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# Managerial Ownership, Entrenchment and Innovation

Mila Beyer, Dirk Czarnitzki,
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ZEW
Zentrum für Europäische
Wirtschaftsforschung GmbH
Centre for European
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## Non-technical summary

Economic theory suggests that managers' investment behavior differs from that of owners. On the one hand, managers might under-invest into R&D compared to owners for reasons of risk. R&D projects are typically risky, long-term investments with a high failure rate. Because project failure can have detrimental effects on a manager's career and eventually lead to job loss, managers might under-invest into R&D projects. On the other hand, managers might over-invest into R&D compared to owners for reasons of growth. Innovation fosters growth, which is found to go along with greater managerial remuneration, power and prestige.

In reality, however, the concept of manager-led versus owner-led firms turns out to be fuzzy, as many managers frequently own shares of their firms. Therefore, the literature discusses incentive effects and entrenchment effects. With an increasing amount of company shares held by the manager, his behavior becomes more aligned to the owners interest (incentive effect). But at the same time ownership shares also result in higher job security for the manager and, hence, make him powerful enough to pursue own goals and disregard owners' interests (entrenchment effect).

In this study, we investigate empirically whether managerial ownership affects a firm's R&D expenditure using a sample of 1,406 Belgian firms. First, we find that managers holding no company shares under-invest into innovation when compared to owners giving rise to the risk argument. These managers seem to have insufficient incentives to invest into R&D, as they fear that project failure could negatively affect their careers. Second, we find an inverse u-shape relationship between the degree of managerial ownership and R&D expenditure. This indicates that managers become entrenched when holding a sufficient amount of company shares. Higher job security allows the managers to pursue their own interests, i.e. to over-invest into innovation for reasons of growth. Due to their ownership shares managers do not have to fear detrimental effects on their career in case of project failure. This reduces the risk tied to R&D investments while the positive aspects remain.

## Das Wichtigste in Kürze

Die Theorie managementgeleiteter Unternehmen geht davon aus, dass sich Investitionsentscheidungen von Managern, die zwar ein Unternehmen führen, aber nicht besitzen, von denen der Eigner unterscheiden können. Zum einen könnten Manager bei Entscheidungen hinsichtlich Forschung und Entwicklung (FuE) aufgrund des damit verbundenen hohen Risikos aus Sicht der Eigner zu wenig investieren. FuE-Projekte sind typische Beispiele für langfristige und riskante Projekte mit ungewissem Ausgang. Scheitern Projekte, so wird sich dies negativ auf die Bewertung des Managers seitens der Eigner auswirken und kann schlimmsten Falls sogar zum Arbeitsplatzverlust führen. Zum anderen könnten Manager aus Sicht der Eigner auch zu viel in FuE-Projekte investieren, um das Unternehmenswachstum zu fördern. Anreiz hierfür ist, dass Wachstum mit einer höheren Entlohnung des Managements, Macht und gesellschaftlichem Ansehen einhergeht.

In der Realität ist die Unterscheidung zwischen Managern und Eignern jedoch nicht trivial, da Manager häufig am Unternehmenskapital beteiligt werden. Aus theoretischer Sicht führt Anteilseigentum des Managers zu zwei gegenläufigen Effekten. Mit steigendem Anteilseigentum nähert sich das Verhalten des Managers dem der Eigner an (Anreiz-Effekt). Gleichzeitig führt ein größerer Kapitalanteil des Managers auch zu einer erhöhten Arbeitsplatzsicherheit, welche den Manager mächtiger macht und ihm mehr Spielraum gibt im eigenen Interesse, nicht aber dem Interesse der anderen Anteilseigner, zu handeln (Entrenchment-Effekt).

In dieser Studie wird auf Basis eines Datensatzes von 1406 belgischen Unternehmen untersucht, wie sich eine Kapitalbeteiligung des Managements auf die FuE-Ausgaben auswirkt. Manager, die keine Anteile halten, investieren weniger in FuE als Manager, die 100% der Anteile besitzen. Dies weist darauf hin, dass Manager versuchen das Risiko des Scheiterns eines FuE-Projekts mit den entsprechenden negativen Auswirkungen auf ihre Karriere zu reduzieren, d.h. sie haben unzureichende Anreize in FuE zu investieren. Weiterhin finden wir einen invers u-förmigen Verlauf zwischen Managereigentum und der Höhe der FuE-Ausgaben. Hält ein Manager einen hinreichend großen Anteil am Unternehmen, so nutzt er diese Möglichkeit, um aus Sicht der anderen Eigentümer zu viel für FuE aufzuwenden. Aufgrund des eigenen Unternehmensbesitzes müssen Manager bei Scheitern eines Projektes weniger um ihren Arbeitsplatz fürchten, was bedeutet, dass FuE-Investitionen für sie in geringerem Maße Risiken darstellen, wohingegen die positiven Aspekte bestehen bleiben.

# Managerial ownership, entrenchment and innovation*

Mila Beyer [a, b], Dirk Czarnitzki [a, b, c] and Kornelius Kraft [d, b]

*a) K.U. Leuven, Dept. of Managerial Economics, Strategy and Innovation, Leuven, Belgium*
*b) Centre for European Economic Research (ZEW), Mannheim, Germany*
*c) Centre for R&D Monitoring (ECOOM), Leuven, Belgium*
*d) Technical University of Dortmund, Faculty of Business, Economics and Social Sciences, Dortmund, Germany*

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**Abstract**

Principle-agent theory suggests managers might under-invest into R&D for reasons of risk tied to project failure, such as reduced remuneration and job loss. However, managers might over-invest into innovation for reasons of growth implying higher remuneration, power and prestige. Using a sample of 1,406 Belgian firms, we find, first, that managers holding no company shares under-invest into R&D compared to owners giving rise to the risk argument. Second, we find an inverse u-shaped relationship between the degree of managerial ownership and R&D. Thus, managers become entrenched, i.e. powerful enough to pursue their own interests. When entrenched, managers do not fear detrimental effects of risky innovation projects on their career, and hence tend to over-invest into innovation.

