified than private firm owners, although heterogeneity in portfolio diversification is exhibited by private firm owners too. Similarly, mean correlation between private firm owners' portfolio returns and the returns in the industry in which the controlled firm operates is 81%, compared with 73% for public firm owners. As for additional, non-diversification-related variables, public firms tend to be significantly older and larger, and exhibit significantly larger sales growth.

[17]These statistics are at firm-year level. At owner-year level (when each firm owner is counted once each year regardless of the number of firms she controls), the average number of firms in a portfolio is 3.4 in the full sample.

4 Empirical tests

In this section we examine empirically the relation between proxies for owners' portfolio diversification and firms' investment levels. Our model delivers equilibrium relations between owner's diversification on one hand and both investment riskiness and level. We focus on the relation between owner's diversification and the level of capital investment, since the association between owners' diversification and firm riskiness has been examined in past literature (e.g., Low (2009), Faccio, Marchica and Mura (2011), and Gormley, Matsa and Milbourn (2013)).

Propositions 1 and 2 imply that the relations between owner's portfolio diversification and firm's capital investment is positive for relatively unconstrained firms, while this relation is negative for relatively constrained ones. As discussed in Section 3.2, capital investment of private firms is likely to be constrained on average, while investment of public firms is likely to be relatively unconstrained. Thus, the model has the following empirical implication:

Empirical prediction: *The relation between firms' capital investment levels and their controlling owners' portfolio diversification is expected to be positive for public firms and negative for private ones.*

4.1 Basic regression

We begin by estimating the differential relations between private and public firms' investment on one hand and their owners' portfolio diversification on the other hand using a simple version of the q-model of investment as in Fazzari, Hubbard and Petersen (1988), augmented by the variables of our interest as follows:

$$Inv\_to\_assets_{i,t} = \alpha PUB_{i,t} + \beta PRI_{i,t} + \gamma(PUB_{i,t} * Diver_{i,t}) + \delta(PRI_{i,t} * Diver_{i,t}) + \\ \mathbf{\Theta X}_{i,t} + Country * IndustryFE + YearFE + u_{i,t}, \quad (8)$$

where $PUB_{i,t}$ ($PRI_{i,t}$) is a indicator variable equalling one if company i is publicly-traded (privately-held) in year t, and equalling zero otherwise; $Diver_{i,t}$ stands for one of our three measures of portfolio diversification (Ln(number of firms), 1-Herfindahl index, and -Correlation); $PUB_{i,t} * Diver_{i,t}$

$(PRI_{i,t} * Diver_{i,t})$ is the interaction variable equalling the product of public (private) firm indicator and one of the diversification measures; $\mathbf{X}_{i,t}$ is a vector of control variables that includes 1) sales growth, 2) cash flow, and 3) ln(1+age). Following Gormley and Matsa (2014), all regressions include country*3-digit SIC industry and year fixed effects. Standard errors are clustered at the industry-country level.

The columns in Table 2 correspond to the three portfolio diversification measures. $\widehat{\gamma}$ and $\widehat{\delta}$ represent the estimated sensitivities of investment rate to variation in owners' portfolio diversification for public and private firms separately. The model predicts a positive $\widehat{\gamma}$ and a negative $\widehat{\delta}$. Table 2 reports results of estimating the regression in (8).

Insert Table 2 here

It is evident from the public/private indicators in all three specifications (6.8% to 9.7% for public firms and 3.8% to 4.2% for private ones) that public firms invest more than private ones, ceteris paribus.

More interestingly, controlling owners' portfolio diversification has significantly different impacts on capital investment of public and private firms. Across all three measures of portfolio diversification, the relation between owners' diversification and their firms' investment-to-assets ratios is positive and significant for publicly-traded firms. The overall impact of portfolio diversification is also economically important for public companies. For example, a one-standard-deviation increase in ln(number of firms) corresponds to an average increase of almost 8% in the investment-to-assets ratio, ceteris paribus. This effect is large not only in absolute terms but also in relative terms. For comparison, a one-standard-deviation increase in cash flow, which is the primary determinant of investment, is associated with 30% increase in investment, and a one standard-deviation increase in sales growth is associated with 9% increase in investment.

In contrast, the relation between owners' portfolio diversification and firms' investment is significantly negative for two measures of portfolio diversification out of three, albeit less economically meaningful. Overall, the results in Table 2 are consistent with the model's prediction of a positive relation between owners' portfolio diversification and investment of public (unconstrained) firms and of a negative relation for private (constrained) ones.

4.2 Endogeneity of portfolio diversification

One possible concern that arises when one regresses firms' investment rates on measures of their owners' portfolio diversification is that the latter may be endogenous. Admittedly, we cannot unequivocally rule out the effects of endogeneity on our results. However, we try to address the endogeneity issue in several ways.

4.2.1 Omitted variable bias: Owner fixed effects

It is possible that in addition to the potential causal effect of owner's portfolio diversification on her firm's investment, owner's unobserved characteristics, such as her utility function or risk aversion, simultaneously affect owner's portfolio diversification and firm investment. This omitted variable bias could make our estimates in Table 2 biased and inconsistent (e.g., Wooldridge (2010)). To address this concern, we exploit the panel dimension of our database by including in the baseline regressions owner fixed effects, which should capture all time-invariant owner characteristics, and re-estimate the regression in (8).

Insert Table 3 here

In line with our baseline findings, the results in Table 3 show that a positive change in portfolio diversification is associated with a positive change in investment rate for publicly-traded firms. The relation is statistically significant at the 5% level in all three specifications and is economically larger than in the baseline regression in Table 2: a one-standard-deviation increase in measures of portfolio diversification is now associated with 10%-12% increase in capital investment.

Consistent with the baseline results in Table 2, the relation between owners' diversification and firm investment is significantly negative for privately-held firms in two out of three specifications. Importantly, the negative relation is now economically sizable: a one-standard-deviation increase in measures of portfolio diversification is associated with 4%-6% reduction in investment of private firms. Overall, including owner fixed effects strengthens the support of the model's prediction of a positive (negative) relation between owners' portfolio diversification and capital investment of unconstrained (constrained) firms.

4.2.2 Owner self-selection: Acquisitions

An additional concern related to firm owners' choices could be that more diversified owners may select to invest in companies with higher investment rates that suit better their own preferences towards risk, rather than directly affect investment decisions of these companies. If this is the case, then the causality would run from firms' investment to owners' portfolio diversification, and not the other way around.

To address possible self-selection, we use acquisition events as instances of a change in the composition of owners' portfolios, and examine subsequent changes in investment rates of public and private firms controlled by these owners. Acquiring an equity stake in a company is obviously an endogenous decision. However, if an investor is simply acquiring a firm with investment characteristics that suit her risk preferences, then we should observe no change in capital investment of the *other* existing firms in her portfolio following the acquisition of a new firm.

To perform this analysis, we first identify controlling owners who experience a net increase in the number of firms in their portfolios. Among these, we focus on acquisitions that account for at least 50% of pre-acquisition portfolio value and that are, therefore, likely to have a substantial impact on a diversifying owner's portfolio structure. We identify 8,867 such instances. We then require: 1) the *existing* firms controlled by the owner to have information on the investment-to-assets ratio before and after the acquisition; and 2) these existing firms to maintain the same private/public status before and after the acquisition to avoid possible confounding effects. We end up with a final sample of 2,357 private and 97 public companies.

Acquisition events indeed increase (mechanically) the number of firms in controlling owners' portfolios, as evident in the first two rows of both panels of Table 4. In addition to the increased number of firms, our second measure of portfolio diversification, 1-Herfindahl index of portfolio holdings increases significantly after acquisition events, suggesting that owners' portfolios become more diversified post-acquisitions.

