ERASMUS UNIVERSITEIT ROTTERDAM
ERASMUS SCHOOL OF ECONOMICS

How Institutional Owners, Decentralization of the Firm and Unions Determine Innovation: Empirical evidence from the U.K

Master thesis Economics of Management and Organizations

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February 2016

ABSTRACT

Using a large dataset from the U.K., this study analyzes the relationship between institutional ownership, the level of decentralization in the firm, and the level of innovation. It is predicted that a higher percentage of institutional ownership increases the innovativeness of the firm, due to a more long-term orientation. Part of this relation is predicted to run through decentralization, as this may enhance the innovative activity of employees. Using OLS regressions, this study finds that decentralization increases the innovativeness of the firm and that firms with 25% to 50% of institutional ownership seem to be more innovative. However, when comparing the view of employees on decentralization in the firm with the view of the mangers, it seems that these firms are more decentralized according to the employees while less decentralized according to the managers. This study also finds that firms with at least 50% of institutional ownership seem to be less innovative and more decentralized. The innovativeness of these firms seems to decrease in decentralization, indicating that the owner of the firm might affect the relationship between decentralization and innovation. This study also analyzes the relationship between decentralization, unions and innovation. It is predicted that union power might enhance the positive effect of decentralization on innovation. However, it seems that only in firms that are highly decentralized, union power increases the innovativeness of the firm.

Keywords: Institutional Investors, Ownership structure, Decentralized organization, Union power, Innovation, R&D spending.

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1. Introduction

Since the studies of Williamson (1967) and Grossman & Hart (1986), researchers have started to understand what factors inside the firm are of importance to the firm in generating innovative products or processes in an ever changing environment (Swann, 2009). The organizational structure is one of the factors that has demonstrated its importance. In particular, studies such as Rajan & Wulf (2006) and Acemoglu, et al (2007) have observed a recent trend of firms decentralizing their organizational structure, in which an increasing number of firms have allocated more autonomy and responsibility to employees in the lower layers of the firms' hierarchy.

Although economists have become increasingly aware of the importance of the organizational structure in the firms survival, the determinants of a decentralized organizational structure are not yet fully understood. In a pioneering empirical study, Colombo & Delmastro (2004) found that the ownership status of plants in the Italian manufacturing sector in 1997 is linked to a more decentralized organizational structure. Similar evidence is documented in a more recent study of Kastl, Martimort, & Piccolo (2013). By examining the Italian manufacturing sector between 1997 and 2003, they found a positive correlation between ownership concentration and decentralization. However, because a negative correlation between ownership concentration and decentralization was predicted, they argued that more complex forces might influence the relationship between ownership concentration and decentralization in practice.

By exploring the link between *institutional investors* that own shares of the firm and decentralization, this study extends earlier research that examined the link between the owners of the firm and the organizational structure. Using a dataset from the U.S, a positive relationship between institutional investors (e.g. pension funds, private equity funds, banks and insurance companies) and innovation has been documented in the study of Aghion, Van Reenen, & Zingales (2013). This might be due to the typical high percentages of the firm's shares owned by the institutional investors (Shleifer & Vishny, 1986). Therefore, the following questions are asked: Does the level of innovation in the firm increase in the percentage of institutional ownership? And: Does the level of decentralization of the organizational structure in the firm increase in the percentage of shares owned by institutional investors?

This study also examines the link between *unions* and decentralization. Since the seminal contribution of Freeman & Medoff (1984) researchers have extensively examined the direct relationship between unions and innovation. However, the line of research that studies unions as a determinant of a decentralized organizational structure is still by and large in its infancy. Using a British dataset, the study of Bryson, Forth, & Kirby (2005) shows that a positive impact of new management practices (i.e. high-involvement management (HIM)) on the productivity of the firm is restricted to unionized workplaces. The study of Zoghi & Mohr (2011) links the impact of new management practices, such as HIM, to a more decentralized organizational structure. They documented that new management practices are positively associated with a more decentralized organizational structure in a dataset that includes 10 European countries, Australia and Canada. This study extends this research by examining the relationship between unions and a decentralized organizational structure. Therefore, the second question this study asks is: Does the effect of a decentralized organizational structure on the level of innovation of the firm depend on the power unions have in the firm?

Based on existing theoretical and empirical evidence, this study develops three hypotheses that help answering the main questions. The first hypothesis predicts that the level of innovation of the firm increases with the percentage of ownership of institutional investors. The second hypotheses set predicts that a) the level of decentralization in the firm increases with the percentage of institutional ownership and that b) the percentage spend on R&D by these firms increases with the level of decentralization. The third and last hypothesis predicts that decentralized firms with high union power in the workplace are more innovative than decentralized firms with low union power.

This study constructs a sample of 545 workplaces from the British Workplace Employment Relations Study (WERS) 2011 to test the hypotheses at establishment-level. Different from prior work with the WERS, this study compares the level of decentralization in the firm according to the employees with the level of decentralization in the firm according to the managers. In addition, this study considers various measures of the power of unions in the firms, tests for correlations and includes a selection of control variables in different OLS regression models. To remove any concerns about biases in the measure of institutional ownership, measures of a single family or individual that holds a percentage of the shares of the firms are also considered in the analysis.

The findings of this study contribute in the first place to the literature on corporate ownership and managerial incentives (e.g. Shleifer & Vishny, 1986; Bushee, 1998; Eng & Shackell, 2001; Burkart, Gromb, & Panunzi, 1997; Aghion, Van Reenen, & Zingales, 2013). This study extends this line of research by examining the relationship between institutional ownership and the innovativeness of the firm and by comparing it to the relationship between a single family or individual owner and the innovativeness of the firm. In doing so, this study finds that when an institutional investor, single family or individual has at least 50% of the shares, firms in the U.K. tend to be less innovative. While firms with smaller sizes of institutional ownership tend to be more innovative, firms with smaller sized of family or individual ownership tend to be less innovative. This suggests that the design of the ownership structure might be of importance to firms. For example, a dispersed ownership structure of the firms might avoid a free-riders situation in which one institutional investor holds high percentages of the firms and results in a less innovative firm.

The second strand of literature that is broadly related to the present study examines determinants of a decentralized organizational structure. Important determinants of a decentralized organizational structure are the information technology in the firm (e.g. Bresnahan, Brynjolfsson, & Hitt, 2002; Caroli & van Reenen, 2001; Acemoglu et al., 2007), communication technology at hand and the product mix of the firms (e.g. Colombo & Delmastro, 2004), the competition of the firm (e.g. Bloom, Sadun, & Van Reen, 2010), social capital (such as trust and religion) in the firm (e.g. Bloom, Sadun, & Van Reenen, 2012), and the ownership structure of the firm (e.g. Kastl, Martimort, & Piccolo, 2013). This study contributes to this line of research by examining the link between institutional investors and decentralization. In doing so, this study finds that firms are more decentralized when at least 25% of the firm's shares are owned by an investment institution, a single family or individual. However, the perception of decentralization in the firm by the respondents seems to be important to this relationship. In addition, this study finds that the effect of decentralization on innovation seems to depend on the percentage of institutional ownership in the firm. This suggests that decentralization might also be used as an instrument to increase the current value of the firm at the cost of the percentage spend on R&D.

Third and last, this study makes a contribution to the strand of literature that examines the link between unions and innovation. For example, using a sample of British workplaces between 1972 and 1978, Ulph & Ulph (1989) have found mixed evidence for the link between unions and innovation. By using a dataset from the U.K. and Germany, Addison & Wagner (1994) also found mixed evidence for this particular link. The present study contributes to this line of research by arguing that unions, might be used as a mechanism by which managers could incentivize employees to be more innovative. The results of this study suggests that unions in the U.K. mostly act as rent-seekers. Thus, use their monopoly position to decrease the percentage spend on R&D. Only in highly decentralized firms unions seem to act as the collective voice of employees, as in these firms the level of innovation seems to increase in the power of unions.

The rest of this study is structured as follows. In section 2, the three hypotheses are developed from existing theoretical and empirical research. Section 3 provides an introduction to the WERS 2011 and discusses the construction of the key measures of this study. Section 4 first discusses the construction of the OLS regression models before presenting and discussing the results of the regression analysis. Lastly, Section 5 concludes and discusses the limitations of this study.

2. Hypothesis Development

In this section, three hypotheses are developed that help analyzing the main questions of this study.

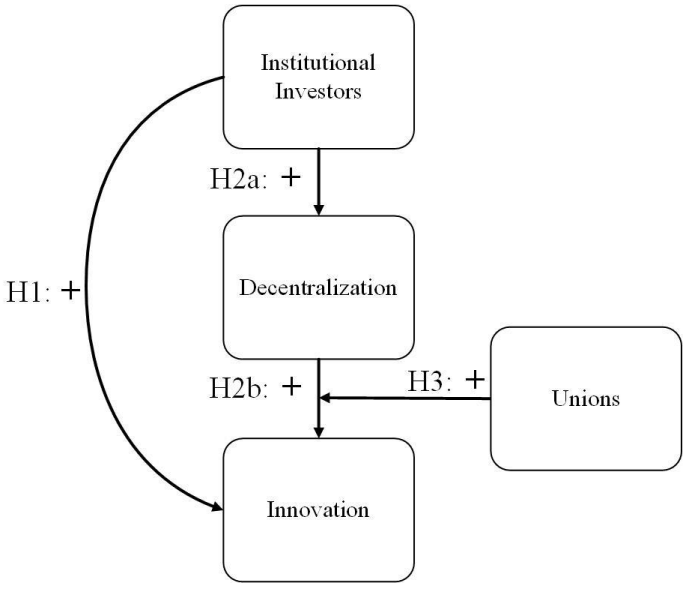


Figure 1. An overview of the hypotheses.

Consider Figure 1, which is a graphical overview of the three hypotheses and their sub-hypotheses that are developed in this study. The first hypothesis captures the relationship between institutional ownership and innovation. The second and third hypotheses are developed to get a deeper understanding of what mechanisms drive this relationship. Therefore, the second hypothesis captures (a) the relationship between institutional ownership and the organizational structure and (b) the relationship between decentralization and innovation. The third and last hypothesis captures the role of unions in the design of the organizational structure.