**JEL-Classification:** G32, O31, O32
**Keywords:** Corporate governance, managerial ownership, entrenchment, innovation, R&D investments

**Contact details:**
*Mila Beyer*
K.U. Leuven, Department of Managerial Economics Strategy and Innovation,
Naamsestraat 69, 3000 Leuven, Belgium
Phone: +32 16 326 783, e-mail: Mila.Beyer@econ.kuleuven.be

*Dirk Czarnitzki*
K.U. Leuven, Department of Managerial Economics Strategy and Innovation,
Naamsestraat 69, 3000 Leuven, Belgium
Phone: +32 16 326 906, e-mail: Dirk.Czarnitzki@econ.kuleuven.be

*Kornelius Kraft*
TU Dortmund, Faculty of Business, Economics and Social Sciences,
Vogelpothsweg 87, 44227 Dortmund, Germany
Phone: +49 231 755 5916, e-mail: Kornelius.Kraft@tu-dortmund.de

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# 1 Introduction

In industrialized economies, many companies are not owner-led but manager-led which causes the well known principal-agent problem. The principal-agent problem arises from different interests of the manager and the owner in combination with information asymmetries (cf. Berle and Means 1932, Holmström and Milgrom 1987). As a manager cannot be completely monitored by an owner, he is expected to lead the company less efficient than an owner, as he maximizes his own utility and not necessarily the firm's profits.

It is likely that differences in leadership also affect a firm's investment into innovation. Holmström (1989) analyzed this relationship theoretically. He concludes that leadership structure affects R&D investments as agency costs associated with innovation – i.e. an investment into risky and long-term projects – are high. Even though innovation projects might lead to potentially high rewards, he argues that managers under-invest into innovation compared to owners due to the *risk* associated with those projects. Innovation projects face a high risk of failure which can have detrimental effects on a manager's career and eventually lead to job loss (see also Zwiebel 1995). Besides, a risk-averse manager has the incentive to reallocate resources to less risky projects, in order to reduce the volatility of his flexible wage component that depends on company profits.

In contrast to the risk-argument stands the *growth*-argument which states that managers have an incentive to over-invest into R&D compared to owners. A manager's wage is positively correlated with company size (Baker et al. 1988, Murphy 1985). As innovation fosters growth (e.g. Aghion and Howitt 1997, 2009, Abramowitz 1989), higher R&D investments might positively affect a manager's remuneration. This might incentivize managers to over-invest into innovation relative to the interests of the owners. Besides,

managers have non-monetary incentives to invest into innovation such as status, power, prestige, and that innovation is positively valued in public.

Recent literature on corporate governance also highlights another factor that should be taken into account when investigating the impact of leadership structures. Most firms are not *purely* owner-led or manager-led but managers hold *some* shares of the firm. Thus, the question on how managerial decision processes affect the firm may depend on their degree of ownership. Among others, Shleifer and Vishny (1997) and Morck et al. (2005) have discussed the existence and relevance of so-called incentive effects and entrenchment effects in the context of firm performance.

Depending on the ownership share, the principal-agent problem may result in different decision making behavior. Increasing ownership shares may entail an incentive effect, that is, the manager behaves more like an owner. But at the same time the manager may become entrenched, i.e. is powerful enough to use his discretion in own interests rather than pursuing the owners' goals. Clearly, entrenchment will exert a particularly strong impact if risk of dismissal is highly relevant. This in turn is the case if activities pursued by managers have a high risk of failure and the cause of the failure cannot be identified. This is true for innovation projects, where the owners usually are unable to identify the reason for failure of one or more innovation projects and make the managers responsible for it. Hence in the case of innovation activities entrenchment might exert a particularly strong effect on managers' behavior.

Surprisingly the topic of managerial entrenchment has rarely been studied in the context of innovation.[1] We only know of a singly study by Cosh et al. (2007), who find managerial entrenchment in combination with a firm's innovative efficiency. In contrast, we

[1] Aghion et al. (2009) touch upon this issue in a study where they investigate the relationship between innovation and institutional ownership. They compare scenarios with different entrenchment levels of managers and find that the positive effect of institutional ownership on innovation is stronger when managers are less entrenched.

investigate in this paper how different levels of managerial ownership influence innovation investment decisions of firms.

The remainder of the paper is structured as follows. The second section briefly reviews the empirical literature on innovation and corporate governance and then discusses the entrenchment and incentive effect. Section three introduces data and methods and the fourth section presents the results. The final section concludes.

# 2 Literature review and theoretical background

## 2.1 Corporate governance and innovation: evidence on risk versus growth effects

Surprisingly, there is only little empirical research on the link between corporate governance and innovation. The majority of studies find that management control or managerial ownership has a positive effect on a firm's innovative activity supporting the risk argument (Hill and Snell 1989, Baysinger et al. 1991, Francis and Smith 1995, Lee and O'Neil 2003, Honoso et al. 2004, Makri et al. 2006, Lerner and Wulf 2007, Aghion et al. 2009, Lhuillery 2009, Lerner et al. 2010)[2]. Other studies demonstrate that managers tend to over-invest into innovation compared to owners supporting the growth-argument (Czarnitzki and Kraft 2004a/b and 2009, Munari et al. 2005, Hall and Oriani 2006).

Most of these studies use information on the stock ownership concentration or the existence of large shareholders to measure a firm's corporate governance structure (Hill and Snell 1989, Baysinger et al. 1991, Francis and Smith 1995, Lee and O'Neil 2003, Honoso et al. 2004, Munari et al. 2005, Hall and Oriani 2006, Czarnitzki and Kraft 2004a/2009).[3] Only

[2] See also Eisenmann (2002) who finds a positive relationship between CEO equity ownership and risk-taking propensity for the U.S. cable television industry.

[3] Other studies focus on different ownership issues. Aghion et al. (2009) show that institutional ownership positively influences R&D investments. Lhuillery (2009) considers governance structures of French firms that are designed in order to defend shareholders' rights and finds that shareholders' rights positively

a few studies use information on managerial ownership as a measurement of inter-firm differences in leadership, as we do in this paper (Francis and Smith 1995, Czarnitzki and Kraft 2004a/b). These studies employ dummy variables to measure the impact of managerial ownership on innovation. Czarnitzki and Kraft (2004a) compare firms led by managers who own no shares with those who are led by owners. They find that owner-led firms have a lower R&D intensity. If a major stockholder exists, the differences between manager-led and owner-led firms disappear. Czarnitzki and Kraft (2004b) find that firms led by an owner or a member of the owner's family have significantly less successful innovations. Interestingly Francis and Smith (1995) find the opposite, that is firms with a high concentration of management ownership (>30% of ownership shares) or a significant equity block held by an outside investor are more innovative than firms with widely held stock.