Insert Table 4 here

If firms' controlling owners influence corporate investment decisions, then we should observe a change in the investment-to-assets ratio of existing firms controlled by diversifying owners. In particular, we expect to observe an increase in investment of existing public firms and a decrease in investment of existing private firms. Consistent with this prediction, Table 4 demonstrates that there is an increase following acquisitions in the mean investment-to-assets ratio of public firms controlled by diversifying owners, of about 4 percentage points (or close to 40% of mean pre-acquisition investment-to-assets ratio), which is significant at 10% level. In contrast, existing private companies in the diversifying owners' portfolios experience a mean decrease in investment of about 0.6 percentage points following acquisitions, which constitutes around 8% decrease relative to the mean pre-acquisition investment level. Both findings are consistent with the model and the regression results in Tables 2 and 3.

4.2.3 Reverse causality: Instrumental variables analysis

Although panel estimates with shareholder fixed effects and the event of acquisitions partially address the omitted variable bias and potential endogeneity of owners' portfolio composition, there may still be a feedback effect present from a firm's investment decisions to its owner's portfolio diversification. To address this issue we employ an instrumental variable approach as an alternative way to capture the part of owners' portfolio diversification that is arguably independent of their controlled firms' investment decisions. In particular, we use the *geographical distance* between the owner's location and the stock market of the country in which she is based as an instrument for her portfolio diversification.

The choice of this instrument is based on evidence regarding biases that shape individual and institutional investors' strategies. First, home bias is inversely related to the degree of investors' portfolio diversification (e.g., Goetzmann and Kumar (2008)). That is, the level of under-diversification of individual investors is greater among those who invest locally. Second, home bias is lower for investors located closer to the stock markets (e.g., Grinblatt and Keloharju (2001) and Zhu (2003)).[18]

[18] A possible reason is that high density of finance-related professionals around stock market areas may help firm owners increase their portfolio diversification.

Based on these two pieces of evidence, we argue that the degree of portfolio diversification is inversely related to firm owners' geographical distance from the stock markets.

Importantly, the exclusion restriction in our setting – i.e. that the distance between the firm's owner and the country's stock market does not have a direct effect on firms' investment decisions through its effect on the availability of external finance – is likely to be satisfied. For privately-held firms, the crucial determinant of the availability of external finance is their proximity to local banks (e.g., Alessandrini, Presbitero, and Zazzaro (2009) and Agarwal and Hauswald (2010)), which tend to be more geographically dispersed than stock markets. For publicly-traded firms, external financing is readily available in public markets regardless of the firms' physical distance from them. Further, there is evidence that what matters for investment is proximity to industry clusters and high-tech cities (e.g., Almazan, De Motta, Titman, and Uysal (2010)), or geographical concentration (e.g., Landier, Nair, and Wulf, 2009)), regardless of the distance to stock markets.

Our instrument is constructed in the following manner. For each controlling owner we collect information on her location using the postal code provided by Amadeus and find its latitude and longitude. Similarly, for each country we identify the location of its main stock market area. We then calculate the spherical distance $d_{j,c}$ between each shareholder j and the stock market of country c, where she is based, using the following formula:

$$
\begin{aligned}
d_{j,c} = {} & \arccos(\cos(lat_j) * \cos(lon_j) * \cos(lat_c) * \cos(lon_c) \\
& + \cos(lat_j) * \sin(lon_j * \cos(lat_c) * \sin(lon_c) + \sin(lat_j) * \sin(lat_c)) * r, \qquad (9)
\end{aligned}
$$

where lat and lon refer to the latitude and longitude in radians and r is the radius of Earth in miles. In cases in which a country has more than one stock market area (i.e. Denmark, Germany, Russia, Spain and Switzerland), we use the distance from the closest market. We are able to estimate the geographical distance to the stock market for 82,726 unique owners, corresponding to 258,324 firm-year observations. Half of firm owners are located less than 70 miles away from the stock market of their country.

In the first stage, we regress firm owner's portfolio diversification on the geographical distance between the firm owner and her country's stock market, along with all exogenous variables and (3-

digit SIC) industry, country, and year fixed effects.[19] In the second stage, we employ the predicted values of owner's portfolio diversification and its interaction with private/public status and estimate the relation between the investment-to-assets ratio and the instrument for owner's portfolio diversification interacted with the firm's public/private indicators.

For brevity, in Panel A of Table 5 we report only the estimates of the geographical distance from the first-stage regressions and their associated F-statistics. The instrument of geographical distance is significantly correlated with portfolio diversification across all models, as expected, and the F-statistics suggest that this is not a weak instrument, as discussed in Staiger and Stock (1997). Further, we check whether the geographical distance is significantly correlated with our investment variable and we do not find any significant correlation.

Insert Table 5 here

In panel B we report the second-stage estimates. Consistent with the model's prediction, the relation between capital investment and our instrument for owner's portfolio diversification is positive and significant for public firms, while it is significantly negative for private firms.

4.3 Self-selection of the mode of incorporation

The previous subsection focused on addressing potential endogeneity of firm owners' portfolio diversification. The second potential source of endogeneity is firms' public/private status. Descriptive statistics in Panel B of Table 1 show that subsamples of public and private companies differ significantly in terms of all independent variables. Thus, it is important to examine whether and to what extent our results are affected by firms' self-selection into the public and private modes of incorporation. We address this issue in three ways.

[19]Since in our tests portfolio diversification is interacted with the private/public indicator, it is possible that this interaction term is also endogenous. Therefore, following Wooldridge (2010), we use the product between geographical distance and the private/public indicator as an instrument for that interaction term and we estimate an additional first-stage model in which we regress the interaction term on its corresponding instrument along with all other exogenous variables. For brevity, we only show the first-stage regressions with portfolio diversification as dependent variable.

4.3.1 Matched sample

First, we repeat our tests within a sub-sample of public firms matched with private ones. We use the propensity score matching procedure to find for each public firm a possible match within the subsample of private firms (e.g., Rosenbaum and Rubin (1983) and Michaely and Roberts (2012)). To implement this methodology, we calculate the probability (e.g., the propensity score) of being a public firm. This probability is computed as a function of all firm characteristics that we include in the baseline model, portfolio diversification, country, industry and year dummies. To ensure that the two groups of firms are sufficiently similar, we require that the maximum difference between the propensity score of a public firm and that of its matching peer does not exceed 0.1% in absolute value. We then re-estimate the regressions in (8) within the matched sample. The results are reported in Table 6.

Insert Table 6 here

The results for public firms are qualitatively similar to the full-sample results in Table 2. The coefficient on the interaction between public firm indicator and owner's portfolio diversification is positive and significant for all three measures of diversification. The economic significance is somewhat smaller than in the baseline regressions in Table 2: a one-standard-deviation increase in a measure of portfolio diversification is associated with an average 3.1% increase in public firms' capital investment rate. The coefficient on the interaction between private firm dummy and owner's portfolio diversification is negative in all three specifications, and significant in two out of three models, as in Table 2. In these specifications, the relation between diversification and investment of private firms is economically sizable: a one-standard-deviation increase on owner's diversification is associated with an average of 3.5% reduction in firm capital investment. Similar to Table 2, the stand-alone dummies demonstrate that, ceteris paribus, public firms invest more than private ones.

4.3.2 Treatment effect model

An alternative way of dealing with potential self-selection of companies into public and private is to estimate a two-stage Heckman (1979) selection model. In the first stage, we explicitly estimate the choice between public and private status using a probit regression. In the second stage, we re-estimate our baseline model while augmenting it by the inverse Mills ratio from the first-stage regression in order to correct for potential self-selection. Following Maddala (1991), the binary choice model of the mode of incorporation is represented as:

$$P^*_{i,t} = \kappa' Z_{i,t} + v_{i,t}, \tag{10}$$

where $Z_{i,t}$ is a vector of exogenous variables that influence the choice of firm i to be either private or public: $P_{i,t}$=1 if $P^*_{i,t} > 0$ and $P_{i,t} = 0$ if $P^*_{i,t} \leq 0$. If a firm's mode of incorporation is correlated with that firm's capital investment, we would have a non-zero correlation between the error term, $v_{i,t}$ in (10), and the error term in the investment model. Therefore, estimating the latter model via OLS may lead to inconsistent estimates.