2.1. The Behavior of Institutional Owners.

The first hypothesis predicts that institutional investors that own shares in the firm are focused on the development of the long-term value of the firm in terms of innovation (H1 in Figure 1). When the institutional owners' behavior is similar to that of 'traders', it is argued that they act in favor of the short-term value of the firm (Bushee, 1998; Eng & Shackell, 2001). Because the objective of these traders is to make a short-term profit, they are typically interested in the current (i.e. the short-term) value of the firm. When current earnings or current cash flows turn out to be disappointing, these traders are likely to sell their share. To prevent this from happening, managers are incentivized to make short-term value increasing investments at the cost of long-term value increasing investments, such as R&D expenditure (Bushee, 1998; Eng & Shackell, 2001).

In contrast, the size of shares that institutional investors hold in a firm and their sophistication, could provide an incentive for the managers to focus on the long-term value of firm (Bushee, 1998; Eng & Shackell, 2001). As institutional owners typically own a high percentage of the firm's shares, they also have a higher stake in the firm compared to other owners (Shleifer & Vishny, 1986). Therefore, institutional owners will have a greater incentive to monitor managers because the higher stake makes them benefit more from value increases than the other owners. In an extreme case, the difference in incentives could lead to a free-riders problem: The smaller owners will have no incentive to monitor and only the largest owner will bear all costs of monitoring, (Burkart, Gromb, & Panunzi, 1997; Shleifer & Vishny, 1986). By monitoring, the sophisticated institutional owners gather valuable information about the actions of the manager. This information gathering reduces the opportunities of the manager to take the preventive action, such as reducing long-term value increasing investments (Bushee, 1998). Hence, sophisticated

institutional investors that have a large size of ownership, highlight the development of the long-term value of the firm (Eng & Shackell, 2001).

Although there is a lot of empirical evidence for both views, most evidence points in the direction of institutional owners focusing on the development of the long-term value of the firm. For example, Bushee (1998) studied a sample of firms listed to the NYSE, NASDAQ and AMEX between 1983 and 1994. Their results show in the first place that when institutional investors own a significant proportion of the shares, managers are more likely to increase R&D expenditure for the long-term development of the firm. However, they also show that those institutional investors that act like 'traders' (i.e. have a high portfolio turnover and engage in momentum trading) and own a significant proportion of firm shares, increase the likelihood of the managers focusing on short-term firm value increases. Similar results have been found in the study of Eng & Shackell (2001). Their dataset consists of 58 firms in the U.S. between 1981 and 1989, which have been extracted from Fortune magazine. Fortune magazine publishes a lists of the best 200 industrial firms ranked by sales on a year basis. The results of their analysis show that there is a positive association between institutional owners and the level of R&D expenditure. However, by separating the different institutional investors, they found evidence for a negative association between R&D expenditure and banks that own a fair amount of shares and insurance companies that own a fair amount of shares.

Most of the empirical studies regarding institutional ownership and innovation, have found evidence in the form of associations. However, a more recent study by Aghion, van Reenen and Zingales (2013) found evidence for a positive *causal* relationship between institutional owners and the innovation levels of the firm in a sample of 803 publicly listed firms in the U.S. between 1991 and 1999. Using the method of instrumental variables (IV) they found a positive effect of a policy change in the U.S. in 1992, which favored institutional ownership, and the innovation levels of the firms. In addition, an additional listing to the S&P500, which makes firms more attractive to institutional investors, provided evidence for a positive relationship of institutional ownership with the level of innovation of the firms

These arguments support the view of institutional investors as sophisticated and typically large owners of the firm. Therefore, the first hypothesis predicts that institutional owners create an incentive for managers to focus on the development of the long-term value of the firm and increase the level of innovation in the firm.

H1: A higher percentage of shares of the firm owned by institutional investors, increases the level of innovation of the firm.

2.2. Decentralized Organizational Structure and Innovation.

The second hypothesis is based on the prediction that in innovative projects of which the outcomes are highly uncertain, the principal's benefit from delegation of authority might outweigh the costs of delegation. This prediction is based on the basic incentive view. The incentive view argues that when the agent has more local knowledge available relative to the principal to make the decision that is in the best interest of the firm, the principal might be best off allocating the decision-making authority to the agent[1]. However, because the agent's interests are not always perfectly aligned with the interests of the principal, delegation by the principal could come at the cost of losing control over the agent (Aghion & Tirole ,1997; Colombo & Delmastro, 2004). Examples of such loss of control are the agent underinvesting in risky projects because of career concerns (Beyer, Czarnitzki, & Kraft, 2011) and the agent strategically withholding valuable information from the principal to increase its private benefits (Aghion & Tirole, 1997; Dessein, 2002).

The loss of control is especially important in a highly uncertain environments. Intuitively, in *stable* environments the principal knows which activities the agent has to undertake to increase the success of the project. The action the principal selects will be relatively close to the first best action.

[1] The theoretical literature also considers delegation of decision-making authority in the project selection stage compared to the project implementation stage. In a project selection stage, the delegation of authority to the agent works as an incentive mechanism to increase the agents' initiative to acquire information (Aghion and Tirole, 1997). However, delegation may not be optimal in the project implementation stage when the principal uses monetary incentives and takes private benefits into account (Bester and Krahmer, 2008). In addition, situations with multiple agents where side-contracting is possible are also considered in the literature. See, for example, Laffont and Martimort (1998) and Balinga and Sjostrom (1998).

In this situation, there is a relatively small loss of information compared to the loss of control and the principal will be more likely to centralize the authority and observe the agents' efforts on the assigned tasks (Dessein, 2002). However, when the principal keeps control in *unstable* environments, he is more likely to select an action that is relatively far off the first best action. As both the principal and agent know communication will always be strategic, the principal's loss of control is relatively small compared to the loss of information. The principal is now better-off delegating the choice of the action to the agent and avoiding communication (Manso, 2011; Dessein, 2002). The agent will choose which actions he needs to take to get a successful outcome of the project, and the principal will monitor the outcome of the project (Pendergast, 2002). Thus, as innovative projects are highly uncertain, the principal is more likely to decentralize the organizational structure to allocate more authority and autonomy to the agent as long as the difference in interests is not too large relative to the environmental uncertainty.

One example of an emperical study that have found evidence in support for this view is the sudy of Acemoglu et al. (2007). Using datasets from France and the U.K., they found that firms are more likely to be decentralized in situtations where there is limited public information availible to the managers. Firms that are closer to the technological frontier, that are in more heterogeneous environments or that are relatively young compared to other firms were found to be more decentralized. Another and more recent study by Kastl, Martimort, & Piccolo (2013) tested whether the principal increases the agents' marginal return on the investment in R&D by making the agent the residual claimant for the choice of his effort (i.e. a decentralized organizational structure) and by assuming an endogenous information structure. Because a robust positive association between decentralization and innovation in a sample of Italian manufacturing firms with 10 to 500 employees between 1997 and 2003 is documented, this form of decentralization is found to increase the agent's incentive to innovate.

To summarize, managers can design a decentralized organizational structure to utilize the information asymmetry between him and the agent. This will incentivize the agent to act in a way that is most optimal to the long-term value of the firm. Especially, in uncertain environments (such as investments in innovation) decentralization is argued to be the most beneficial organizational structure.

The second hypothesis (H2a and H2b in Figure 1) captures this in two ways. First, because managers are incentivized to increase the innovativeness of the firm by institutional owners, firms with a higher percentage of institutional ownership are more likely to be decentralized. Second, because the process of innovating is highly uncertain, it is optimal for managers to delegate authority to their subordinates:

H2a: A higher percentage of shares of the firm owned by institutional investors, increases the level of decentralization in the firm

H2b: A more decentralized organizational structure increases the level of innovation of the firm

2.3. Unions as a Commitment to the Long-Term.

The third and last hypothesis predicts that the power of unions in the workplace is an important mechanism through which managers can increase the innovativeness of the agent. Consider, for example, a decentralized organizational structure in which the authority is delegated to the agent. In this situation, the structure of the incentive scheme is essential to align the interests of the manager and the worker. When managers need to motivate workers to be innovative, standard pay-for-performance schemes might not be optimal. More appropriate incentive schemes focus on long term performance by motivating agents to explore new opportunities and by having substantial tolerance for failure in the short-term. An important factor for such exploration is the *commitment* of the manager to a long-term contract with the agent (Manso, 2011). Management might make such a commitment by allowing more power of unions in the workplace.

When management allows more power of unions in the workplace, they have to take into account the behavior of unions. Unions might act as the *collective voice of workers* or they might act as rent-seekers by using their *monopoly position* (Freeman & Medoff, 1984). The first view argues that unions arise when the costs for employees to switch firms are higher than the costs of assembling a ‘collective’ voice. The collective voice makes employees less likely to exit the workplace, which extends the job tenure of employees in unionized firms. The extended job tenure encourages employees to invest in firm-specific capital, which increases the investment in the training of employees by firms and increases the morale of the workforce. This will encourage the

employees to be innovative and boost the R&D expenditure of the unionized firm (Fang & Ying, 2012; Bryson, Forth, & Kirby, 2005; Menezes-Filho & Van Reenen, 2003).

The second view argues that the monopoly position of unions highlights their rent-seeking behavior. This position of unions is argued to constrain the capital investment of firms (and to some extent R&D investments) (Menezes-Filho & Van Reenen, 2003). The power of unions to constrain management comes forth from their ability to restrict the availability of the labor supply to the firm. This gives unions the power to bargain with the management of the firm for better terms and conditions of employment. Of course, this results in an increase in the labor costs per employer, which in turn constrains the financial resources of the firm (Bryson, Forth, & Kirby, 2005). When increased labor costs results in an increased allocation of the profits to employees, it does not constrain the innovative activities of the firm. However, to pay for the increased cost of labor, others have argued that some firms are more likely to decrease their risky R&D investments (Menezes-Filho & Van Reenen, 2003).

Just as there is not one explicit theoretical view on the role of unions, the empirical literature is also ambiguous regarding the role of unions in the firm[2]. For example, Menezes-Filho, Ulp & Van Reenen (1998) found a negative correlation between unions and R&D in a cross section sample of 826 establishments in the UK in 1990. The negative correlation might be restricted to high tech industries. As Ulph & Ulph (1989) found a positive association in low tech industries in a dataset of workplaces in the UK between 1972 and 1978. Addison & Wagner, (1994) found similar evidence when comparing industries from the UK and Germany. According to Fang & Ting (2012) unions do have a positive impact on innovation output or R&D investments of Chinese industries. While in Canadian industries, there is a negative relationship between the unionization of firms and R&D (Betts, Odgers, & Wilson, 2001).

[2] For a survey of emperical studies that have focussed on the relationship between (measures of) unions and (measures of) innovation around the globe, see Menezes-Filho & Van Reenen (2003). In addition, Bryson, Forth, & Kirby (2005) provide an overview of emperical studies that have focussed on the relationship between (measures of) unions and (measures of) the firm's fianancial performance in the UK.