In contrast to most of the existing literature, we employ a continuous measure of managerial ownership which allows us to investigate the relationship between the degree of capital ownership and innovation in detail. Besides analyzing whether the risk effect outweighs the growth effect when it comes to investments of the management into innovation, this allows us to analyze potential managerial entrenchment in the context of innovation.

### 2.2 Managerial Ownership: incentive versus entrenchment effects

When studying how the level of managerial ownership influences firm performance two opposing forces come into place: the incentive and the entrenchment effect (Shleifer and Vishny 1997, Morck et al. 2005). Firstly, it is expected that with increasing stake ownership

affect R&D intensity. Makri et al. (2006) find that technology-intensive firms can be more effective if they base CEO incentives on a combination of short-term financial results (ROE) and behavioral indicators of long-term innovation quality. Lerner and Wulf (2007) show for the US publicly traded companies that in centralized R&D organizations more long-term incentives, such as stock options, go along with more heavily cited patents, more frequent awards, and patents of greater originality. And Lerner et al. (2010) find that patents of private equity-backed up firms applied for in the years after the investment are more frequently cited.

of the company a manager's interest should be more aligned to those of an owner (incentive effect). Secondly, the more shares a manager holds, the less power the other owners of the company have upon a manager's decisions (entrenchment effect). This allows managers to undertake specific investments complementing their own skills which at the same time strengthens their bargaining power and makes them hard to replace (see also Shleifer and Vishny 1989). Higher job security allows a manager to entrench behind his increased bargaining power and pursue strategies to enrich himself at the expense of the company or other shareholder's wealth. Hence, both the incentive and the entrenchment effect come into play with increasing managerial ownership, but oppose each other.

Empirical research on the effect of entrenchment on firm performance shows that the incentive effect is offset by the entrenchment effect beyond a certain level implying that a high degree of managerial ownership affects company performance negatively. These studies frequently find a non-linear relationship between managerial ownership and firm performance (see Shleifer and Vishny 1997, Morck et al. 2005, and Adams et al. 2010 for comprehensive overviews about the entrenchment literature).[4] Most of the empirical research on entrenchment dates back to the work of Morck et al. (1988) who find a positive correlation between management ownership and Tobin's Q in the 0% to 5% ownership range, a negative relationship from 5% to 25%, and again positive levels when management ownership exceeds 25%.[5] Other studies find a non-linear relationship in form of an inverted u-shape (McConell and Servaes 1990, Gugler et al. 2008).

In the context of innovation Cosh et al. (2007) show based on a sample of British SMEs that CEO ownership positively affects innovative efficiency at low levels of ownership until

[4] At what level managers become entrenched seems not clear from those studies. Demsetz and Villalonga (2001) demonstrate well that the studies on insider shares and firm performance do not find a common pattern.

[5] These findings have been verified by Kole (1995).

it peaks at about 65 to 68% of ownership after which the effect turns negative.[6] Besides, Wright et al. (1996) find that the relationship between insider ownership and corporate risk taking is positive at low levels of insider ownership while it becomes negative at high levels.[7] R&D is possibly the most prominent example for a risky investment. Once R&D is expensed, it is basically sunk, as it mainly consists of wages for R&D personnel. In addition, the returns from R&D are highly uncertain, and some R&D projects may simply fail to deliver any usable result for the company.

In this study, we investigate the influence of managerial ownership on R&D investments, as most innovation projects require a firm to invest in R&D. It is likely that at various levels of managerial ownership the potential for entrenchment will differently influence managers' attitudes towards investments into innovation. As managers might become entrenched at high levels of ownership, we expect the relationship between managerial ownership and innovation not to be of a linear, but a non-linear form.

### 2.3 Identifying risk and growth as well as incentive and entrenchment effects

In order to make predictions on the direction of the effect of managerial ownership, we have to clearly define managerial ownership and use some level of R&D investment as benchmark. For instance, one could safely argue that an owner-led company is a firm where the manager or the board of managers owns 100% of the shares. In the empirical literature, however, "owners" are sometimes defined as managers that (a) own any share of the firm, (b) own some non-negligible share (e.g. more than 25%), (c) are majority owners (i.e. more than 50%) or (d) persons (incl. families) that wholly own a firm.

[6] Cosh et al. (2007) measure innovative (output-oriented) efficiency by data envelopment and stochastic frontier analysis. They measure innovation output by the percentage of sales with new or significantly improved products. Inputs include R&D expenditure as percentage of sales and the number of R&D personnel as a share of the total labor force.

[7] Wright et al. (1996: 451) use the standard deviation of analysts' forecasts of earnings per share as a measure of risk, because uncertainty in analysts' forecasts should be highly correlated with the unpredictability in cash flows generated by a firm's assets, which are a result of corporate risk-taking behavior.

Theoretically, it would be most appropriate to presume that a "purely" owner-led firm is one where the manager owns 100% of the firm, and that such firms invest at profit-maximizing levels of factor inputs. Taking this investment level as point of reference, we can define a "purely" manager-led firm as a firm where the manager owns 0% of the shares. In between 0% and 100% ownership, the concept of manager-led versus owner-led becomes fuzzy.

Applying this concept, we can first identify whether "pure" managers with no equity shares deviate from the level of R&D investment of "pure" owners with 100% equity shares because of the principal-agent problem. The direction of the deviation from the profit-maximizing level is a-priori unclear. On the one hand, "pure managers" may invest more than "pure owners", as they are typically rewarded by a combination of firm size (or growth) and profitability. On the other hand, they may invest less, because of the arguments concerning risk of failure with regard to R&D projects. Therefore a "pure" manager may under-invest into R&D as the risk of project failure is too high and appropriation in case of success is limited.