Instead, in the first stage of the Heckman (1979) model we estimate (10) with a probit regression and obtain consistent estimates of κ'. These coefficient estimates are then used to compute the inverse Mills ratio, the correction for self-selection.[20] This parameter is then included in the second-stage regressions along with all other independent variables. In this way, we can explicitly test whether a firm's private/public status is still related to its investment and operating decisions after self-selection due to unobservable factors has been controlled for (e.g., Çolak and Whited (2007)).

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 annual fraction of privately-held companies in a 3-digit SIC industry and country where a company operates in order to predict the decision to be private or public without otherwise affecting capital investment. It is unlikely that the average fraction of private firms in a certain industry in a given country influences capital investment decisions of a firm headquartered in that country and operating in that industry. 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 model. Inspection of the data reveals that this is not the case: 35% of private firms operate in the manufacturing sector; 33% in the trade sector; 15% in services; 9% in transport; and the remaining in agriculture, mining, and construction sectors. Nevertheless,

[20] The inverse Mills ratio is equal to: $\lambda_1(\kappa' Z_{it}) = \frac{-\phi(\kappa' Z_{it})}{\Phi(\kappa' Z_{it})}$ for public firms and $\lambda_2(\kappa' Z_{it}) = \frac{\phi(\kappa' Z_{it})}{1-\Phi(\kappa' Z_{it})}$ for private firms, where ϕ is the standard normal pdf, and Φ is the standard normal cdf.

to mitigate this potential bias, we include also industry, country, and year fixed effects in both the first-stage and second-stage regressions. In Panel A of Table 7 we report the estimated coefficients on the instrument only and the pseudo R squared from the first-stage regressions. The results of the second-stage regressions are reported in Panel B.

Insert Table 7 here

Augmenting the regressions by the inverse Mills ratio produces results for public firms that are consistent with the baseline results in Table 2. The coefficients on the interaction between public firm indicator and portfolio diversification are positive, statistically significant for all three measures of diversification, and somewhat larger than the corresponding figures in the baseline specification. The coefficients on the interaction between private firm dummy and owner diversification are negative and significant in two specifications out of three. Similar to the baseline results in Table 2, the economic significance of the relation between owners' diversification and firm investment is smaller for private firms than for public ones.

4.3.3 An alternative measure of financial constraints

While our tests using a matched sample of private and public firms and employing a treatment effect model are aimed at mitigating the potential bias due do self-selection of firms into public/private, they may not fully solve the selection issue. Thus, in this section we examine the relation between owners' portfolio diversification and firms' investment using a different measure of financial constraints, which is not based on firms' mode of incorporation and for which the endogeneity concerns are less severe.

The investment literature offers a number of financial constraint indices (e.g., Kaplan and Zingales (1997), Lamont, Polk and Saa-Requejo (2001), Whited and Wu (2006), and Hadlock and Pierce (2010) among others). However, recent studies cast doubt on the ability of these measures to properly capture financial constraints. For example, Farre-Mensa and Ljungqvist (2015) find that most companies that are classified as constrained according to common financial constraint indices are in fact able to raise debt and use proceeds from equity issues for increasing payout to shareholders. Bodnaruk, Loughran and McDonald (2014), Elsas, Glaser, Klepsch and Szabo (2015), and Hoberg and Maksimovic (2015) report low correlations between common financial constraint indices on one hand and alternative text-based financial constraint measures for U.S. firms or qualitative financial constraint measures for non-U.S. firms, and argue that one possible reason for these findings is the parameter instability of these indices across firms and time.[21] Comparisons of characteristics of our sample firms with those of the samples used to construct common financial constraint indices reveal dramatic differences in size, age, leverage, sales growth, capital expenditures, and cash flows. Therefore, since we do not have the qualitative information to re-create common financial constraint indices, we rely on several observable firm characteristics and follow the methodology proposed by Campello and Chen (2010) in constructing our financial constraints measure.

First, each year we independently sort firms based on several characteristics employed in Campello and Chen (2010): size, cash flow, and cash holdings (defined as the ratio of cash and cash equivalents to total assets). We include additional characteristics that previous studies showed to be associated with access to external finance: total leverage (as in Kaplan and Zingales (1997) and Whited and Wu (2006)),[22] age (included in Hadlock and Pierce (2010) index), firm-level sales growth and 2-digit SIC industry-level sales growth (both included in Whited and Wu (2006) index).[23]

Second, we rank firms into quintiles by each of the seven characteristics described above and give a score of 1 to 5, with a higher number indicating lower degree of financial constraints. We then compute the total score of each firm by adding all seven scores. This final composite financial constraints index ranges from 7 to 35. Finally, we define a firm as financially constrained

[21] Common financial constraint indices are based on coefficients estimated within small samples, with the implicit assumption that they can be applied out of sample to materially different population of firms.

[22] Replacing total leverage with coverage ratio (defined as the ratio of earnings before interest and taxes to interest paid) does not affect the results.

[23] We do not include Tobin's q (as in Kaplan and Zingales (1997)), dividend payout (as in Kaplan and Zingales (1997), Whited and Wu (2006), and Campello and Chen (2010)), and commercial paper and bond rating (as in Campello and Chen (2010)), as these variables are unavailable in our sample.

(unconstrained) if its index is higher (lower) than in-sample median.

We begin by verifying our assertion that private firms are on average more constrained than public ones. In the unconstrained subsample we find almost 67% of all public firms, compared to only 48% of all private ones. On the contrary, only 33% of public firms, compared to 52% of private ones belong to the constrained subsample. We proceed to estimating the relation between firms' investment and their owners' portfolio diversification for constrained and unconstrained firms, defined according to Campello and Chen (2010) index:

$$Inv\_to\_assets_{i,t} = \alpha Unconst_{i,t} + \beta Const_{i,t} + \gamma(Unconst_{i,t} * Diver_{i,t}) + \delta(Const_{i,t} * Diver_{i,t}) + \mathbf{\Theta X}_{i,t} + Country * IndustryFE + YearFE + u_{i,t}, \quad (11)$$

where $Const_{i,t}$ and $Unconst_{i,t}$ are indicator variables equalling one for constrained and unconstrained firms respectively.

Insert Table 8 here

The estimated coefficients on the interaction between the unconstrained firm indicator and measures of owners' portfolio diversification are significantly positive for all three measures of diversification. While the economic significance is lower than the one in Table 2, in which only public firms are designated as financially unconstrained, it is still sizable: a one-standard deviation increase in portfolio diversification measures is associated with 1.4%-2.7% increase in a typical unconstrained firm's investment. In contrast, the relation is negative and significant for constrained firms, for all three measures of portfolio diversification. The economic magnitude of this relation is larger than in Table 2: a one-standard-deviation increase in owner's diversification is associated with 1.3%-2.7% decrease in a typical constrained firm's investment. Overall, the estimates in Table 8 are consistent with the results of regressions in which we use firms' mode of incorporation's as a measure of financial constraints. These results highlight the importance of financial constraints in shaping the effect of firm owners' portfolio diversification on their firms' capital investment.

Overall, from the results in Tables 3-8, endogeneity in either owner's portfolio diversification or firm's mode of incorporation does not appear to be responsible for the positive relation between public firm owners' portfolio diversification and their firms' capital investment and the negative relation for private firms. While we acknowledge that none of these alternative tests in isolation can provide a fully convincing argument as to the direction of causality, their combination forms a body of evidence that owners' portfolio diversification affects firms' investment decisions differently for public and private firms.