The view of the power of unions as a commitment of management to increase the innovativeness of the agents is captured in the third hypothesis (H3 in Figure 1). This hypothesis states that a higher power of unions in the workplace is positively associated with the link between a decentralized organizational structure and the innovativeness of the firm:

H3: The strength of the relation between decentralization and innovation increases in the power of unions.

3. Data and Descriptives

This study uses the British Workplace Employment Relations Study (WERS) 2011 dataset. The institution behind the WERS has a renowned reputation as it has published a similar study in 1980, 1984, 1990, 1998 and 2004[3]. For these studies, an extensive national wide survey (i.e. in around 2300 workplaces in the UK) is conducted to provide extensive information about the 'employment relations practices in workplaces' ("About the 2011 WERS", n.d.) in different industries within the U.K.[4].

An advantage of the WERS 2011 is that it contains the views of 2.680 workplace managers, 545 financial managers and 21.981 employees on subjects as the organizational structure, the workplace characteristics, the hiring and firing policies, the payment systems, and the representation of employees in the workplace. This study makes use of this advantage by studying the views of the workplace managers on these subjects *and* the views of the employees of the workplace on these subjects. In addition, as part of the design of the WERS 2011, information about the financial performance of the workplaces were provided by the financial managers of the workplaces. Therefore, the main sample consists of the 545 workplaces of which there is information about their financial performance. In 480 of these 545 workplaces an employees'

[3]Other studies that have used the WERS are: Acemoglu et al. (2007) which used the WERS published in1998 to assess the level of decentralization at industry level. Zoghi & Mohr (2011) also used the WERS 1998 to investigate the relationship between decentralization and new workplace practices. Bryson, Forth, & Kirby (2005) used the WERS 1998 to measure the level of union power in the workplace. And Cox, Zagelmeyer, & Marchington (2006) also used the WERS 1998 dataset to assess the employee involvement and participation. A panel dataset of the WERS 1984 and WERS 1990 has been used by Caroli & van Reenen (2001) highlighting the skill-biased organizational change.

[4] For more detailed information about the construction of the dataset and more general information see the website of British Workplace Employment Relations Study 2011: http://www.wers2011.info.

questionnaire has been distributed, which resulted in a sample of 5.680 employees who have provided their view on the workplace.

This dataset is used to conduct an establishment-level analysis. Because of confidentiality reasons, the names of the organizations where the workplaces are part of are not included. However, every workplace is assigned a unique workplace identification number. Because of this unique identification number is included in the employee questionnaire, the financial manager questionnaire and the answer set provided by the workplace manager, it is possible to compare the views of the workplace managers, financial managers and the employees of the workplace.

From the dataset, measures of the percentage of institutional ownership, the level of decentralization in the firms, the power of unions in the firm, and the innovativeness of firms are constructed. Table 1 presents an overview of each measure which are described in more detail in the sections below.

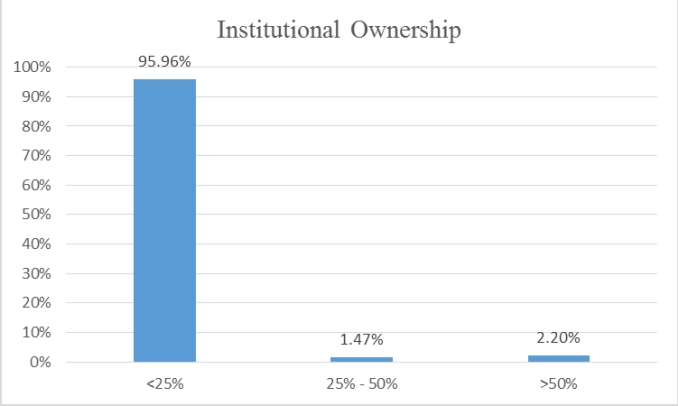
Table 1. An overview of the key measures that are used in this study.

Variable	**Measure**
Percentage of institutional ownership	INST*ci*
The level of decentralization	
-Rated by the employees:	DECe*i* and DECB*i*
-Rated by the managers:	DECm*i* and DECin*i*
Unions	
-Union bargaining power:	UP*i*
-Union recognition:	UR*i*
Innovation	R&Dexp*i*

3.1. Measuring the Proportion of Institutional Ownership

For institutional ownership, a dummy variable that measures the percentage of the firms *i* that are owned by *institutional investors* (INST*ci*) and divides these firms into multiple categories *c* is constructed. The first category of these measures, consists of workplaces with less than 25% shares of the firm owned by institutional investors. The second category consists of workplaces where institutional investors hold between 25% and 50% of the shares of the firm and the last category consists of workplaces where institutional investors hold more than 50% of the total shares. These categories are constructed from the questions that asked whether *a single individual or family, or an investment institution owns at least 25 per cent of* the firm and whether *a single individual or family, or an investment institution owns at least 50 per cent of* the firm.

Figure 2. The percentage of institutional ownership in the observed firms.



Notes: The graph shows the percentage of the workplaces in the sample that are owned for less than 25% by an investment institution. The workplaces of which an investment institution owns between 25% and 50% of the shares. And the workplaces of which an investment institution owns more than 50% of the shares of the firm.

As Figure 2 shows, about 95.64% of the 545 workplaces are in the first category of INST. This category consists of workplaces that are part of a governmental organization, or are part of a company that does not have any shares for sale, or the workplace manager did *not* confirm that an investment institution owns any percentages of the firm. The second category consists of workplaces in which the manager answered the first question with 'yes - an investment institution owns at least 25 per cent of the firm' and did not confirm that an investment institution owns at least 50 per cent of the firm. This category of INST consists of about 1.47% of the workplaces. About 2.20% of the workplaces are in the third category of INST, which consists of workplaces of which the manager answered the second question with 'yes- an investment institution owns at least 50 per cent of the firm'.

3.2. Measuring the Level of Decentralization

From the WERS 2011 four *measures of the level of decentralization* are constructed. These include two proxies for the view of the employees on their own discretion and two proxies for the view of the managers on the discretion of the employees in the workplace[5]. As Table 2 shows, the level of decentralization in firm *i* from the e*mployees' point of view* (i.e. DECe*i*) is constructed from the questions (A*i*, B*i*, C*i*) that asked a number of employees of each workplace to rate their influence on the tasks they do in their job, the pace at which they work, and how they do their work. The scaling of these questions is formalized from 0 to 3, where 0 is 'no' influence and 3 is 'a lot' of influence. The table also shows that the minimum rating of DECe*i* is 0 and the maximum rating is 3 and the ratings of the three separate questions range from 0 to 3. This is because the overall level of decentralization in each workplace *i*, DECe*i*, is calculated by taking the average of the rating of the three questions for each workplace. The ratings of the three questions are calculated by averaging the ratings the interviewed employees of workplace *i* provided. For example, if 5 employees of a workplace (i) provided a rating (R1, R2, R3, R4 and R5) of their influence on the tasks they do in their job (question A). The rating of this question for the workplace (Ai) is calculated by the formula:

$$\text{Ai} = \frac{(R1+R2+R3+R4+R5)}{5} \quad (1)$$

As this calculation makes the range and the standard deviation of DECe*i* become smaller than the range and standard deviation of the separate questions, DECe*i* might be bias towards a mean rating. Therefore, this study also considers question B*i* in the analysis, which has the biggest standard deviation.

[5]Because the questions from the WERS 2011 used in this study to construct the measures of the level of decentralization are similar to the questions in the WERS 1998, the measures of decentralization in this study are comparable to the measures used by Zoghi & Mohr (2011).

Table 2. Descriptive statistics of the key measure of decentralization from the employees' point of view.

	N	Median	Mean	SD	Minimum	Maximum
DECe*i*	480	2.302	2.271	0.354	0	3
A*i*: The tasks you do in your job	480	2.250	2.227	0.399	0	3
B*i*: The pace at which you work	480	2.176	2.152	0.424	0	3
C*i*: How you do your work	480	2.489	2.435	0.356	0	3

Notes: The table shows the number of observations (N), the median, the mean, the standard deviation (SD), the minimum rating and the maximum rating.

The measure of employees rating of discretion is calculated by the equation,

$$\mathbf{DECe}\boldsymbol{i} = (\mathbf{A}\boldsymbol{i} + \mathbf{B}\boldsymbol{i} + \mathbf{C}\boldsymbol{i}) / \mathbf{3} \quad \textbf{(2)}$$

where:

- A*i*, is the average level of influence of employees in the tasks they do in their job in firm *i* according to the employees.
- B*i*, is average level of influence of employees in the pace at which they do their work in firm *i* according to the employees.
- C*i*, is average level of influence of employees in how they do their work in firm *i* according to the employees.

The scaling of these questions is formalized from 0 to 3, where 0 is 'no' influence and 3 is 'a lot' of influence.

The main measure of the level of discretion in workplace *i* from the *managers' point of view* (DECm*i*) is constructed from the questions (L*i*, M*i*) that asked the managers to rate the level of discretion their employees have over how they do their work and the pace at which they work. The measure is constructed for every workplace by calculating the average of the ratings provided to these two questions by the workplace managers. As shown in PANEL A of Table 3, the rating of the level of discretion provided by the managers on the two questions ranges from 0 to 3, where 0 is 'none' and 3 is 'a lot' of discretion. By averaging the two questions, the main measure of decentralization also ranges between 0 and 3.

In addition to the main measure of decentralization from the managers' point of view, this study considers decentralization measured as *the level of employee-involvement* (DECin*i*). The measure of employee involvement is directly constructed from the question that asked the manager to rate "the level of involvement employees have in the decisions over how their work is organized". As shown in PANEL B of Table 3, the scaling of this measure is from 0 to 3, where 0 is 'none' and 3 is 'a lot' of involvement in the decisions. Employee involvement is considered separately because the involvement of employees might not serve the same cause as a decentralized organizational

structure would have. It is argued by Zoghi & Mohr (2011) that employee involvement might be related to less responsibility or autonomy for employees. Which would make employee-involvement more related to a centralized organizational structure. Other researchers have argued that employee involvement, such as joint consultative committees, works councils or representative forums, is merely a strategy to avoid the involvement of unions in the workplace (e.g. Martin, 1996).