Second, we can identify the balance between managerial entrenchment and incentive effects. According to the incentive effect we would expect the interests of managers converging to those of an owner with increasing equity stakes. If managers become entrenched, however, they may deviate from the interest of an owner as their equity stakes increase. If the investment level departs from the purely owner-led firms as managerial ownership increases, one can conclude that the entrenchment effect outweighs the incentive effect. Second, if the investment level converges towards the purely owner-led firms, one can conclude that incentive effects outweigh potential entrenchment effects. Thus, we are interested in the *slope* of the curve describing the relationship between investment level and ownership shares to conclude on managerial entrenchment versus incentive effects.

In contrast, the *level* of the investment of "pure managers" compared to the level of investment of "pure owners" will indicate whether the risk argument, i.e. managers invest less, or the growth argument, i.e. managers invest more than purely owner-led firms, applies on average, all else constant.

# 3 Data

## 3.1 Sample

We use firm level data from the Flemish part of the sixth Community Innovation Survey (CIS) collected in 2009. The CIS is a business survey collecting firm-level data on innovation inputs and outputs. It is to a large extent harmonized across European Member States (see Eurostat 2004 for a detailed description of the CIS at European level). The CIS conducted in 2009 covers the innovative activity of companies between 2006 and 2008. It also provides general information on the company, such as sales, the number of employees, export share, and the sector of economic activity. We add firm-level financial data from Bel-First, a database provided by Bureau van Dijk that contains detailed financial information such as capital intensity, cash-flow and leverage.[8] The final database includes information on a cross-section of 1,406 firms that are active in manufacturing and selected service industries.[9] It constitutes a representative sample of these sectors in the economy of Flanders, Belgium.

## 3.2 Variable description

As discussed above, we analyze whether the company stakes a manager owns influence his decision to invest into innovation. As a measure of a firm's investments into innovation we

[8] The overlap of the companies in the Flemish CIS 2009 and Bel-First database is almost 100%. We lose only 12 observations when including the financial information provided by Bel-First.

[9] Selected service industries include NACE Ref.2 industries G, H, J, and M (see Table 4 in the appendix).

observe a firm's R&D expenditure in 2008. The distribution of R&D expenditure is highly skewed, and many firms do not invest into R&D at all. In our sample the mean of R&D expenditure is 0.8 million EUR, while the median company does not conduct any R&D. Because of the skewness of the distribution, we use the logarithm of R&D investment in 2008 (*lnRD*) as dependent variable (Table 1).[10] In order to check the robustness of our results concerning the measure of investments into R&D, we also look at R&D intensity, i.e. the relation of a firm's R&D expenditure compared to its turnover in 2008. R&D intensity takes values between 0 and 100%.

We measure managerial ownership in two different ways. First, we employ dummy variables to compare "pure" owners, i.e. managers that are 100% owners (*MAN100*), and managers that own more than 0 but less than 100% (*MAN1-99*), with "pure" managers that hold no company shares. *MAN100* takes on the value 1 if a manager owns 100% of the company shares between 2006 and 2008, and 0 otherwise. *MAN1-99* takes on the value 1 if a manager owns more than 0 but less than 100% of the company shares between 2006 and 2008, and 0 otherwise.

Second, we are interested in the continuous relationship between the degree of ownership and the level of R&D spending. Therefore we employ a continuous variable that reflects the percentage of the shares the management owned of the company between 2006 and 2008. *SHARE* can take on values between 0 and 100%. We also employ its square to allow for a non-linear effect due to managerial entrenchment. Table 1 shows that managers in the sample hold on average 25% of company shares. Figure 1 displays the distribution of managerial ownership in our sample. We see that managerial ownership clusters at 0, 50 and 100%. However, a closer look at the distribution of managers' shares, which are greater than

[10] As many companies have an R&D expnditure of zero, we take the logarithm of R&D expenditure plus one, so that the logarithm of R&D expenditure (*lnRD*) will be zero, if a firm does not invest into R&D. Equivalently we could have replaced lnRD by the minimum value of lnRD, if the R&D expenditure equals to zero, which leads to similar results.

0 and smaller than 100%, demonstrates that there are sufficient observations for all levels of managerial ownership (see Figure 2).

**Figure 1: Distribution of managerial ownership between 0 and 100%**

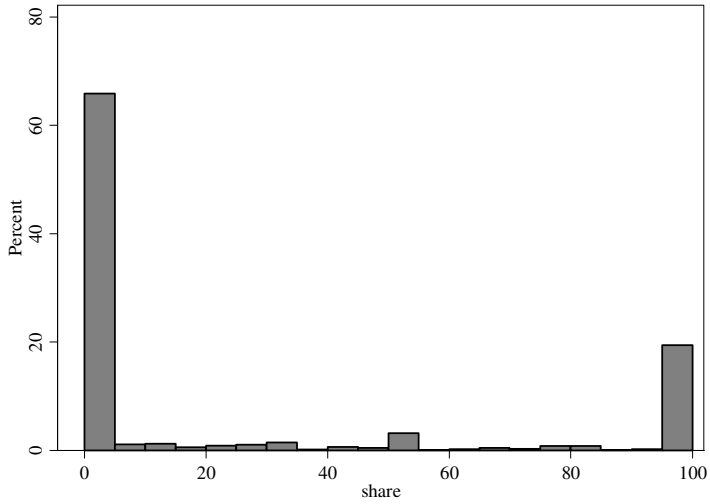
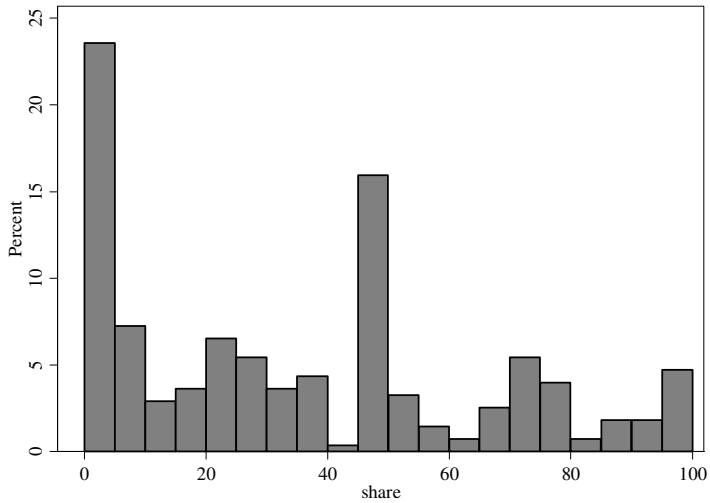



**Figure 2: Distribution of managerial ownership over 0 and under 100%**




We control for firm size, as managerial ownership is correlated with firm size (Bitler et al. 2005) and firm size also determines a firms investments into innovation (Schumpeter 1950, Cohen and Levin 1989). We measure firm size as the number of employees in 2006. Due to the skewness of its distribution the variable enters the regression in a log-linear form

(*lnEMP*). To allow for a non-linear effect between firm size and R&D investments, we include the squared term of *lnEMP*, too.