4.4 Robustness tests

In this section we assess the robustness of our results with respect to a number of alternative specifications and subsamples. In these tests we use the full sample of public and private firms, employ our main proxy for financial constraints – public/private status, and estimate the regressions using OLS with the same controls as in our baseline estimation. Importantly, the vast majority of the robustness results reported below continue to hold when we control in various ways for the endogeneity of firms' mode of incorporation and of their owners' portfolio diversification. In what follows, to conserve space, we report results using only one measure of portfolio diversification (ln(number of firms)). Results (available upon request) tend to hold when we use the other two measures of diversification. Table 9 reports the summary of the robustness results.

Insert Table 9 here

4.4.1 Alternative dependent variables

Since R&D expenditures may be as important as capital expenditures for some firms, we define an alternative dependent variable, which takes into account R&D expenditures in addition to capital expenditures. Following Giannetti (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. The first column shows the results of estimating the baseline regressions using this alternative investment measure. Our main findings are robust to the alternative definition of investment: total-investment-to-assets ratio is increasing in owner's portfolio diversification for public firms, while it is decreasing in diversification for private firms, the relation being significant at the 10% level.

4.4.2 Ultimate owners: Dual class shares

One limitation of our calculation of each ultimate shareholder's voting rights is that we are unable to take into account the presence of dual class shares. The omission of dual class shares may potentially create a measurement error in the identification of (ultimate) controlling owners and, therefore, in the construction of our proxies for controlling owners' portfolio diversification. 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 sources providing accurate information on the extent of dual class shares use among private firms.

Dual class shares are used extensively only in 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.[24] 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 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 private firms' use of dual class shares mirrors the one by public firms. Therefore, we exclude the countries above from our sample and re-estimate the regression in (8). The second column demonstrates that potential bias due to dual class shares is unlikely to be responsible for our findings.

4.4.3 Voting rights

An important assumption behind our empirical analysis is that the ultimate controlling shareholders that we identify are the firms' decision makers. As discussed in Section 3.1, in most cases, this assumption is reasonable. However, in some cases, a firm's ultimate controlling shareholder owns

[24]Similar result is reported by the ECGI in their study commissioned by the European Union (2007).

only a relatively small fraction of the firm, in which case it is less clear whether she determines the firm's investment strategy. To alleviate this concern, we re-estimate the regression in (8) within the sample of firms whose ultimate shareholders have at least 10% of voting rights in their firms or sit on their firms' board. The results are reported in column 3 and are consistent with the baseline results in Table 2.

4.4.4 Financial owners

The main assumption in our analysis is that firm owners are risk-averse and underdiversified. This assumption may not hold in case of controlling owners that are themselves financial companies, which correspond to about 9% of our sample (3.1% of firms are controlled by banks, 1.2% are controlled by insurance companies, and 5% are controlled by other financial investors). To mitigate this concern, we re-estimate our baseline regression for non-financial owners and report the results in column 4. The results are consistent with the full-sample estimates in Table 2. Moreover, the negative relation between owners' portfolio diversification and investment of private firms becomes stronger.

4.4.5 Tunneling

Although in the majority of cases, owners' cash flow rights coincide with their control rights, it is not always the case: 17% (24%) of public (private) companies in our sample are controlled by largest shareholders whose voting rights exceed their cash flow rights. This wedge between voting rights and cash flow rights can be a result of dual class shares and/or of a pyramidal ownership structure. In cases in which this wedge is positive, owners may have incentives to siphon ("tunnel") firm's resources to other firms they have stakes in, at the expense of minority shareholders (e.g., Johnson, La Porta, Lopez-de-Silanes and Shleifer (2000), Bertrand, Mehta and Mullainathan (2002), and John, Litov and Yeung (2008)).

The possibility of tunneling may potentially affect the relation between firms' investment and their owners' portfolio diversification. In particular, high diversification (i.e. large number of firms in an owner's portfolio) may facilitate the transfer of controlled firm's assets to other firms in the same owner's portfolio (disinvestment). To examine whether tunneling is responsible for our results, we construct a measure of the likelihood of tunneling, which equals the wedge between voting rights and cash flow rights of each controlling shareholder, as in Claessens, Djankov, Fan, and Lang (2002). Then, we exclude firms in the top decile of the wedge distribution – i.e. observations in which controlling owners have the strongest incentives to engage in tunneling. For excluded companies, the average (median) wedge is over 13% (11%) and the largest wedge is 49%. The estimates, reported in column 5, are similar to those in the baseline specification – the sensitivity of capital investment to owners' diversification is large and significant for public firms, while it is significantly negative for private firms. This result suggests that tunneling is unlikely to be driving our results.

4.4.6 Portfolio diversification measures

As mentioned above, a potential limitation of our portfolio diversification measures is that we are not able to capture indirect equity investments. The exclusion of investments in mutual and hedge funds may bias our measures of diversification downwards, especially if the presence of mutual and hedge funds in Europe is as pervasive as in the U.S. However, 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 U.S. The average fraction of stocks held by institutional investors (mutual funds) in Europe equals 20% (4%), while the corresponding figures in the U.S. are 66% (18%). Also, the descriptive statistics of our portfolio diversification measures are similar to the estimates reported in Barber and Odean (2000) and Goetzman and Kumar (2008) for U.S. investors, and in Karhunen and Keloharju (2001) for Finnish investors. In addition, a comparable level of diversification is documented in Moskowitz and Vissing-Jørgensen (2002) for U.S. households investing in the private equity market.

Nevertheless, we attempt to mitigate the potential bias 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 exceeds 10%: Belgium, Austria, Spain, Sweden, Germany, and Switzerland. 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 repeat our tests. The results, reported in column 6, are generally consistent with our baseline findings, suggesting that this potential limitation of our portfolio diversification proxies is unlikely to be driving our empirical results.

Our second proxy for the share of mutual fund investments in each country's stock market is based on the fraction of market capitalization held by mutual funds as of 2005, reported in Ferreira and Matos (2008). 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 the regression of firms' investment on their owners' portfolio diversification. The results, which are reported in column 7, are consistent with the full-sample findings.

Similarly, our diversification measures are unable to account for real estate investments. Their exclusion may further bias our measures of owners' diversification downwards. As we do not have information on real estate investments at the individual level, we gauge their importance at the country level. We use the ratio of gross value-added of the real estate industry to gross value-added of the total economy as a proxy for the size of the real estate sector in each country. We calculate this fraction at the end of 2006 using data from the National Accounts at both sector and country levels. The idea is that the larger the size of the real estate sector in each country, the higher the investments in real estate of individuals in that country and, therefore, the larger the potential downward bias of our measures of owners' portfolio diversification.[25] 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. As

[25] 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.

above, we exclude these countries from our sample and re-estimate the investment regression. The coefficient estimates, reported in column 8, are in line with the baseline results.

4.4.7 Disclosure requirements, and accounting and reporting standards

Although most 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 and Herzegovina, 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.[26] This could lead to a potential selection bias towards successful (private) companies that choose to file financial reports. While in all our empirical specifications 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 firms incorporated in countries listed above. The results, reported in column 9, mirror our previous findings.

A further potential concern relates to the quality of accounting information across countries. Although all countries in our sample 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 still be differences in reporting standards. 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.[27] Countries in the bottom decile of the

[26]See Marchica and Mura (2013) for a more detailed analysis of the disclosure requirements in European countries.

[27]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 Survey was completed by 2,881 top European business leaders with an average of 88 respondents per country. The Survey asks 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 of financial performance (item 1.16).

accounting standards distribution are: Bosnia and Herzegovina, Ukraine, Russia, and Bulgaria. To control for potential misreporting bias, we exclude these countries from the sample. The results, reported in column 10, are similar to the baseline results.