Table 3. Descriptive statistics of the key measures of decentralization from the managers' point of view

PANEL A

	N	Median	Mean	SD	Minimum	Maximum
DECm*i*	545	2	1.874	0.787	0	3
L*i*: How they do their work	545	2	1.927	0.915	0	3
M*i*: The pace at which they work	545	2	1.820	0.871	0	3

Notes: The table shows the number of observations (N), the median, the mean, the standard deviation (SD), the minimum rating and the maximum rating.

The measure of the management's rating of discretion of employees is calculated by the equation,

$$\mathbf{DECm}\boldsymbol{i} = (\mathbf{L}\boldsymbol{i} + \mathbf{M}\boldsymbol{i}) / \mathbf{2} \quad \textbf{(3)}$$

where:

- L*i*, is the level of discretion employees have in how they do their work in firm *i* according to their manager.
- M*i*, is the level of discretion employees have in the pace at which they do their work in firm *i* according to their manager.

The rating of these questions is formalized from 0 to 3, where 0 is 'none' and 3 is 'a lot' of discretion.

PANEL B

	N	Median	Mean	SD	Minimum	Maximum
DECin*i*: involvement in decision over how their work is organized	545	2	1.938	0.870	0	3

Notes: The table shows the number of observations (N), the median, the mean, the standard deviation (SD), the minimum rating and the maximum rating.

3.3. The Measure of Union Power

To measure the power of unions in the workplace, a measure of *union recognition* and of *union bargaining power* is constructed from the WERS 2011. The measure union recognition (UR*i*) is constructed from the question that asked the workplace managers how many unions are recognized by management. For this measure the workplaces are divided in a category of workplaces that do not recognize any workplaces, a category of workplaces that recognize a single union and a category of workplaces that recognizes multiple unions. As shown in Table 4, the majority of the workplaces (i.e. about 79.82% of the all workplaces) do not recognize any unions. Of the workplaces that recognize at least one union, 16.51% reconigzes multiple unions, while 3.76% recognize only one union. In addition, Table 4 shows that 55.31% of all employees in the 545 workplaces, are in the workplaces that recognize multiple unions[6].

The questions that are used to measure the bargaining power of unions (UP*i*) in firm *i*, asked the workplace managers to rate their interaction with unions about rates of pay, hours of work, holiday entitlements, pension entitlements, training of employees, grievance and disciplinary procedures, and health and safety. As shown in Table 5, the scaling from 'negotiate' (i.e. 3) to 'not inform' (i.e. 0) can be used as a direct measure to the bargaining power of unions. For instance, unions have more power when management negotiates (i.e. 3) with unions than when management does not inform (i.e. 0) unions about any of the workplace changes. Because the measure of union bargaining power is the average of all questions that were answered by the workplace manager, the overall scaling of the measure of union power in the firm (UP*i*) is from 0 to 3. There are 542 workplaces of which the level of union power are observed, as the managers of these workplaces have provided an answer to at least one of the questions that are used to calculate UP*i*.

[6] The measure of union recognition is similar to the measure of union recognition used in the study of Bryson, Forth, & Kirby (2005). However, they observed that, in the WERS 1998, 15% of the workplaces recognized a single union and that 5% of the workplaces recognized multiple unions. They also observed that the majority of the employees were in workplaces that do not recognize unions (i.e. 59%)

Table 4. Descriptive statistics of the measure of union recognition.

	Percentage of workplaces	**Percentage of employees in such workplaces**
Classification of recognized unions		
Multiple recognized unions	16.51	55.31
Single recognized union	3.76	2.84
No recognized unions	79.82	41.84

Notes: Included are the percentage of workplaces that recognize no unions, a single unions or multiple unions and the percentage of the total employees in these workplaces.

Table 5: Descriptive statistics of the measure of union power (UP*i*).

	N	**Median**	**Mean**	**SD**	**Minimum**	**Maximum**
UP*i*	542	0	1.055	1.403	0	3
O*i*: Health and safety	541	0	1.102	1.453	0	3
P*i*: Grievance and disciplinary	540	0	1.024	1.396	0	3
Q*i*: Training of employees	540	0	1.204	1.568	0	3
R*i*: Pension entitlements	539	0	1.137	1.534	0	3
S*i*: Holiday entitlements	540	0	0.989	1.419	0	3
T*i*: Hours of work	540	0	0.965	1.387	0	3
U*i*: Rates of pay	540	0	0.913	1.363	0	3

Notes: The table shows the number of observations (N), the median, the mean, the standard deviation (SD), the minimum level and the maximum level for each variable.

The measure of the union's bargaining power in the workplace is calculated by the formula,

$$\mathbf{UP}i = (\mathbf{O}i + \mathbf{P}i + \mathbf{Q}i + \mathbf{R}i + \mathbf{S}i + \mathbf{T}i + \mathbf{U}i) / \mathbf{N}i \quad \textbf{(4)}$$

where:

- O*i*, is the level of power unions have in bargaining about health and safety conditions in firm *i* according to the manager.
- P*i*, is the level of power unions have in bargaining about grievance and disciplinary procedures in firm *i* according to the manager.
- Q*i* is the level of power unions have in bargaining about the training of employees in firm *i* according to the manager.
- R*i*, is the level of power unions have in bargaining about pension entitlements in firm *i* according to the manager.
- S*i* is the level of power unions have in bargaining about holiday entitlements in firm *i* according to the manager.
- T*i*, is the level of power unions have in bargaining about the hours of work in firm *i* according to the manager.
- U*i*, is the level of power unions have in bargaining about the rates of pay in firm *i* according to the manager.

- N*i*, is the number of these questions (O*i*, P*i*, Q*i*, R*i*, S*i*, T*i*, U*i*,) answered by the manager in firm *i*. The rating of these questions is formalized from 0 to 3, where 3 is 'negotiate' and 0 is 'not inform' (i.e. 0).

3.4. The Measure of Innovation

The WERS 2011 is also used to construct the measure of the level of innovation (R&Dexp*i*) of firm *i*. In particular, a question in the financial performance questionnaire asked the financial manager of the workplace whether any R&D activity is carried out at that workplace, and if so, what the percentage of total current expenditure is spend on R&D. 14 financial managers refused to answer this question or did not know whether the workplace carried out any R&D activities (i.e. answered the first part of the question with 'don't know'). Therefore, the total number of financial managers that reported whether their workplace carried out any R&D activities is 535. As Table 6 shows, 20.68% of the 535 workplace managers confirmed that their workplace carries out any R&D activity. In addition, of all the financial managers that did know whether the workplace carried out any R&D expenditure, 4 financial managers did not know the percentage of the total expenditure spend on R&D (i.e. answered the second part of the question with 'don't know'). Of the workplaces that carry out R&D activity (i.e. Conditional R&Dexpi), the lowest percentage spend on R&D is 0.02% (i.e. 0.0002) and the highest is 99.98% (0.9998), while the mean percentage is 6.8% (i.e. 0.068). By formalizing the workplaces that do not carry out any R&D activity to 0 percentage R&D expenditure (i.e. about 80% of total workplaces), the observed mean and median of R&Dexp*i* are 1.4% (i.e. 0.014) and 0% (i.e. 0.000), while the observed R&D expenditure ranges from 0 to 99,98 percent (i.e. 0.000 to 0.9998). Table 6 also shows that although 20 percent of the 535 workplaces carry out R&D activity, more than half (i.e. 50.68 percent) of all employees are in the workplaces that carry out any R&D activity.

Table 6. Descriptive statistics of the measure of innovation.

	Percentages of workplaces		**Percentage of employees is such workplaces**			
Carry out R&D activity	20.68		50.68			
	N	**Median**	**Mean**	**SD**	**Minimum**	**Maximum**
R&Dexp*i*	531	0.000	0.014	0.059	0.0000	0.9998
Conditional R&Dexp*i*	106	0.032	0.068	0.117	0.0002	0.9998

Notes: Included are the percentage of workplaces that carry out R&D activities and the percentage of the total employees in such workplaces. And the mean, standard deviation (SD), number of observations (N), the minimum value and the maximum value of the percentage of R&D expenditure of total current expenditure for these workplaces.

3.5. Correlation Tests

Now that the key measures are defined, it is possible to analyze the strength of the correlation between these measures. To test such a strength, the correlation coefficients are calculated using a Pearson Correlation-Test and a Spearman Rank-Test. The latter correlation test does not make any assumptions about the distribution of the variables, which might be more appropriate for testing the correlation between some of the key variables. The results of the Spearman Rank-Test are presented in Table 7. The results of the Pearson Correlation-Test are presented in Table 8.

The percentage of institutional ownership seems to be very weakly correlated with the percentage of R&D expenditure of the firm. The strongest correlation of 0.057 is documented between INST2 and R&Dexp in the Spearman Rank-Test. The signs of the coefficients do not seem to suggest an increasingly positive relationship between R&D expenditure in the percentage of institutional ownership. For instance, the documented correlation coefficients of for INST3 are -0.04 in Table 7 and -0.034 in Table 8. While the documented correlation coefficients of INST2 are 0.040 in Table 7 and 0.057 in Table 8.

The measures of decentralization seem to be very weakly correlated with the measures of institutional ownership. The strongest documented correlation of -0.105 is documented in Table 8 between INST2 and DECm. It seems that institutional ownership of 25% to 50% is negatively related to decentralization in the firm as apart from the correlation coefficient of DECB and INST2, the documented correlation coefficients are negative. Institutional ownership of at least 50% seems to be positively related to a decentralized organizational structure. For instance, the documented correlation between DECe and INST3 is 0.055 in Table 7. The correlation between INST3 and DECin of -0.029 seems to indicate that employee involvement is negatively related to the percentage of institutional ownership.

The documented coefficients suggest that there is a positive correlation between the measures of decentralization from the employees' point of view and the measure of decentralization from the managers' point of view. Although the measures of decentralization seem to be positively related, the strength of the correlation between DECe and DECin seems to be relatively weak compared to the strength of the positive correlation between DECe and DECm. For instance, the coefficient of DECe and DECin is 0.197 in Table 7, while the coefficient of DECe and DECm is 0.270.

The documented correlations between the measures of decentralization and the percentage spend on R&D seems to suggest that these measures are very weakly related. In Table 8, the coefficients range from 0.012 for the correlation between DECe and R&Dexp to 0.106 for the correlation between DECm and R&Dexp. In Table 7 the coefficients range from 0.037 for the correlation between DECm and R&Dexp to -0.058 for the correlation between DECe and R&Dexp. Because the coefficients of decentralization from the managers' point of view seem to be positive, decentralization seems to be positively related to R&D expenditure. While for decentralization from the employees' point of view, the tests suggest mixed relationships with R&D expenditure.