**Table 1: Descriptive statistics (N = 1,406)**

| Variable | Unit measurement | Mean | Std. dev. | Median | Min | Max |
|---|---|---|---|---|---|---|
| R&D expenditure | 1000 EUR | 788.353 | 5238.206 | 0 | 0 | 109194 |
| lnRD | Log(R&D expend. + 1) | 2.102 | 2.983 | 0 | 0 | 11.6 |
| R&D intensity | % | 3.068 | 10.110 | 0 | 0 | 100 |
| MAN100 | Dummy | 0.182 | .386 | 0 | 0 | 1 |
| MAN1-99 | Dummy | 0.196 | .397 | 0 | 0 | 1 |
| SHARE | % | 25.484 | 40.277 | 0 | 0 | 100 |
| GROUP | Dummy | 0.506 | 0.500 | 0 | 0 | 1 |
| CAPINT | 1000 EUR / employee | 40.755 | 50.726 | 25.5 | 0.370 | 424.4 |
| LIAB | % | 0.640 | 0.210 | 0.660 | 0.092 | 1 |
| CF/EMP | 1000 EUR / employee | 20.147 | 27.195 | 14 | -79.5 | 209.2 |
| EXPORT | % | 30.588 | 35.226 | 13 | 0 | 100 |
| C1 | Dummy | 0.344 | 0.475 | 0 | 0 | 1 |
| C2 | Dummy | 0.262 | 0.440 | 0 | 0 | 1 |
| C3 | Dummy | 0.347 | 0.476 | 0 | 0 | 1 |
| EMP | Head counts | 100.019 | 340.721 | 27 | 1 | 6078 |
| AGE | Years | 28.389 | 23.714 | 21 | 1 | 227 |

Note: Industry dummies omitted.

Managerial ownership might also differ between firm consortia versus family businesses. It is argued that institutional ownership provides effective monitoring and encourages managers to pursue risky projects like innovations, as they do not need to fear harsh penalty or job loss in case the project fails (Aghion et al. 2009). Therefore we employ a dummy variable (*GROUP*) that takes on the value 1, if a firm was member of a group of companies between 2006 and 2008.

In addition, we include the company's liability (*LIAB*) and cash flow per employee (*CF/EMP*) in the regression analysis to capture potential market discipline of managers by financial constraints as well as internal resources as these are the primary source for funding R&D investments (see e.g. the survey by Hall and Lerner 2010). *LIAB* is measured as the percentage of the current and non-current liabilities in total assets of a firm. *CF/EMP* is measured as cash flow (in thd. EUR) per employee. We also include a firm's capital intensity

(*CAPINT*), measured as tangible assets (in thd. EUR) per employee. It serves as a signal for the market entry cost or also potential technological opportunities in the innovation process. We use information about liability, cash flow intensity and capital intensity from 2007, a pre-sample period, to circumvent endogeneity issues. When information on one of these variables is missing in 2007 we impute the information of 2006, or respectively 2005.

We also control for market structure as this may affect the investment into innovation (see e.g. Gilbert 2006). We include the number of competitors in the firm's most important market in terms of turnover. This is measured by three dummy variables: *C1* contains firms that have between 4 and 6 competitors in their most important market, *C2* those that have 7 to 15 competitors, and *C3* firms with more than 15 competitors. The reference category is firms in a monopoly or tight oligopoly with up to 3 competitors. In addition, we use the firm-level share of exports in total sales (*EXPORT*) in 2008 to proxy the degree of international competition the firm is facing.

The companies' age in 2008 serves as a proxy for a firm's market experience and reputation. It also reflects the firm's ability to access financial sources, which influences a company's innovative activity (Schneider and Veugelers 2010). Therefore we include age (*AGE*) in the analysis and control for a potentially non-linear effect of age on R&D expenditure by including the square of age as well.

Eleven sector dummies capture different technological opportunities of the companies and other unobserved factors that vary across industries (see Table 4 in the appendix).

## 3.3 Econometric model

We estimate a Tobit model, as 884 firms in the sample of 1406 companies do not invest into R&D, i.e. those observations are left censored at zero. The Tobit model can be written as follows (cf. e.g. Greene 2003)

(1) $y_i^* = x_i'\beta + \varepsilon_i \quad \text{with} \quad \varepsilon_i \sim N(0, \sigma^2)$

where $y_i^*$ is the unobserved latent variable, $\beta$ is the vector of parameters which has to be estimated, $x_i$ represents the vector of explanatory variables, and $\varepsilon_i$ is the error term. We observe

(2) $y_i = \begin{cases} y_i^* & if \;\; y_i^* > 0 \\ 0 & otherwise \end{cases}$

The corresponding likelihood function for the homoscedastic model Tobit model is

(3) $\ln L = \sum_{y_i>0} -\frac{1}{2}\left[\ln(2\pi) + \ln\sigma^2 + \frac{(y_i - x_i'\beta)^2}{\sigma^2}\right] + \sum_{y_i=0} ln\left[1 - \Phi(\frac{x_i'\beta}{\sigma})\right]$

where $\sigma$ is the standard deviation to be estimated and $\Phi$ indicates the cumulative density function of the standard normal distribution.

We estimate two different model specifications to analyze the impact of managerial ownership on R&D investment. First, we estimate a model employing dummy variables, where we compare firms managed by "pure owners" (*MAN100*) which we assume to behave profit-maximizing, and manager that own some company shares (*MAN1-99*) with those of "pure" managers (the reference category). The relationship is described in equation (4) below. We can thus test if owner-led companies' R&D investments differ from that of manager-led ones.