We also control for potential corporate corruption, since the higher the perceived corruption in a country the higher the probability for firms in that country to cheat (also) in their financial statements. To control for corruption, we use a proxy of perceived ethical behavior of firms at country level.[28] To obtain a sample with relatively reliable accounting information we exclude the following countries in the bottom quartile of the business ethics ranking: Bosnia and Herzegovina, Ukraine, Russia, Romania, Macedonia, Bulgaria, Serbia, Greece, Hungary, Czech Republic, and Slovakia. The results, reported in column 11, are consistent with our baseline findings.

5 Conclusions

We investigate theoretically and empirically the relation between firms' capital investment and diversification of their owners' portfolios. Existing literature concentrates mainly on the effects of owners' portfolio diversification on firms' risk taking. We take one step further and examine the joint choice by a firm's controlling owner of the *level* and *riskiness* of the firm's investment. The interaction between these two choices drives the relation between firm owner's portfolio diversification and firm investment. Our model shows that the sign of this relation depends crucially on whether the firm's investment is constrained. In particular, the impact of owner's diversification on capital investment level is positive if a firm's investment is unconstrained and is negative if a firm is constrained.

Empirically, we examine the relation between owners' portfolio diversification and firm investment using Amadeus Top 250,000 database, which provides comprehensive accounting and ownership data on both privately-held and publicly-traded firms in 34 European countries. Using this dataset, we reconstruct equity portfolios of a large number of firms' controlling owners, which we use to build measures of owners' portfolio diversification. Amadeus' coverage of both public and

[28]This is item 1.15 in the Executive Opinion Survey.

private firms allows us to use firms' modes of incorporation as a proxy for their financial constraints, following recent evidence that public firms tend to be relatively unconstrained, while private ones are typically constrained.

Consistent with the model's predictions, we find that investment of relatively unconstrained (public) firms is positively related to their owners' portfolio diversification and that this relation is typically economically sizable. In contrast, the relation between firms' investment and their owners' diversification is significantly negative for relatively constrained (private) firms.

We show in multiple ways that these results are not likely to be driven by the endogeneity of firm owners' portfolio diversification. In particular, we use owner fixed effects to control for unobserved time-invariant shareholder characteristics that might bias the results and their interpretation. In addition, we use a quasi-natural experiment in which new firms are added to owners' portfolios to address potential selection of firms by owners. In addition, we perform an instrumental variables analysis, in which we instrument owners' diversification by their distance from capital markets, to address potential reverse causality. We also demonstrate, using matched sample, treatment effect estimations, and an alternative measure of financial constraints that is not based on firms' modes of incorporation that our results are not due to possible self-selection of firms' mode of incorporation. Further, the results are robust to a battery of additional tests that control for a) alternative definition of investment; b) separation of ownership and control rights due to prevalence of dual class shares; c) owners with large voting rights; d) various types of owners; e) potential tunneling effects; f) potential measurement errors in the portfolio diversification proxies; and g) subpar accounting and reporting standards.

Overall, our theoretical and empirical results suggest that a firm's controlling owner's portfolio diversification is an important determinant of the firm's capital investment. The relation between owner's diversification and the firm's investment level is more subtle than the relation between owner's diversification and the riskiness of the firm's investment. While the latter relation is positive for both constrained and unconstrained firms, as shown in our model and in the existing empirical studies, the effect of owner's diversification on investment depends crucially on whether the firm's investment is constrained.

The real effects of firm owners' portfolio diversification may have important policy implications. In particular, if policymakers' goal is to improve the allocation of capital and foster economic growth through capital investment, then it is important not only to reduce firms' financial constraints by enhancing capital market development, but also to reduce barriers to firm owners' portfolio diversification by fostering their participation in capital markets.

Appendix

Proof of Lemma 1 Differentiating firm owner's expected utility in (3) with respect to K results in

$$\frac{\partial \mathbb{E}u(w)}{\partial K} = -2\lambda K + \lambda\mu(\sigma) - a\lambda\sigma x s\rho - \lambda^2 K\sigma^2. \tag{12}$$

Equating (12) to zero leads to K_u^* in (4). Differentiating firm owner's expected utility in (3) with respect to σ results in

$$\frac{\partial \mathbb{E}u(w)}{\partial \sigma} = -a\lambda K x s\rho - a\lambda^2 K^2\sigma + \lambda\mu'(\sigma)K. \tag{13}$$

Equating (13) to zero leads to the equilibrium condition for σ_u^* in (5).

Proof of Lemma 2 Assume that $K_u^* > \overline{K}(f, \sigma_u^*)$. Substituting K by $\overline{K}(f,\sigma)$ in the owner's expected utility in (3) and differentiating it with respect to σ results in

$$\begin{aligned}\frac{\partial \mathrm{E}u(w)}{\partial \sigma} = &-\frac{\partial \overline{K}(f,\sigma)}{\partial \sigma}\big(2\lambda\overline{K}(f,\sigma) + \lambda\mu(\sigma)\big) + \lambda\mu'(\sigma)\overline{K}(f,\sigma) - \\ &-a\lambda\overline{K}(f,\sigma)\left(x s\rho + \lambda(\overline{K}(f,\sigma))\sigma + \sigma x s\rho + \lambda\sigma^2\frac{\partial \overline{K}(f,\sigma)}{\partial \sigma}\right).\end{aligned} \tag{14}$$

Equating (14) to zero leads to the equilibrium condition for cash flow volatility of a constrained firm, given in (6).

Proof of Proposition 1 The total differential of K_u^* in (4) with respect to s is

$$\frac{dK_u^*}{ds} = \frac{\partial K_u^*}{\partial s} + \frac{\partial \sigma_u^*}{\partial s}\frac{\partial K_u^*}{\partial \sigma}. \tag{15}$$

Partially differentiating K_u^* with respect to s produces

$$\frac{\partial K_u^*}{\partial s} = -\frac{a\sigma_u^* x\rho}{2 + \lambda a\sigma_u^{*2}}. \tag{16}$$

Plugging K_u^* in (4) into $\frac{\partial K_u^*}{\partial \sigma}$ leads to

$$\frac{\partial K_u^*}{\partial \sigma} = \frac{a x s\rho}{2 + \lambda a\sigma_u^{*2}}. \tag{17}$$

Differentiating the F.O.C. in (13) with respect to s leads to

$$\frac{\partial \sigma_u^*}{\partial s} = \frac{-ax\rho}{\lambda a K_u^* - \mu''(\sigma_u^*)}. \tag{18}$$

Plugging (16), (17), and (18) into (15) and simplifying results in

$$\frac{dK_u^*}{ds} = \frac{\mu''(\sigma_u^*)}{\lambda a K_u^* - \mu''(\sigma_u^*)}. \tag{19}$$

Since $\mu''(\sigma) < 0$ by assumption, $\frac{dK_u^*}{ds} < 0$. Totally differentiating the F.O.C. in (13) with respect to s and plugging (15) and (18) into the resulting expression leads to:

$$\frac{d\mu'(\sigma_u^*)}{ds} = -\frac{2ax\rho\mu''(\sigma_u^*)}{\left(2 + a\lambda\sigma_u^{*^2}\right)\left(\lambda a K_u^* - \mu''(\sigma_u^*)\right)}. \tag{20}$$

Since $\mu''(\sigma) < 0$ by assumption, $\frac{d\mu'(\sigma_u^*)}{ds} < 0$ and $\frac{d\sigma_u^*}{ds} < 0$.