For the measures of union power, the correlations with the measures of decentralization from the employees' point of view seem to be the opposite of the correlations with the measure of decentralization from the managers' point of view. For instance, while the relationship between DECm and UP of 0.005 is suggested to be weakly positive in Table 8. The documented correlation coefficient of DECe and UP suggests a weak negative relationship of -0.101. The most consistent correlation is the correlation of UR2, which ranges from 0.121 to -0.061 in the Pearson Correlation-Test and the Spearman Rank-Tests. These coefficients suggests that recognizing a single union in the firm is negatively related to the level of decentralization in the firm.

Although this study does not consider the direct relationship between the percentage of institutional ownership and union power or the direct relationship between union power and innovation, the direct relationship between these measures seems to be very weak. For instance, for the measure of union bargaining power, the coefficient of 0.154 in Table 8 and 0.138 in Table 7 between INST3 and UP is the strongest documented coefficient. This suggests that institutional ownership of at least 50% is positively related to the bargaining power of unions. Union bargaining power seems to be positively related to R&D as well. The correlation coefficient between UP and R&Dexp is 0.056 in Table 8 and 0.027 in Table 7. For the measures of union recognition, the strongest correlation with institutional ownership is documented for INST2 and UR1. Because the coefficient is -0.077 in both tests, institutional ownership of 25% to 50% seems to be negatively related to recognizing no unions. The correlation coefficient of UR and R&Dexp ranges from -0.200 to 0.220 in both correlation tests. It seems that the correlation between union recognition and R&D expenditure seem to increase with the number of unions recognized by the firm.

3.6. The Control Variables

To control for factors that have been found to be significantly associated with the level of innovation in similar analyses (see, for example, Colombo & Delmastro, 2004 and Acemoglu et al., 2007) this study will include the selection of control variables in the regression models that are presented in Table 18, 19 and 20 in the APPENDIX A: CONTROL VARIABLES. To control for *firm* differences the regression models will include continuous variables, such as the size of the firm, the age of the firm, the percentage of computer usage in the firm and the level of competition the firm faces. And dummy variables such as the legal description of the firm, whether the interviewed workplace is the head office of a firm, whether the head office is in the UK, whether there are other workplaces to which the participated workplace belongs to are also included. The regression will also control for the personal characteristics of the respondents. Therefore, the *management control* variables include the job tenure of the manager, the number of responsibilities the manager has and a dummy variable for the gender of the manager. The *employee control* variables include the academic level of the employees, their professional qualification, their health status, and their gender.

Table 7. Spearman rank correlation matrix for the key variables.

Variable	INST1	INST2	INST3	DECe	DECB	DECm	DECin	UP	UR1	UR2	UR3	R&Dexp
INST1	1											
INST2	-0.680***	1										
INST3	-0.718***	-0.022	1									
DECe	-0.028	-0.018	0.055	1								
DECB	-0.042	0.004	0.053	0.890***	1							
DECm	0.054	-0.084*	0.006	0.270***	0.227***	1						
DECin	0.075	-0.078	-0.029	0.197***	0.162***	0.554***	1					
UP	-0.106**	0.007	0.138***	-0.144***	-0.096**	0.055	0.062	1				
UR1	0.052	-0.077	0.002	0.162***	0.128***	-0.026	-0.023	-0.619***	1			
UR2	-0.051	0.039	0.032	-0.121**	-0.075	-0.091*	-0.070	0.380***	-0.581***	1		
UR3	-0.019	0.059	-0.031	-0.089*	-0.089*	0.112**	0.089*	0.413***	-0.697***	-0.179***	1	
R&Dexp	0.002	0.040	-0.040	-0.058	-0.049	0.037	0.000	0.056	-0.200***	0.099**	0.154***	1

Notes: This matrix shows the Spearman Rank correlation coefficients of the key measures used in the study. The darkest grey color indicates a correlation coefficient of 1 between the variables. The weaker the correlation between two variables the less grey the color becomes; the color changes at a critical absolute value of 1, 0.5, 0.3, 0.2 and 0.1. And: *p<0.1, **p<0.05, ***p<0.01.

Table 8. Pearson correlation matrix for the key variables.

Variable	INST1	INST2	INST3	DECe	DECB	DECm	DECin	UP	UR1	UR2	UR3	R&Dexp
INST1	1											
INST2	-0.680	1										
INST3	-0.718	-0.022	1									
DECe	-0.030	-0.008	0.048	1								
DECB	-0.030	-0.003	0.044	0.896	1							
DECm	0.067	-0.105	0.009	0.274	0.222	1						
DECin	0.080	-0.085	-0.029	0.185	0.148	0.559	1					
UP	-0.105	-0.011	0.154	-0.101	-0.066	0.073	0.084	1				
UR1	0.052	-0.077	0.002	0.124	0.107	-0.022	-0.031	-0.509	1			
UR2	-0.051	0.039	0.032	-0.090	-0.061	-0.098	-0.061	0.320	-0.581	1		
UR3	-0.019	0.059	-0.031	-0.071	-0.076	0.113	0.091	0.333	-0.697	-0.179	1	
R&Dexp	-0.015	0.057	-0.034	0.012	0.025	0.106	0.064	0.027	-0.162	-0.028	0.220	1

Notes: This matrix shows the Pearson correlation coefficients of the key measures used in the study. The darkest grey color indicates a correlation coefficient of 1 between the variables. The weaker the correlation between two variables the less grey the color becomes; the color changes at a critical absolute value of 1, 0.5, 0.3, 0.2 and 0.1.

4. Regression Analysis

To test whether the relationships between the key variables are truly linear, the correlation tests do not seem to be sufficient. Instead, the ordinary least squares (OLS) regression model can provide a good linear approximation of the relationship between the key variables. This section discusses the design and the results of the OLS regression models that are used to formally test the three hypotheses sets with the key measures and the control variables illustrated in Section 3.

This study does not consider the OLS regression to be the only regression model to test the predictions. However, other non-linear relationships tests which might fit the dataset better, are out of the scope of this study. Therefore, it is important to stress that the documented results of the OLS regression models are not intended to be interpreted as an indication of causality. More complex forces that could affect the relationship between the percentages of shares owned by investment institutions, the level of decentralization in the firm and the power of unions, might not be captured by the designed OLS regression models of this study

4.1 Institutional Investors and Innovation.

In this section the first hypothesis is investigated, which predicts a positive linear relationship between the percentages of the shares of the firm owned by institutional investors and the level of innovation of the firm. Regression model (5) is designed to test this prediction. In this regression model, the coefficient of the dummy variable INST*ci* (i.e. $\beta 1$) is expected to be positive for each category *c*. The coefficient of INST3 is expected to be more positive than INST2, indicating that firms with at least 50% of institutional ownership spend more on R&D (i.e. R&Dexp*i*) compared to firms with lower percentages of institutional ownership.

$$\mathbf{R\&Dexp}\boldsymbol{i} = \boldsymbol{\beta 0}\ \boldsymbol{\alpha i} + \boldsymbol{\beta 1}\ \mathbf{INSTc}\boldsymbol{i} + \boldsymbol{\beta 2}\ \boldsymbol{\omega i} + \boldsymbol{\varepsilon i} \quad \textbf{(5)}$$

where:

-**R&Dexp*i*:** The percentage of the current expenditure spend on R&D by firm *i*

-$\boldsymbol{\alpha i}$: The intercept of the regression model.

- **INSTc*i***: The dummy variable that separates the observed firms in categories c, where institutional investors hold between 0% - 25%, 25% - 50% or at least 50% of the shares.

-$\boldsymbol{\omega i}$: Firm and management control variables.

-$\boldsymbol{\varepsilon i}$: The standard errors of the OLS regression model.

As the effect of the firm control variables in the regression seems to be greater than the effect of management control variables, the difference between the responding firms seems to have a greater effect on the estimated coefficients than the difference in the responding managers. The inclusion of firm control variables in this regression seems to enhance the predictive power of the regression models. The highest adjusted-R^2 in Table 9 is about 0.15 documented in Model 3 and Model 4. These adjusted-R^2 are relatively high compared to the documented adjusted-R^2 in the models without firm control variables, which are about 0.000 Model 1 and -0.004 in Model 2.

The documented coefficients in Table 9 seem to indicate that firms with institutional investors who own between 25% and 50% of the shares spend more on R&D compared to firms with less than 25% of institutional ownership. For INST2, the documented coefficients in Model 3 of 0.035 and in Model 4 of 0.033 are found to be significant at a 10% significance level. The coefficients suggest that these firms spend 3.3% to 3.5% more R&D compared to firms with less than 25% of institutional ownership. This relationship seems to be relatively strong, as the percentage spend on R&D in these firms seem to be 235% (i.e. 2.35 = 3.3/1.4) to 250% (i.e. 2.5 = 3.5/1.4) higher, given the mean percentage of R&Dexp = 1.4%. Thus, in line with the first hypothesis, firms with 25% to 50% of institutional ownership seem to be more innovative compared to firms with less than 25% of institutional ownership.

Firms in which institutional investors own at least 50% of the firms seem to spend less on R&D compared to firms with less than 50% of institutional ownership. Although the documented coefficients of INST3 are not significant, they seem to indicate that these firms spend 0.8% (i.e. -0.008 in Model 4) to 1.1% (i.e. -0.011 in Model 1) less on R&D compared to firms with less than 50% of institutional ownership. Given the mean R&Dexp = 0.014, it seems that the percentage spend on R&D in these firms is 57% (i.e. -0.570 = -0.008/0.014) to 79% (i.e. -0.785 = -0.011/0.014) lower. These results seem to be opposed to the first hypothesis, as they indicate that there is a strong negative relationship with innovation in firms in which there is at least 50% of institutional ownership. In this situation, the institutional investor is the biggest owner of the firm and the investors might bear all cost of monitoring the performance of the firm. When the institutional investors is more interested in current earnings, it might be possible that the higher percentage of the expenditure is distributed away from R&D to increase the current earnings of the firm.

Table 9. Results of the OLS regression that tests the relationship between institutional ownership and innovation.