(4) $lnRD_i^* = \beta_1 + \beta_2\, MAN1\text{–}99_i + \beta_3\, MAN100_i + \gamma\, Controls_i + \varepsilon_i$

$\gamma$ symbols a vector of coefficients of the further controls: size, liability, cash flow intensity, capital intensity, export intensity, the number of competitors, age, and industry.

In our second model we employ the continuous measure of managerial ownership *SHARE* and its square to test for a non-linear relationship between the degree of managerial ownership and R&D expenditure, see equation (5).

$$(5) \quad lnRD_i^* = \beta_1 + \beta_2\, SHARE_i + \beta_3\, SHARE^2{}_i + \gamma\, Controls_i + \varepsilon_i$$

If various levels of managerial ownership lead to different behavior of the management towards R&D investments, we should see a non-linear relationship between R&D expenditure and managerial ownership, indicating managerial entrenchment.

If heteroskedasticity occurs in the Tobit model, the homoscedastic model will lead to inconsistent estimates for both the standard errors and the coefficients. In order to correct for heteroskedasticity in the Tobit model, one has to model heteroskedasticity in the maximum likelihood estimation, as the variance $\sigma^2$ is estimated as parameter along with the coefficients $\beta$. We consider a Tobit model with multiplicative heteroskedasticity (cf. Greene 2003). We replace the homoscedastic standard error $\sigma$ by

$$\sigma_i = \sigma\sqrt{\exp(z_i'\alpha)},$$

where $z_i$ denotes a vector of variables suspected to cause the heteroskedasticity and $\alpha$ is a vector of additional parameters to be estimated. We check for heteroskedasticity due to size and industry including four size class dummies, based on the number of employees of the firms in the sample, and ten industry dummies in $z_i$. Conducting Wald tests on joint significance of the size class dummies and the joint significance of the industry dummies, we find heteroscedasticity due to industry, but not due to size, for both of our model specifications. Consequently, we model the heteroskedastic variance with industry dummies and only present the results of the heteroskedastic Tobit models.

# 4 Results

Table 2 provides the estimation results for the heteroscedastic Tobit, where managerial ownership is measured in form of dummy variables. Column (1) presents the results for the first model, where we compare R&D expenditure of firms that are led by a "pure" owner (*MAN100*) or other degrees of managerial ownership (*MAN1-99*) with our reference category of "pure" managers that hold no company shares. Column (2) contains the results for the second model where we employ the continuous measure of managerial ownership and test for a non-linear relationship between managerial ownership and investments into R&D.

We find that firms, which are led by a "pure" owner (*MAN100*), as well as managers that own more than 0 but less than 100% of the ownership shares (*MAN1-99*), invest significantly more into R&D than firms led by a "pure" manager (see Table 2, Column 1). This result supports the theory that "pure" managers face high costs investing into risky R&D projects and therefore under-invest into innovation compared to managers that own any company shares. Hence, "pure" managers that own no company shares seem to have insufficient incentives to invest into risky, long-term R&D projects. This result is robust to a different model specification where we employ R&D intensity instead of the logarithm of R&D expenditure. We again find that owner-led companies have a significantly higher R&D intensity than "purely" manager-led companies (see Table 5, Column 1 in the appendix).

In addition, the estimation results of model one show that the coefficient of *MAN100* is smaller than the coefficient of *MAN1-99* (see Table 2, Column 1). This indicates, all else equal, that there is a non-linear relationship between various degrees of managerial ownership and R&D investments suggesting that managers are entrenched when it comes to investments into innovation.

**Table 2: Heteroscedastic Tobit regression results for lnRD**

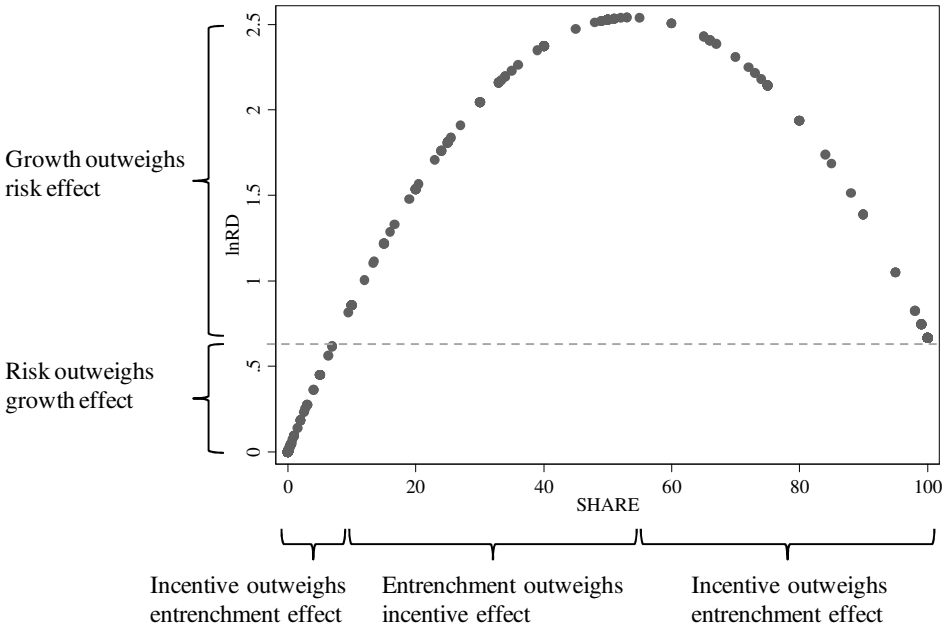
| **Model** | **(1)** Coef. (Std. err) | **(2)** Coef. (Std. err) |
|---|---|---|
| MAN1-99 | 1.792*** | |
| | (0.433) | |
| MAN100 | 1.062** | |
| | (0.504) | |
| SHARE | | 0.094*** |
| | | (0.024) |
| $SHARE^2/100$ | | -0.088*** |
| | | (0.024) |
| GROUP | 0.116 | 0.159 |
| | (0.425) | (0.433) |
| LIAB | 2.045** | 1.974** |
| | (0.863) | (0.863) |
| CAPINT | 0.005 | 0.005 |
| | (0.004) | (0.004) |
| CF/EMP | 0.008 | 0.009 |
| | (0.007) | (0.007) |
| C1 | -0.792** | -0.759** |
| | (0.384) | (0.384) |
| C2 | -0.417 | -0.408 |
| | (0.406) | (0.406) |
| C3 | -1.735*** | -1.752*** |
| | (0.407) | (0.408) |
| EXPORT | 0.042*** | 0.042*** |
| | (0.005) | (0.005) |
| lnEMP | 0.204 | 0.142 |
| | (0.420) | (0.420) |
| $(lnEMP)^2$ | 0.163*** | 0.171*** |
| | (0.049) | (0.049) |
| AGE | -0.019 | -0.015 |
| | (0.017) | (0.017) |
| $AGE^2/100$ | 0.015 | 0.012 |
| | (0.013) | (0.013) |
| Constant | -7.332*** | -7.155*** |
| | (1.434) | (1.433) |
| Test on joint significance of industry dummies, $\chi^2(10)$ | 68.21*** | 66.66*** |
| Log-likelihood | -2038.854 | -2039.235 |
| McFadden $R^2$ | 0.098 | 0.098 |
| Number of obs. | 1406 | 1406 |
| Left-censored obs. | 884 | 884 |