Proof of Proposition 2 Differentiating the F.O.C. in (6) with respect to s and equating the resulting expression to zero results in

$$\frac{\partial \sigma_c^*}{\partial s} = -\frac{ax\rho\left(K_c^* + \sigma\frac{\partial K_c^*}{\partial \sigma}\right)}{\Omega}, \tag{21}$$

where

$$\Omega = \overline{K}(f,\sigma_c^*)\left(a\lambda\overline{K}(f,\sigma_c^*) - \mu''(\sigma_c^*)\right) + 2\frac{\partial \overline{K}(f,\sigma_c^*)}{\partial \sigma}\left(axs\rho + 2a\lambda\overline{K}(f,\sigma_c^*)\sigma_c^*\mu'(\sigma_c^*)\right) +$$
$$\left(\frac{\partial \overline{K}(f,\sigma_c^*)}{\partial \sigma}\right)^2\left(2 + a\lambda\sigma_c^{*^2}\right) + \frac{\partial^2\overline{K}(f,\sigma_c^*)}{\partial \sigma^2}\left(2\overline{K}(f,\sigma_c^*) - \mu(\sigma_c^*) + axs\sigma_c^*\rho + a\lambda\overline{K}(f,\sigma_c^*)\sigma_c^{*^2}\right). \tag{22}$$

Differentiating the F.O.C. in (6) with respect to σ results in $-\lambda\Omega$. Since this derivative has to be negative in equilibrium, we have $\Omega > 0$. Differentiating the owner's utility in (3) with respect to $\overline{K}(f,\sigma)$ and equating the resulting expression to zero results in

$$(2\overline{K}(f, sigma_c^*) - \mu(\sigma_c^*)) = asx\rho\sigma_c^* + a\overline{K}(f,\sigma_c^*)\sigma_c^* > 0 \tag{23}$$

Thus, it follows from the F.O.C. in (6) that

$$\frac{\partial \overline{K}(f,\sigma_c^*)}{\partial \sigma}(2\overline{K}(f,\sigma_c^*) - \mu(\sigma_c^*) < 0 \tag{24}$$

and

$$\left(\overline{K}(f,\sigma_c^*) + \sigma_c^*\frac{\partial \overline{K}(f,\sigma_c^*)}{\partial \sigma}\right) > 0. \tag{25}$$

Therefore, $\frac{d\sigma_c^*}{ds}$ in (21) is negative. Since $\frac{\partial \overline{K}(f,\sigma)}{\partial \sigma} < 0$ by assumption, $\frac{dK_c^*}{ds} > 0$.

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Figure 1. Capital investment level and riskiness, and portfolio standard deviation

Figure 1A depicts unconstrained optimal capital investment, ${K_u^*}^2$; equilibrium investment capacity of the firm with less binding constraint ($f = f_l = 400$), $\left(\overline{K}(f_l, \sigma_c^*)\right)^2$; equilibrium investment capacity of the firm with more binding constraint ($f = f_h = 800$), $\left(\overline{K}(f_h, \sigma_c^*)\right)^2$; equilibrium investment of the firm with $f = f_l$, $(K^*(f_l))^2$; and equilibrium investment of the firm with $f = f_h$, $(K^*(f_h))^2$, as functions of owner's portfolio standard deviation, s. Figure 1B depicts unconstrained optimal investment riskiness, σ_u^*; equilibrium investment riskiness of the firm with $f = f_l$, $\sigma^*(f_l)$; and equilibrium investment riskiness of the firm with $f = f_h$, $\sigma^*(f_h)$, as functions of owner's portfolio standard deviation, s. The functional forms are: $\mu(\sigma) = \sqrt{\sigma}$, $\overline{K}(f, \sigma) = \frac{1}{f\sqrt{\sigma}}$. The parameter values are: $\lambda = 0.5$, $a = 1$, $x = 10$, and $\rho = 0.5$.

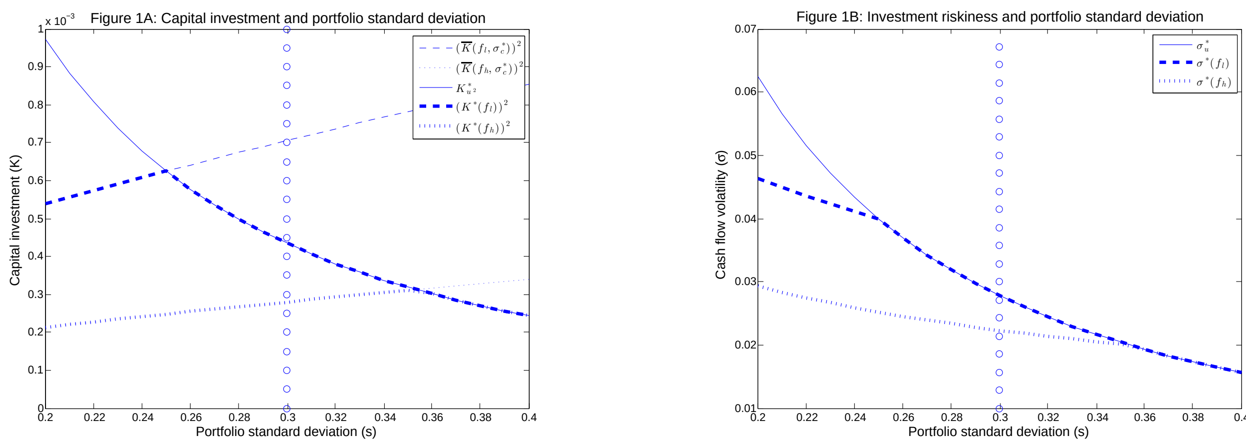

Table 1. Summary statistics

Panel A reports country coverage of our sample and the proportion of public and private firms in each country. Panel B reports descriptive statistics of the dependent and independent variables for the full sample, and separately for subsamples of public and private firms. Investment-to-assets ratio is defined as year-to-year change in gross fixed assets divided by lagged total assets, where total assets are computed as the sum of fixed and current assets. Private is a dummy equalling 1 if a company is privately-held in a given year and equalling zero otherwise. # firms is the total number of firms in which a company's 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 the controlling owner's portfolio, where the weights are based on the book value of assets. -Correlation is the correlation of mean stock return of public firms in a controlled firm's industry with the controlling owner's overall portfolio returns, multiplied by -1. Sales growth is defined as the annual growth rate in total revenues. Cash flow is the ratio of income plus depreciation to lagged total assets. Age is the number of years since incorporation. Total assets are reported in thousands $U.S. and expressed in 1999 prices.

Panel A. Number of observations by country

Country	Obs.	% of All Public	% of All Private
Austria	2,388	0.02	0.44
Belgium	29,999	0.08	5.60
Bosnia and 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	47,401	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	528,110	4.13	95.87

Panel B. Summary statistics: Dependent and independent variables

	All firms			Public firms		Private firms		p-values of diff.	
Variable	Mean	Median	St. dev	Mean	Median	Mean	Median	Mean	Median
Investment	0.0709	0.0321	0.1624	0.1087	0.0612	0.0693	0.0313	[0.000]	[0.000]
Private	0.9587	1	0.1989						
No. firms	20.70	2	70.49	42.38	4	19.77	2	[0.000]	[0.000]
Ln(# firms)	1.3241	0.6931	1.5286	1.8483	1.3863	1.3015	0.6931	[0.000]	[0.000]
1-Herfindhal index	0.3320	0.2733	0.3413	0.4191	0.4643	0.3282	0.2605	[0.000]	[0.000]
-Correlation	-0.8092	-1	0.2344	-0.7276	-0.7531	-0.8128	-1	[0.000]	[0.000]
Sales growth	0.1116	0.0512	0.5161	0.1086	0.0510	0.1822	0.0543	[0.000]	[0.106]
Cash flow	0.0875	0.0723	0.1161	0.0755	0.0753	0.0880	0.0722	[0.000]	[0.000]
Age	25.18	18	21.56	35.44	22	24.74	18	[0.000]	[0.000]
Total assets	167,706	22,753	2,624,713	1,260,874	87,516	120,638	21,895	[0.000]	[0.000]
Firm-year observations		528,110		21,211		506,899			
No. of firms		162,688		6,163		156,525			

Table 2. Regressions of investment-to-assets ratio on measures of portfolio diversification: Full sample

This table reports results of estimating the regression in (8) for the full sample of public and private firms during the period 1999-2010. The dependent variable is investment-to-assets ratio, defined as year-to-year change in gross fixed assets divided by lagged total assets, where total assets are computed as the sum of fixed and current assets. Public (private) is an indicator variable equalling one for publicly-traded (privately-held) firms and equalling zero for privately-held (publicly-traded) ones. Public x diversification (private x diversification) is the product of public (private) indicator and one of the three portfolio diversification measures: No. firms, 1-Herfindahl index, and -Correlation. All regressions are estimated using OLS and include country*industry, and year fixed effects. p-values, adjusted for heteroskedasticity and clustering at the industry-country level, are reported in brackets below the coefficients.