	Model 1		**Model 2**		**Model 3**		**Model 4**	
R&Dexp	*β*	*SD*	*β*	*SD*	*β*	*SD*	*β*	*SD*
Intercept	0.013***	0.003	0.000	0.014	-0.067	0.083	-0.095	0.084
INST2	0.021	0.018	0.023	0.018	0.033*	0.019	0.035*	0.019
INST3	-0.011	0.017	-0.010	0.017	-0.009	0.017	-0.008	0.017
Management	NO		YES		NO		YES	
Firm	NO		NO		YES		YES	
N	511		511		511		511	
ADJ-R^2	0.000		-0.004		0.147		0.149	

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01

4.2 Decentralization and Innovation

Regression model (6) is designed to test the relationship between the levels of decentralization in the firm and the percentage of current expenditure spend on R&D (R&Dexp). DEC*i* symbolizes the measure of decentralization that is considered in the regression. This study considers the measure of decentralization according to the managers of firm *i* (i.e. DECm*i* and DECin*i*) and the level of decentralization according to the employees of firm *i* (i.e. DECe*i* and DECB*i*). The measures of decentralization are expected to be positively related to R&Dexp$i$. Thus, when the coefficient of the measures of decentralization, $\beta 1$, is positive, this regression could provide evidence for a positive linear relationship between decentralization and innovation in the firm.

$$\mathbf{R\&Dexp}\boldsymbol{i} = \boldsymbol{\beta 0}\ \boldsymbol{\alpha i} + \ \boldsymbol{\beta 1}\ \mathbf{DEC}\boldsymbol{i} + \boldsymbol{\beta 2 \omega i} + \boldsymbol{\varepsilon i} \qquad \textbf{(6)}$$

where:

-$\mathbf{R\&Dexp}\boldsymbol{i}$: The percentage of the current expenditure spend on R&D by firm *i*

-$\boldsymbol{\alpha i}$: The intercept of the regression model.

-$\mathbf{DEC}\boldsymbol{i}$: The general measure of decentralization in firm *i*

-$\boldsymbol{\omega i}$: Firm and management control variables.

-$\boldsymbol{\varepsilon i}$: The standard errors of the OLS regression model.

The results of the regression with measures of decentralization from the managers' point of view seems to provide evidence in line with the predicted positive relationship. For instance, in the models that have the highest fit to the dataset, Model 3 and Model 4 of PANEL A of Table 10, the documented coefficients for DECm of 0.003 are similar to the documented coefficients of DECin of 0.003 and 0.002. Given that the mean of R&Dexp = 0.014, it seems that a one level increase in decentralization in these models indicates an increase in the percentage spend on R&D of 21% (i.e. 0.214 = 0.003/0.014) to 14% (i.e. 0.142 = 0.002/0.014). Thus, although none of these coefficients are significant, they do seem to suggest that decentralization in the firm increases the percentage spend on R&D.

Table 10: The results of the regression with different measures of decentralization and innovation.

PANEL A

R&Dexp	Model 1				Model 2				Model 3				Model 4			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Management:																
Intercept	0.004	0.007	531	0.002	-0.01	0.015	531	-0.001	-0.008	0.017	531	0.155	-0.025	0.021	531	0.155
DECm	0.005	0.003			0.005	0.003			0.003	0.003			0.003	0.003		
Involvement:																
Intercept	0.008	0.006	531	0.000	-0.005	0.015	531	-0.003	-0.006	0.016	531	0.155	-0.023	0.021	531	0.155
DECin	0.003	0.003			0.003	0.003			0.003	0.003			0.002	0.003		
Controls	NO				Management				Firm				Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01

PANEL B

R&Dexp	Model 1				Model 2				Model 3				Model 4				Model 5			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Employee:																				
Intercept	0.012	0.013	466	-0.002	0.009	0.006	412	0.025	-0.030*	0.014	466	0.361	-0.036	0.024	412	0.313	-0.032	0.026	412	0.309
DECe	0.000	0.005			0.002	0.008			0.005	0.005			0.005	0.005			0.005	0.005		
Pace:																				
Intercept	0.008	0.010	466	-0.002	0.005	0.024	412	-0.002	-0.029**	0.013	466	0.361	-0.036	0.022	412	0.314	-0.033	0.025	412	0.310
DECB	0.002	0.005			0.003	0.005			0.005	0.004			0.006	0.004			0.006	0.004		
Controls	NO				Employee				Firm				Employee and Firm				Employee, Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.

In line with these results are the documented coefficients in the regression with the measure of decentralization from the employees' point of view. Although none of these coefficients in PANEL B of Table 10 are significant, it seems that the coefficients of DECe indicate that there is a positive relationship between decentralization and innovation. For instance, the documented coefficients in Model 3 and Model 4 are both 0.005. Given the mean R&Dexp = 0.014, the coefficient seems to suggest that for every level of decentralization, the percentage spend on R&D is 36% (i.e. 0.357 = 0.005/0.014) higher. When DECB is considered as the measure of the level of decentralization, the results seem to suggest that the percentage spend on R&D is 14% (i.e. 0.143 = 0.002/0.014 in Model 1) to 43% (i.e. 0.428 = 0.006/0.014 in Model 4 and Model 5) higher for every level of decentralization.

4.3 Institutional Investors, Decentralization and Innovation.

This section describes whether there is a positive relationship between the percentage of shares of the firm owned by institutional investors and decentralization. In this section the possibility that the relationship between the level of decentralization in the firm and the percentage spend on R&D is different in firms with 25% to 50% of institutional ownership than in firms with at least 50% of institutional ownership is also considered.

4.3.1 Institutional Investors and Decentralization

OLS regression model (7) is designed to test whether there is a positive linear relationship between the percentage of shares owned by institutional investors and the level of decentralization in the firm. In this regression model, the variable INSTci is expected to explain (a part of) the variation in the level of DECi in the firms. Therefore, it is expected that $\beta 1$, which is the coefficient of INSTci, is positive in the regression models that consider the level of decentralization according to the managers of firm *i* (i.e. DECm*i* and DECin*i*) and the level of decentralization according to the employees of firm *i* (i.e. DECe*i* and DECB*i*).

$$\mathbf{DEC}\boldsymbol{i} = \boldsymbol{\beta 0}\ \boldsymbol{\alpha i} + \ \boldsymbol{\beta 1}\ \mathbf{INSTc}\boldsymbol{i} + \boldsymbol{\beta 2 \omega i} + \boldsymbol{\varepsilon i} \qquad \textbf{(7)}$$

where:

-$\mathbf{DEC}\boldsymbol{i}$: The general measure of decentralization in firm *i*

-$\boldsymbol{\alpha i}$: The intercept of the regression model.

-$\mathbf{INSTc}\boldsymbol{i}$: The dummy variable that separates the observed firms in categories c, where institutional investors hold between 0% - 25%, 25% - 50% or at least 50% of the shares.

-$\boldsymbol{\omega i}$: Firm and management control variables.

-$\boldsymbol{\varepsilon i}$: The standard errors of the OLS regression model.

In Table 11, the adjusted-R^2 of the regression models indicate that the designed regression might not the best predictor of the variation in the measures of decentralization. For instance, the documented adjusted-R^2 of the regression from the managers' point of view does not exceed 0.085, as PANEL A of Table 11 shows. As PANEL B of Table 11 shows, the adjusted-R^2 of the regression models from the employees' point of view does not exceed 0.049. This might suggest that the designed OLS regression does not account for all variables or forces that affect the level of decentralization in the firm.

For firms in which institutional investors hold between 25% and 50% of the shares of the firm, the regression results from the managers point of view seems to indicate that these firms are *less* decentralized compared to firms with less than 25% of institutional ownership. While from the employees' point of view, the results suggests that these firms are *more* decentralized compared to firms with less than 25% of institutional ownership. For instance, the significant coefficients of INST2 in the regression from the managers' point of view in Model 3 and Model 4 of PANEL A of Table 11, seems to suggest that these firms are about 0.442 to 0.467 less decentralized. While the coefficients of DECe and DECB in Model 3 and Model 4 in PANEL B of Table 11 range from 0.032 to 0.117. Although these coefficients do not seem to be as strong as the coefficients in PANEL A, they also seem to indicate that there is a positive relationship between INST2 and decentralization from the employees' point of view. The difference in the coefficients of PANEL A to PANEL B could be the result of the difference in the respondent's perception of how decentralized the firm is.

Table 11. The results of the regression that tests the relationship between institutional ownership and the different measures of decentralization.

PANEL A

	Model 1				**Model 2**				**Model 3**				**Model 4**			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
DECm																
Intercept	1.903***	0.035	524	0.007	2.070***	0.182	524	0.005	1.277***	0.234	524	0.042	1.559***	0.293	524	0.049
INST2	-0.540**	0.236			-0.533**	0.237			-0.467**	0.236			-0.442*	0.236		
INST3	0.097	0.226			0.098	0.226			0.221	0.226			0.225	0.225		
DECin																
Intercept	1.964**	0.039	524	0.004	1.958***	0.205	524	0.002	0.889***	0.258	524	0.080	1.040***	0.323	524	0.085
INST2	-0.510*	0.265			-0.505*	0.266			-0.389	0.26			-0.357	0.26		
INST3	-0.131	0.254			-0.117	0.255			0.039	0.249			0.052	0.248		
Controls	NO				Management				Firm				Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01

PANEL B

	Model 1				**Model 2**				**Model 3**				**Model 4**				**Model 5**			
	β	*SD*	*N*	*Adj-R^2*	*B*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
DECe																				
Intercept	2.275***	0.017	461	-0.002	2.408***	0.185	411	-0.004	2.204***	0.108	461	0.049	2.276***	0.214	411	0.042	2.298***	0.237	411	0.041
INST2	-0.016	0.118			0.041	0.129			0.032	0.117			0.080	0.129			0.089	0.129		
INST3	0.113	0.112			0.114	0.115			0.181	0.112			0.185	0.115			0.191*	0.115		
DECB																				
Intercept	2.159***	0.020	461	-0.002	2.328***	0.221	411	-0.005	2.026***	0.131	461	0.029	2.113***	0.256	411	0.030	2.149***	0.285	411	0.029
INST2	-0.005	0.142			0.058	0.155			0.054	0.143			0.117	0.155			0.129	0.155		
INST3	0.127	0.135			0.136	0.137			0.202	0.136			0.220	0.138			0.226	0.138		
Controls	NO				Employee				Firm				Employee and Firm				Employee, Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01

For firms with institutional investors that own at least 50% of the shares, the gross of the results indicate that there is a positive relationship with decentralization. For instance, the coefficient of 0.191 of INST3 in Model 5 in PANEL B of Table 11 is found to be significant. This coefficient suggests that firms with at least 50% of institutional ownership are more decentralized compared to firms with less than 50% of institutional ownership. The documented coefficients of -0.131 and -0.117 of INST3 in Model 1 and Model 2 of the regression with decentralization measured as the involvement of employees in the firm are the only negative correlations. These coefficients might be negative because Model 1 and Model 2 are of relatively low fit to the dataset.