Notes: *** (**, *) indicate a significance level of 1% (5%, 10%).

Indeed our second model specification in Column (2) demonstrates that there is a highly significant non-linear relationship in form of an inverse u-shape between the amount

of capital shares the management owns and R&D investments. The peak is at 54% of the shares owned by the management. The relationship is depicted in Figure 3. We see that R&D investments do not monotonically rise with increasing ownership shares of the management. Instead, R&D initially grows but then decreases as managers expand their equity holdings beyond some threshold.

**Figure 3: The inverse u-shape relationship between a firm's R&D investment (lnRD) and the % of capital shares a manager owns (SHARE)**




The quadratic specification allows a more detailed interpretation of the regression results as our previous specification using the dummy variables. First, we see that managers owning a relatively small share of the firm under-invest when compared to "pure" owners (see the dotted horizontal line in Figure 3). In this range of the ownership we thus conclude that the risk argument outweighs the growth argument as the level of investment is lower. As in the dummy variable specification, we also see that over-investment is present over a large range of the distribution (all observations above the dotted horizontal line). Here the interest in growth opportunities outweighs the fear of innovation project failure. Increased job

security due to the possession of higher stakes in the firm reduces the managers' fear that R&D project failure can negatively affect his career. More stakes give rise to the growth argument that is tied to higher managerial remuneration, power and prestige.

In addition to the vertical location of the curve, we can also interpret the shape of the curve, i.e. the slope. The upward sloping part of the curve – below the dotted horizontal line in Figure 3 – indicates that managers' interests become more aligned with those of the 100% owners' with increasing ownership shares. Above the dotted horizontal line the investment level departs further and further away from the 100% owners' investment, indicating that entrenchment effects outweigh the opposing incentive effects. The downward sloping part after the peak, that is, managerial interests become more aligned to owners, points to the dominance of the incentive effect in this part of the ownership distribution. The results remain robust to a different model specification, when we analyze the relationship between managerial ownership and R&D intensity (cf. Table 5, Column 2 in the appendix).

Besides, the estimation results show that larger enterprises invest more into R&D than smaller ones, which might be due to the fact that smaller companies have insufficient access to financial resources. Firms that export have a higher R&D expenditure, reflecting a positive effect of international competition on innovation. However, this result could also be due to the fact that Belgium is a small European economy and therefore innovative companies are likely to export. Higher liability seems to affect the R&D expenditure positively. High competition in the market of the product with the highest turnover has a negative impact on a firms R&D expenditure when compared to a close oligopoly, where firms face a maximum of three competitors. Being part of a company group, capital intensity, cash flow per employee, and company age do not significantly impact R&D expenditure in the present sample.

*Robustness of results*

As it often criticized that innovations in the service sector are fundamentally distinct from those in the manufacturing sector, we conducted another robustness check of the results by estimating the same models on a subsample of 778 manufacturing firms. The regression results are displayed in Table 3. Our result that "pure" managers seem to under-invest into innovation compared to owners holds (cf. Table 3, Column 1). However, when we compare "pure" managers only to "pure owners" the effect is still positive but not significant any more. Second, the inverse u-form relationship between the degree of managerial ownership and the logarithm of R&D investments remains highly significant for the subsample of manufacturing industries (cf. Table 3, Column 2). Our finding that managers seem to be entrenched when it comes to investments into innovation holds for the subsample of manufacturing industries.

Nevertheless, our results have to be interpreted with caution as they could be subject to endogeneity, if ownership is not exogenous but determined by economic forces (Demsetz 1983, Demsetz and Lehn 1985). Because it may be optimal to wider disperse capital shares in a risky environment, the risk structure of a firm could determine its ownership structure. But we believe that our model specification rules out potential endogeneity problems to a certain extent, as our data on managerial ownership is an average over the years 2006 to 2008, while we use information about R&D spending in 2008. Besides, La Porta et al. (1999) state that ownership changes very slowly over time. Of course, it would be desirable to employ instrumental variable regressions to rule out potential endogeneity more convincingly. Unfortunately, we do not have suitable candidates for instrumental variables in our data.