Measure of diversification	Ln(# firms)	1-Herf. index	-Correlation
Public	0.0682***	0.0741***	0.0965***
	[0.000]	[0.000]	[0.000]
Private	0.0382***	0.0421***	0.0425***
	[0.000]	[0.000]	[0.000]
Public x diversification	**0.0037*** **	**0.0145*** **	**0.0213*** **
	[0.000]	[0.001]	[0.000]
Private x diversification	**-0.0003*** **	**-0.0025*** **	**0.0003**
	[0.009]	[0.001]	[0.898]
Sales growth	0.0554***	0.0555***	0.0552***
	[0.000]	[0.000]	[0.000]
Cash flow	0.2466***	0.2535***	0.2484***
	[0.000]	[0.000]	[0.000]
Ln(1+age)	-0.0033***	-0.0032***	-0.0032***
	[0.000]	[0.000]	[0.000]
R-squared	0.161	0.163	0.162
Obs.	528,110	518,501	525,686

Table 3. Regressions of investment-to-assets ratio on measures of portfolio diversification: Owner fixed effects

This table reports results of estimating the regression in (8), augmented by owner fixed effects, for the full sample of public and private firms during the period 1999-2010. See Table 2 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-country level, are reported in brackets below the coefficients.

Measure of diversification	Ln(# firms)	1-Herf. Index	-Correlation
Public	0.0598***	0.0593***	0.0992***
	[0.000]	[0.000]	[0.000]
Private	0.0458***	0.0443***	0.0392***
	[0.000]	[0.000]	[0.000]
Public x diversification	**0.0046****	**0.0245*****	**0.0375*****
	[0.014]	[0.004]	[0.000]
Private x diversification	**-0.0027****	**-0.0075*****	**-0.0035**
	[0.035]	[0.008]	[0.291]
Sales growth	0.0551***	0.0553***	0.0550***
	[0.000]	[0.000]	[0.000]
Cash flow	0.2506***	0.2543***	0.2515***
	[0.000]	[0.000]	[0.000]
Ln(1+age)	-0.0037***	-0.0038***	-0.0038***
	[0.000]	[0.000]	[0.000]
R-squared	0.207	0.206	0.206
Obs.	528,110	518,501	525,686

Table 4. Post-acquisition changes in investment-to-assets ratios

This table reports changes in investment-to-assets ratios of (existing) firms controlled by owners who acquire additional (new) firms to their portfolios. Panel A reports results for existing public portfolio firms, while Panel B reports results for existing private portfolio firms. The first two rows in each panel report the mean numbers of portfolio companies pre-acquisition and post-acquisition. Rows 3 and 4 report the mean value of 1-Herfindahl index of portfolio holdings pre-acquisition and post-acquisition. Rows 5 and 6 in each panel report the mean investment-to-assets ratios pre-acquisition and post-acquisition. The third column reports the change in the mean ln(1+ number firms) and the mean investment-to-asset ratio following acquisitions. The fourth column reports p-values of the differences in column 3.

Panel A. Public firms

	Obs.	Mean	Diff. mean	P-value diff.
Ln(1+no.Firms) (pre-acquisition)	97	1.3101		
Ln(1+no.Firms) (post-acquisition)	97	1.8147	0.5046	[0.002]
1-Herfindahl index (pre-acquisition)	97	0.3160		
1-Herfindahl index (post-acquisition)	97	0.4799	0.1638	[0.000]
Investment-to-assets (pre-acquisition)	97	**0.1058**		
Investment-to-assets (post-acquisition)	97	**0.1480**	**0.0422**	[0.074]

Panel B. Private firms

	Obs.	Mean	Diff. mean	P-value diff.
Ln(1+no.Firms) (pre-acquisition)	2,357	1.5285		
Ln(1+no.Firms) (post-acquisition)	2,357	1.8699	0.3414	[0.000]
1-Herfindahl index (pre-acquisition)	2,357	0.4039		
1-Herfindahl index (post-acquisition)	2,357	0.5067	0.1028	[0.000]
Investment-to-assets (pre-acquisition)	2,357	**0.0767**		
Investment-to-assets (post-acquisition)	2,357	**0.0706**	**-0.0061**	[0.088]

Table 5. Regressions of investment-to-assets ratio on measures of portfolio diversification: Instrumental variables

This table reports results of estimating the regression in (8), for the full sample of public and private firms during the period 1999-2010, while using an instrument for portfolio diversification. The instrument is the spherical distance between firm owner and the stock market in her country. In the first stage, we regress owner's portfolio diversification on the geographical distance between the firm owner and her country's stock market, along with all exogenous variables and industry, country, and year fixed effects. In the second stage, we employ the predicted values of the owners' portfolio diversification from the first-stage regressions. For brevity, in Panel A we report only the estimated coefficients of the geographical distance. We also report the F-statistics of the instruments from the first stage regressions. In Panel B we report the second-stage estimates. All second-stage regressions are estimated using OLS and include country*industry, and year fixed effects. See Table 2 for variable definitions. p-values, adjusted for heteroskedasticity and clustering at the industry-country level, are reported in brackets below the coefficients. The p-value of the significance of the difference between public x diversification and private x diversification are reported in square brackets underneath the private x diversification coefficients.

Panel A. First-stage regressions			
IV: distance from capital markets	-0.005***	-0.001***	-0.003***
	[0.000]	[0.000]	[0.000]
F-test of excl. instr.	207.8	155.3	251.7

Panel B. Second-stage regressions			
Measure of diversification	Ln(# firms)	1-Herfindhal Index	-Correlation
Public	-1.8828	-2.2171	7.0917*
	[0.104]	[0.111]	[0.076]
Private	0.1352***	0.1609**	-0.0990
	[0.005]	[0.020]	[0.264]
Public x predicted diversification	**1.4188***	**6.6196***	**8.8666***
	[0.086]	[0.093]	[0.083]
Private x predicted diversification	**-0.0312****	**-0.1704***	**-0.2634***
	[0.045]	[0.060]	[0.061]
Sales growth	0.0549***	0.0550***	0.0587***
	[0.000]	[0.000]	[0.000]
Cash flow	0.2502***	0.2484***	0.2515***
	[0.000]	[0.000]	[0.000]
Ln(1+age)	-0.0234**	-0.0251**	-0.0212**
	[0.036]	[0.046]	[0.038]
Obs.	258,324	254,888	257,407

Table 6. Regressions of investment-to-assets ratio on measures of portfolio diversification: Matched sample

This table reports results of estimating the regression in (8) 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. The propensity score is estimated as a function of all firm characteristics included in the baseline model (sales growth, cash flow, and firm age), portfolio diversification, country, industry and year 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 2 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-country level, are reported in brackets below the coefficients.