4.3.2 Decentralization and Innovation in Firms with Institutional Ownership

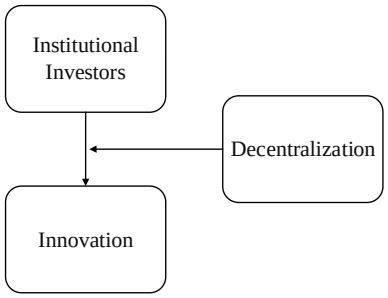


Figure 3. The effect of decentralization in the firm with institutional owners

As presented in Figure 3, this section investigates the direct effect of decentralization on the relationship between the percentage of institutional ownership and innovation. For example, it might be possible that firms with at least 50% of institutional ownership and with more decentralization tend to be less innovative. Whereas firms with less than 50% of institutional ownership and with more decentralization tend to be more innovative. Thus, OLS regression model (8) is designed to test the interaction effect of decentralization on the relationship between institutional ownership and innovation.

$$\mathbf{R\&Dexp}i = \boldsymbol{\beta}0\ \boldsymbol{\alpha}i + \boldsymbol{\beta}1\ \mathbf{INST}ci + \boldsymbol{\beta}2\ \mathbf{INST}ci * \mathbf{DEC}i + \boldsymbol{\beta}3\mathbf{DEC}i + \boldsymbol{\beta}4\boldsymbol{\omega}i + \boldsymbol{\varepsilon}i \qquad (8)$$

where:

-**R&Dexp*i***: The percentage of the current expenditure spend on R&D by firm *i*

-**αi**: The intercept of the regression model.

- **INST*ci***: The dummy variable that separates the observed firms in categories c, where institutional investors hold between 0% - 25%, 25% - 50% or at least 50% of the shares.

- **INST*ci* * DEC*i***: The interaction variable consisting of dummy variable that separates the observed firms in accordance to the percentage of institution ownership and measure of the level of decentralization of firm *i*

-**DEC*i***: The general measure of decentralization in firm *i*

-**ωi**: Firm and management control variables.

-**εi**: The standard errors of the OLS regression model.

The regression results in Table 12 indicate that there is a positive effect of decentralization on innovation in the regression from the managers' point of view. For instance, although the coefficients in Model 3 are not significant, a one unit increase in the level of decentralization in firms with institutional ownership between 25% and 50% seems increase in the level of R&Dexp to 2.1% (i.e. 0.021 = 0.016 + 1*0.005). Given R&Dexp = 0.014, which is the mean R&D expenditure of the sample, it seems that the percentage spend on R&D is 150% (i.e. 1.5 = 0.021/0.014) higher. In the same model in Table 13, the coefficients of INST2 and INST2*DECe are different from zero at a 1% significance level. These coefficients indicate that an increase in the level of decentralization from the employees' point of view above 2.1 (i.e. 2.1 = 0.401/0.187), results in a positive relationship with innovation in firms with 25% to 50% of institutional ownership. For example, given DECe=4, the relationship with the percentage spend on R&D in these firms would be 34.7% (0.347= -0.401 + 4*0.187). However, this relationship has not been found different from zero at any significance level in a Wald Test.

For firms with at least 50% of institutional ownership, decentralization from the managers' point of view seems to decrease the percentage spend on innovation. In Table 12, the positive relationship between INST3 and R&D expenditure without decentralization seems to decrease in the level of decentralization. For instance, although none of the coefficients are significant, in Model 4 the coefficient of INST3 is 0.008 and the coefficient of INST3*DECm is -0.006. This indicates that with an increase in the level of decentralization above 1.333 (i.e. 1.333 = 0.008/0.006), firms with at least 50% institutional ownership spend less on R&D compared to firms with less than 50% of institutional ownership. The negative effect of decentralization on the percentage spend on R&D does not seems to be in line with the positive relationship this study has found in the direct relationship between decentralization and innovation. The negative effect could be the result of the use of output performance measures, which are not related to R&D expenditure. When the manager knows the institutional investors are more interested in current earnings, decentralization of the organizational structure and monitoring the output of the actions employees performed might increase the current earnings of the firm at the cost of R&D expenditure.

The documented coefficients of decentralization from the employees' point of view on innovation in firms with at least 50% of institutional ownership are highly mixed. For instance, although not significant, the coefficient of INST3 in Model 3 of Table 13 seem to suggest a negative relationship with R&Dexp in firms with at least 50% of institutional ownership and no decentralization. This relationship seems to be positive when the level of decentralization increases to at least 2.6 (i.e. 2.6 = 0.013/0.005). The coefficients of INST3 of 0.005 and INST3*DECe of -0.004 documented in Model 5, seem to suggest that the positive relationship with R&D expenditure in firms with at least 50% of institutional ownership changes to a negative relationship when decentralization is at least 1.25 (i.e. 1.25 = 0.005/0.004). In the same model, the documented coefficient of INST3 is -0.002 and the documented coefficient of INST3*DECB is -0.001 indicate that the relationship with R&D expenditure is increasingly negative in DECB.

Table 12. The results of the regression that tests the interaction effects of decentralization and institutional ownership from the employees' point of view.

R&Dexp	Model 1				Model 2				Model 3				Model 4			
	B	*SD*	*N*	*Adj-R²*	*β*	*SD*	*N*	*Adj-R²*	*β*	*SD*	*N*	*Adj-R²*	*β*	*SD*	*N*	*Adj-R²*
Management:																
Intercept	0.001	0.007	511	0.001	-0.014	0.016	511	0.000	-0.012	0.018	511	0.157	-0.030	0.022	511	0.158
DECm	0.007*	0.004			0.007*	0.004			0.004	0.003			0.004	0.003		
INST2	0.017	0.032			0.018	0.033			0.016	0.030			0.017	0.030		
INST2*DECm	0.006	0.019			0.006	0.020			0.005	0.018			0.005	0.018		
INST3	0.009	0.045			0.008	0.045			0.008	0.042			0.008	0.042		
INST3*DECm	-0.010	0.021			-0.010	0.021			-0.007	0.019			-0.006	0.019		
Involvement:																
Intercept	0.007	0.007	511	-0.001	-0.008	0.015	511	-0.005	-0.009	0.017	511	0.156	-0.028	0.022	511	0.157
DECin	0.003	0.003			0.003	0.003			0.003	0.003			0.002	0.003		
INST2	-0.007	0.035			-0.007	0.035			0.000	0.032			-0.001	0.032		
INST2*DECin	0.020	0.020			0.022	0.020			0.015	0.019			0.017	0.019		
INST3	-0.006	0.043			-0.002	0.044			0.001	0.040			0.005	0.041		
INST3*DECin	-0.003	0.022			-0.004	0.022			-0.003	0.020			-0.005	0.020		
Controls	NO				Management				Firm				Management and Firm			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

Table 13. The results of the regression that tests the interaction effects of decentralization and institutional ownership from the employees' point of view.

R&Dexp	Model 1				Model 2				Model 3				Model 4				Model 5			
	β	*SD*	*N*	*Adj-R²*	*β*	*SD*	*N*	*Adj-R²*	*β*	*SD*	*N*	*Adj-R²*	*β*	*SD*	*N*	*Adj-R²*	*β*	*SD*	*N*	*Adj-R²*
Employee:																				
Intercept	0.013	0.013	448	0.023	0.015	0.026	399	0.027	-0.033**	0.014	448	0.405	-0.035	0.023	399	0.361	-0.037	0.025	399	0.359
DECe	0.000	0.006			0.001	0.006			0.004	0.005			0.004	0.005			0.005	0.005		
INST2	-0.403***	0.116			-0.418***	0.121			-0.401***	0.091			-0.430**	0.099			-0.430***	0.100		
INST2*DECe	0.186***	0.051			0.192***	0.053			0.187***	0.040			0.197**	0.043			0.197***	0.043		
INST3	-0.008	0.232			0.003	0.230			-0.013	0.182			-0.009	0.187			0.005	0.188		
INST3*DECe	0.000	0.097			-0.005	0.096			0.005	0.076			0.003	0.078			-0.004	0.079		
Pace:																				
Intercept	0.010	0.010	448	0.013	0.009	0.024	399	0.015	-0.031**	0.013	448	0.394	-0.035	0.022	399	0.348	-0.036	0.025	399	0.346
DECB	0.001	0.005			0.003	0.005			0.004	0.004			0.004	0.004			0.005	0.004		
INST2	-0.197***	0.075			-0.198**	0.079			-0.190***	0.059			-0.200***	0.064			-0.201***	0.065		
INST2*DECB	0.099***	0.034			0.100***	0.035			0.098***	0.027			0.101***	0.029			0.102***	0.029		
INST3	0.007	0.147			0.009	0.146			-0.008	0.116			-0.011	0.119			-0.002	0.120		
INST3*DECB	-0.007	0.064			-0.008	0.064			0.003	0.050			0.003	0.052			-0.001	0.052		
Controls	NO				Employee				Firm				Employee and Firm				Employee, Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

4.4 Robustness of Institutional Ownership

The measure of institutional ownership raises some concerns about the precision of the estimated relationships. The relatively high concentration of firms with less than 25% of institutional ownership indicate that the results of this study might be affected by a sampling bias. In APPENDIX B: ROBUSTNESS CHECK, this study attempts to take away any concerns about the estimated relationships with the measure of institutional ownership. For this robustness check, the relationship between a single family or individual that holds shares in the firm and the level of innovation of the firm is examined. While the relationship between institutional owners and innovation is suggested to be positive, the bulk of research suggests a negative relationship between the involvement of family or individual owners and the innovativeness of the firm. By the use of multiple OLS regression models, a negative relationship is found between family or individual ownership and decentralization. As expected, the level of decentralization seems to be decreasing in the percentage of family or individual ownership. However, in the firms with family or individual ownership and decentralization, the effect of decentralization seems to be negative. This seems to suggest that more complex forces affect the relationship between decentralization and innovation. For example, the negative effect of decentralization might be the result of the output performance measures used in these firms that might not be related to the percentage of R&D expenditure.