**Table 3: Tobit regressions for lnRD: subsample of manufacturing industries[11]**

| **Model** | **(1)** Coef. (Std. err.) | **(2)** Coef. (Std. err.) |
|---|---|---|
| MAN1-99 | 1.195** | |
| | (0.543) | |
| MAN100 | 0.865 | |
| | (0.638) | |
| SHARE | | 0.090*** |
| | | (0.030) |
| $SHARE^2/100$ | | -0.084*** |
| | | (0.031) |
| GROUP | 0.371 | 0.505 |
| | (0.541) | (0.555) |
| LIAB | 1.981* | 1.892* |
| | (1.038) | (1.035) |
| CAPINT | 0.000 | 0.000 |
| | (0.005) | (0.005) |
| CF/EMP | 0.014* | 0.014* |
| | (0.009) | (0.009) |
| C1 | -0.815* | -0.737 |
| | (0.479) | (0.479) |
| C2 | -0.395 | -0.366 |
| | (0.505) | (0.505) |
| C3 | -1.482*** | -1.428*** |
| | (0.521) | (0.520) |
| EXPORT | 0.039*** | 0.038*** |
| | (0.006) | (0.006) |
| lnEMP | 0.197 | 0.143 |
| | (0.569) | (0.567) |
| $(lnEMP)^2$ | 0.174*** | 0.180*** |
| | (0.063) | (0.063) |
| AGE | -0.026 | -0.022 |
| | (0.020) | (0.020) |
| $AGE^2/100$ | 0.022 | 0.019 |
| | (0.015) | (0.015) |
| Constant | -6.726*** | -6.694*** |
| | (1.650) | (1.646) |
| Test on joint significance of industry dummies, $\chi^2(10)$ | 1.24 | 1.30 |
| Log-likelihood | -1208.977 | -1207.045 |
| McFadden $R^2$ | 0.097 | 0.098 |
| Number of obs. | 778 | 778 |
| Left-censored obs. | 460 | 460 |

Notes: *** (**, *) indicate a significance level of 1% (5%, 10%).

[11] We employ a homoscedastic Tobit model, as we do not find heteroscedasticity due to firm size or industry when analyzing the subsample of manufacturing industries.

# 5 Conclusion

This paper considers the impact of managerial ownership on investments into innovation. We find first that managers holding no company shares tend to under-invest into innovation when compared owners holding 100% of the shares. This gives rise to the theory that managers holding no company shares face high agency-costs when it comes to investments into R&D. Innovation projects are risky and can thus have detrimental effects on a manager's career in the case of failure and eventually lead to job loss.

Second, we consider that managers can become entrenched when holding an increasing amount of company shares, i.e. they have the freedom to pursue their own – not the owners' – interest. We find a strong non-linear relationship in shape of an inverse u between the company shares a manager holds and R&D expenditure, suggesting that managers are entrenched when it comes to investments into innovation. Our results indicate that managerial entrenchment allows managers to over-invest into innovation when compared to a 100% owner. With increasing ownership shares managers face higher job security reducing the fear that R&D project failure could negatively affect their career. Hence, managers might over-invest into innovation for reasons of company growth that goes along with higher managerial remuneration as well as increased power and prestige. These findings are in line with the theory about ownership structure and innovative activity of firms as well as the entrenchment literature.

Further research analyzing the relationship between managerial ownership and innovation is needed in order to check the validity of our findings. Especially the use of appropriate instruments for managerial ownership would contribute to gaining further insights in this new research field. If, however, managers do become entrenched with increasing ownership shares when it comes to investments into R&D, the policy of

incentivizing managers to act in the owners' interests by distributing capital shares to the management has to be revisited.

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# Appendix

**Table 4: Classification of industry dummies (N = 1,406)**

| # | Industry definition according to NACE Ref.2 | Sector classification | No. of observations |
|---|---|---|---|
| *Manufacturing industries* | | | |
| 1 | Food, beverages, and tobacco | CA: 10-12 | 112 |
| 2 | Textiles and leather | CB: 13, 14, 15 | 52 |
| 3 | Wood, paper, and printing | CC: 16-18 | 51 |
| 4 | Coke, refineries, chemicals, and pharmaceuticals | CD-CF: 19-21 | 70 |
| 5 | Rubber, plastic, and other non-metallic mineral products | CG: 22, 23 | 112 |
| 6 | Computer, electronic and optical products | CI: 26 | 123 |
| 7 | Electrical equipment, machinery, motor vehicles, trailers and other transport equipment, furniture | CJ-CM: 27- 31 | 258 |
| *Service industries* | | | |
| 8 | Wholesale and retail trade; repair of motor vehicles and motorcycles | G: 45-47 | 214 |
| 9 | Transportation and storage | H: 49-53 | 157 |
| 10 | Information and communication | J: 58-63 | 132 |
| 11 | Professional, scientific and technical activities | M: 69-75 | 125 |

**Table 5: Heteroscedastic Tobit regression results for RDINT**

| **Model** | **(1)** Coef. (Std. err.) | **(2)** Coef. (Std. err.) |
|---|---|---|
| MAN1-99 | 1.631** | |
| | (0.720) | |
| MAN100 | 1.458* | |
| | (0.772) | |
| SHARE | | 0.105*** |
| | | (0.038) |
| $SHARE^2$ | | -0.096** |
| | | (0.038) |
| GROUP | 0.265 | 0.271 |
| | (0.656) | (0.668) |
| LIAB | 1.770 | 1.623 |
| | (1.310) | (1.306) |
| CAPINT | 0.007 | 0.006 |
| | (0.005) | (0.005) |
| CF/EMP | 0.008 | 0.007 |
| | (0.011) | (0.011) |
| C1 | -0.828 | -0.773 |
| | (0.618) | (0.618) |
| C2 | -0.054 | -0.017 |
| | (0.645) | (0.642) |
| C3 | -2.061*** | -1.955*** |
| | (0.649) | (0.646) |
| EXPORT | 0.043*** | 0.043*** |
| | (0.009) | (0.008) |
| lnEMP | 1.072 | 1.142 |
| | (0.931) | (0.932) |
| $(lnEMP)^2$ | 0.014 | 0.010 |
| | (0.106) | (0.106) |
| AGE | -0.020 | -0.017 |
| | (0.027) | (0.027) |
| $AGE^2$ | 0.005 | 0.002 |
| | (0.021) | (0.021) |
| Constant | -9.155*** | -9.334*** |
| | (2.541) | (2.557) |
| Test on joint significance of industry dummies, $\chi^2(10)$ | 28.55** | 26.83** |
| Log-likelihood | -2417.801 | -2416.863 |
| McFadden $R^2$ | 0.117 | 0.117 |
| Number of obs. | 1406 | 1406 |
| Left-censored obs. | 884 | 884 |

Notes: *** (**, *) indicate a significance level of 1% (5%, 10%).
Heteroscedastic standard errors are estimated by 11 industry and 4 size class dummies.