Measure of diversification	Ln(# firms)	1-Herf. index	-Correlation
Public	0.1046***	0.1046***	0.1800***
	[0.000]	[0.000]	[0.000]
Private	0.0696***	0.0686***	0.1270***
	[0.000]	[0.000]	[0.000]
Public x diversification	**0.0021****	**0.0077***	**0.0118***
	[0.028]	[0.099]	[0.053]
Private x diversification	**-0.0013***	**-0.0073****	**-0.0022**
	[0.093]	[0.027]	[0.630]
Sales growth	0.0514***	0.0514***	0.0510***
	[0.000]	[0.000]	[0.000]
Cash flow	0.3471***	0.3568***	0.3519***
	[0.000]	[0.000]	[0.000]
Ln(1+age)	-0.0128***	-0.0127***	-0.0128***
	[0.000]	[0.000]	[0.000]
R-squared	0.182	0.184	0.183
Obs.	42,506	41,873	42,342

Table 7. Regressions of investment-to assets ratio on measures of portfolio diversification: Treatment effect model

This table reports results of estimating the regression in (8) for the full sample of public and private firms during the period 1999-2010 using a two-stage Heckman model. The exclusion restriction is the fraction of private firms in each country, 3-digit U.S. SIC code and year of the company of interest. In Panel A, for brevity, we only report the estimated coefficients on the instrument and the pseudo R squared. In Panel B, we present results of the second-stage regressions. 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 the baseline regressions, augmented by the inverse Mills ratio from the first-stage regressions. See Table 2 for variable definitions. 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-country level, are reported in brackets below the coefficients.

Panel A. First-stage regressions			
Excl. rest.: Fraction of private firms	5.5042***	5.5092***	5.5139***
	[0.000]	[0.000]	[0.000]
Pseudo R-squared	0.297	0.296	0.297

Panel B. Second-stage regressions			
Measure of diversification	Ln(# firms)	1-Herf. index	-Correlation
Public	0.0181***	0.0172***	0.0458***
	[0.000]	[0.000]	[0.000]
Private	0.0131***	0.0112***	0.0128***
	[0.000]	[0.000]	[0.000]
Public x diversification	**0.0044*** **	**0.0170*** **	**0.0279*** **
	[0.000]	[0.000]	[0.000]
Private x diversification	**-0.0005*** **	**-0.0020*** **	**0.0019**
	[0.000]	[0.000]	[0.125]
Inverse Mills ratio	-0.0140***	-0.0145***	-0.0144***
	[0.000]	[0.000]	[0.000]
Sales growth	0.0560***	0.0561***	0.0577***
	[0.000]	[0.000]	[0.000]
Cash flow	0.2565***	0.2635***	0.2583***
	[0.000]	[0.000]	[0.000]
Ln(1+age)	-0.0025***	-0.0024***	-0.0025***
	[0.000]	[0.000]	[0.000]
Obs.	527,427	517,645	524,826

Table 8. Regressions of investment-to assets ratio on measures of portfolio diversification: Financial constraints

This table reports results of estimating (11) for the full sample of public and private firms during the period 1999-2010. Unconstrained (constrained) is an indicator variable equalling one for firms defined as unconstrained (constrained) according to Campello and Chen (2010) methodology. Unconstrained x diversification (constrained x diversification) is the product of unconstrained (constrained) indicator and one of the three portfolio diversification measures: No. firms, 1-Herfindahl index, and -Correlation. See Table 2 for definitions of the rest of the variables. All regressions are estimated using OLS and include country*industry, and year fixed effects. p-values, adjusted for heteroskedasticity and clustering at the industry-country level, are reported in brackets below the coefficients.

Measure of diversification	Ln(# firms)	1-Herfindhal Index	-Correlation
Unconstrained	0.0533***	0.0578***	0.0607***
	[0.000]	[0.000]	[0.000]
Constrained	0.0403***	0.0452***	0.0354***
	[0.000]	[0.000]	[0.000]
Unconstrained x diversification	**0.0008****	**0.0029****	**0.0082*****
	[0.017]	[0.037]	[0.000]
Constrained x diversification	**-0.0012*****	**-0.0055*****	**-0.0039*****
	[0.000]	[0.000]	[0.017]
Sales Growth	0.0535***	0.0536***	0.0533***
	[0.000]	[0.000]	[0.000]
Cash Flow	0.2323***	0.2393***	0.2340***
	[0.000]	[0.000]	[0.000]
Ln(1+age)	-0.0054***	-0.0052***	-0.0053***
	[0.000]	[0.000]	[0.000]
R-squared	0.164	0.166	0.165
Obs.	470,799	462,200	468,623

Table 9. Robustness checks

This table reports results of estimating the regression in (8) using alternative variable definitions and samples. To conserve space, we only report results using ln(1+number of firms) and the main independent variables. (The other control variables are the same as in the baseline model in (8).) See Table 2 for variable definitions. In column 1 we use an alternative measure of investment-to-assets ratio. In particular, we replace investment-to-assets ratio by the sum of investment in CAPEX and investment in R&D, normalized by lagged book assets. In column 2 we re-estimate the regression while excluding observations from countries in which the proportion of dual-class shares exceeds 10%: Sweden, Denmark, Italy, Switzerland, Finland, and Germany. In column 3 we re-estimate the regression while excluding observations in which the controlling owner holds less than 10% of voting rights. In column 4 we re-estimate the regression while excluding firm-years in which the controlling owner is a financial company. In column 5 we re-estimate the regression while using a subsample of firm-years in which the wedge between owners' voting rights and cash flow rights does not belong to the top decile. In column 6 we re-estimate the regression 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 column 7 we re-estimate the regression while excluding observations from countries in which the ownership of the stock market by mutual funds exceeds 5%: Sweden, Ireland, Finland, Luxembourg, Netherlands, and Switzerland. In column 8 we re-estimate the regression 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 column 9 we re-estimate the regression while excluding observations from 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 and Herzegovina, Romania, Russia, Switzerland, Portugal, Germany, Liechtenstein, Malta, Monaco, and Slovak Republic. In column 10 we re-estimate the regression while excluding countries in which the reporting standards are low: Bosnia and Herzegovina, Ukraine, Russia, and Bulgaria. In column 11 we re-estimate the regression while excluding observations from countries that belong to the lowest quintile of the business ethic ranking: Bosnia and Herzegovina, Ukraine, Russia, Romania, Macedonia, Bulgaria, Serbia, Greece, Hungary, Czech Republic, and Slovakia. All regressions are estimated using OLS and include country*industry, and year fixed effects. p-values, adjusted for heteroskedasticity and clustering at the industry-country level, are reported in brackets below the coefficients.

	1	2	3	4	5	6	7	8	9	10	11
	Alternative dependent variable	Dual-class shares	Voting rights	Financial owners	Tunneling	Household investments in mutual funds	Mutual fund market capitalization	Real estate investments	Disclosure requirements	Accounting quality	Corruption
Public	0.0795***	0.0549***	0.0668***	0.1239***	0.0702***	0.0672***	0.0668***	0.1273***	0.0364***	0.0737***	0.0716***
	[0.000]	[0.000]	[0.000]	[0.000] [0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	
Private	0.0355***	0.0259***	0.0378***	0.929***	0.0381***	0.0372***	0.0378***	0.0993***	0.0694***	0.0367***	0.0336***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Public x diversification	**0.0057*** **	**0.0045*** **	**0.0038*** **	**0.0028** **	**0.0031*** **	**0.0040*** **	**0.0042*** **	**0.0055*** **	**0.0035*** **	**0.0025*** **	**0.0025*** **
	[0.000]	[0.000]	[0.000]	[0.019]	[0.001]	[0.000]	0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Private x diversification	**-0.0003***	**-0.0005** **	**-0.0006** **	**-0.0009*** **	**-0.0005***	**-0.0006***	**-0.0006*** **	**-0.0009*** **	**-0.0005***	**-0.0005** **	**-0.0004***
	[0.052]	[0.097]	[0.013]	[0.000]	[0.040]	[0.011]	[0.006]	[0.006]	[0.097]	[0.030]	[0.079]
R-squared	0.155	0.167	0.163	0.162	0.161	0.162	0.164	0.154	0.159	0.159	0.155
Obs.	528,110	434,233	495,744	480,198	475,299	390,394	490,368	309,677	493,540	518,129	486,582