4.5 Decentralization and Union Power

This section is devoted to testing the effect of union power on the organizational structure. OLS regression model (9) is designed to analyze how the power of unions in the firm affects the relationship between decentralization and the percentage spend on R&D by the firm. Recall from the third hypothesis, that the positive effect of decentralization on the percentage spend on R&D is expected to be enhanced by the power of unions in the firm. Section 4.5.1 discusses the regression in which the power of unions is measured by the union bargaining power (UP*i*). In Section 4.5.1 union power is measures by the number of unions recognized by the firms (UR*ci*). These measures are expected to have a positive effect on the relationship between the measures of decentralization (i.e. DECm*i*, DECin*i*, DECe*i* and DECB*i*) and the measure of innovation (i.e. R&Dexp*i*).

$$\mathbf{R\&Dexp}i = \boldsymbol{\beta 0}\,\boldsymbol{\alpha i} + \boldsymbol{\beta 1}\mathbf{UNION}i + \boldsymbol{\beta 2}\mathbf{UNION}i * \mathbf{DEC}i + \boldsymbol{\beta 3}\mathbf{DEC}i + \boldsymbol{\beta 4}\boldsymbol{\omega i} + \boldsymbol{\varepsilon i} \quad \textbf{(9)}$$

where:

-**R&Dexp*i***: The percentage of the current expenditure spend on R&D by firm *i*

-**αi**: The intercept of the regression model.

-**UNION*i***, is the measure of union power for firm *i*.

-**UNION*i* * DEC*i***, is the interaction effect of the measure of union power in firm *i* and the measure of decentralization in firm *i*.

-**DEC*i***: The general measure of decentralization in firm *i*

-**ωi**: Firm and management control variables.

-**εi**: The standard errors of the OLS regression model.

4.5.1 Union Bargaining Power

The bargaining power of unions in decentralized firms seems to have a negative effect on the percentage spend on R&D. For instance, the documented coefficients in Model 4 of Table 14 indicate that for every increase in the bargaining power of unions, the effect of DECm of 0.5% (i.e. 0.005) on R&Dexp decreases with 0.1% (i.e. the coefficient of UP*DECm is -0.001). Although none of these coefficients are significant, the regression with UP and DECm seems to indicate that the positive effect of decentralization on the percentage spend on R&D gets weaker when unions have more power in the firm. Union bargaining power in decentralized firms, measured from the view of the employees, seems to have a negative effect on the percentage spend on R&D as well. For example, the coefficient of DECe in Model 4 of Table 15 of 0.007 indicates that there is a positive relationship with R&Dexp in decentralized firms with no union power. The coefficient of UP*DECe of -0.002 in Model 4 indicates that the percentage spend on R&D decreases in UP. Although none of the coefficients are not significant, an increase in UP of at least 3.5 (i.e. 3.5=0.007/0.002) might result in a negative relationship with the percentage spend on R&D in decentralized firms. Thus, opposed to the third hypothesis of this study, it seems that decentralized firms from the managers and the employees' point of view spend less on R&D when the bargaining power of unions increases. An explanation for this effect could be that the increased bargaining power of unions in decentralized firms might be an opportunity for unions to bargain over the terms and conditions of employment at the cost of R&D expenditure.

Table 14. The results of the regression that tests the interaction effects of decentralization and union bargaining power from the managers' point of view.

R&Dexp	**Model 1**				**Model 2**				**Model 3**				**Model 4**			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Management:																
Intercept	0.004	0.008	528	-0.001	-0.011	0.016	528	-0.004	-0.007	0.018	528	0.159	-0.029	0.022	528	0.160
DECm	0.006	0.004			0.006	0.004			0.004	0.004			0.005	0.004		
UP	0.001	0.005			0.001	0.005			-0.002	0.005			-0.001	0.005		
UP*DECm	-0.001	0.003			-0.001	0.003			-0.001	0.002			-0.001	0.002		
Involvement:																
Intercept	0.005	0.007	528	-0.002	-0.009	0.016	528	-0.006	-0.008	0.017	528	0.159	-0.029	0.021	528	0.161
DECin	0.005	0.004			0.005	0.004			0.004	0.003			0.004	0.003		
UP	0.003	0.005			0.004	0.005			0.000	0.005			0.001	0.005		
UP*DECin	-0.002	0.002			-0.002	0.002			-0.002	0.002			-0.002	0.002		
Controls	No				Management				Firm				Management and Firm			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

Table 15. The results of the regression that tests the interaction effects of decentralization and union bargaining power from the employees' point of view.

R&Dexp	**Model 1**				**Model 2**				**Model 3**				**Model 4**				**Model 5**			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Employee:																				
Intercept	0.006	0.016	464	-0.005	0.004	0.027	410	-0.007	-0.031*	0.016	464	0.366	-0.032	0.025	410	0.319	-0.031	0.027	410	0.315
DECe	0.002	0.007			0.003	0.007			0.007	0.005			0.007	0.006			0.008	0.006		
UP	0.005	0.009			0.005	0.009			0.002	0.007			0.003	0.008			0.004	0.008		
UP*DECe	-0.002	0.004			-0.002	0.004			-0.002	0.003			-0.002	0.003			-0.002	0.003		
Pace:																				
Intercept	0.003	0.012	464	-0.004	0.001	0.025	410	-0.006	-0.028*	0.014	464	0.367	-0.029	0.023	410	0.319	-0.028	0.025	410	0.316
DECB	0.004	0.005			0.005	0.006			0.006	0.004			0.006	0.005			0.007	0.005		
UP	0.006	0.008			0.004	0.008			0.000	0.006			0.000	0.007			0.000	0.007		
UP*DECB	-0.002	0.004			-0.002	0.004			-0.001	0.003			-0.001	0.003			-0.001	0.003		
Controls	NO				Employee				Firm				Employee and Firm				Employee, Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

4.5.2 Union Recognition

In firms that recognize a single union, a positive effect of decentralization from the view of the managers on R&D expenditure by the firm is documented. For instance, although the coefficients of DECm and UR2*DECm in Table 16 are not significant, they seem to indicate that the effect of decentralization in firms that recognize a single union on the percentage spend on R&D is between 0.4% (i.e. 0.004 = 0.005 + -0.001 in Model 1) and 0.6% (i.e. 0.006= 0.006 + 0.000 in Model 3). As the positive effect of decentralization seems to suggest that recognizing a single union by the firm enhances the percentage spend on R&D compared to recognizing any unions, these results seem to be in line with the third hypothesis of this study.

For decentralization measured as employee-involvement, the coefficients in Table 16 indicate that the effect of decentralization in a firm that recognizes a single union might be negative. None of the coefficients of DECin and UR2*DECin are significant. However, in Model 3 and Model 4, which have the highest fit to the dataset, the effect of decentralization in firms that recognize a single union seems to be -0.001 (i.e. -0.001 = -0.002 + 0.001) and -0.002 (i.e. -0.002 = -0.003 + 0.001). The negative effect of employee-involvement seems to enhance the negative relationship between recognizing a single union in the firm and innovation. This might support the idea that employee-involvement is merely an instrument for centralization and the avoidance of union involvement in the workplace.

In Table 17, the documented coefficients, although not significant, indicate that the effect decentralization, in firms that recognize a single union is only positive in the models with the highest fit to the dataset (Model 3 to Model 5). This might be explained by the effect of the firm control variables in the regression models with decentralization according to the employees'. For instance, the coefficient of DECe and UR2*DECe in Model 5 indicate that the effect of decentralization in firms that recognize a single union is 0.9% (i.e. 0.009 = 0.011 + -0.002). The percentage spend on R&D in these firms seems to be 64% (i.e. 0.643 = 0.009/0.014) higher, given the mean expenditure R&Dexp = 0.014. While in Model 1, the effect of decentralization in these firms seems to be - 0.1% (i.e. -0.001 = -0.007 + -0.003). As there are no firm control variables included in this mode, it seems that the percentage spend on R&D is about 7% (i.e. -0.071 = -0.001/0.014) lower. Thus, in line with the third hypothesis, the results indicate that the effect of

recognizing a single union on the relationship between decentralization and innovation, might be enhanced by the power of the unions in the firm.

For firms that recognize multiple unions, the coefficients in Table 16 and Table 17 indicate that although the effect of decentralization in these firms is, it seems that only at high levels of decentralization these firms spend more on R&D compared to firms that do not recognize any unions. For instance, in Model 4 of Table 16 there is a significant positive effect of DECm on R&Dexp of 0.017 (i.e. 0.017 = 0.017 + 0.000). Given the mean R&Dexp=0.014, the percentage spend is about 121% (i.e. 1.214 = 0.017/0.014) higher in these firms. The significant coefficient of UR3 of -0.041, and the significant coefficient of UR3*DECm of 0.017 indicates that increase in the level of decentralization to at least 2.4 (i.e. 2.4 = 0.041/0.017) results in a positive relationship with R&Dexp. Consider a situation in which there is a relatively low amount of information available for the manager about what actions will make an innovative project a success. When the manager decentralizes the organizational structure to take advantage of the information available to the agent, there might be a high need for union power in the firm. Increased union power could provide enough tolerance for failure in the short-term to incentivize the agent to explore new and risky paths to future success.

Table 16 The results of the regression that tests the interaction effects of decentralization and union recognition from the managers' point of view.

R&Dexp	**Model 1**				**Model 2**				**Model 3**				**Model 4**			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Management:																
Intercept	0.013	0.008	531	0.024	0.001	0.016	531	0.020	0.005	0.018	531	0.160	-0.013	0.022	531	0.159
DECm	-0.001	0.004			-0.001	0.004			0.000	0.004			0.000	0.004		
UR2	-0.011	0.018			-0.009	0.018			-0.021	0.017			-0.020	0.018		
UR2*DECm	0.005	0.009			0.005	0.009			0.006	0.009			0.005	0.009		
UR3	-0.034*	0.019			-0.032*	0.019			-0.042**	0.018			-0.041**	0.018		
UR3*DECm	0.025***	0.009			0.025***	0.009			0.017**	0.008			0.017**	0.008		
Involvement:																
Intercept	0.010	0.007	531	0.011	-0.002	0.015	531	0.007	0.003	0.017	531	0.157	-0.015	0.021	531	0.157
DECin	0.001	0.003			0.001	0.003			0.001	0.003			0.001	0.003		
UR2	-0.003	0.018			-0.001	0.018			-0.008	0.017			-0.006	0.017		
UR2*DECin	0.001	0.009			0.000	0.009			-0.002	0.008			-0.003	0.008		
UR3	-0.007	0.018			-0.006	0.019			-0.033*	0.017			-0.033*	0.017		
UR3*DECin	0.012	0.008			0.012	0.008			0.012	0.008			0.012	0.008		
Controls	NO				Management				Firm				Management and Firm			

Notes: An overview of the documented coefficients (**β**), the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

Table 17. The results of the regression that tests the interaction effects of decentralization and union recognition from the employees' point of view.

R&Dexp	**Model 1**				**Model 2**				**Model 3**				**Model 4**				**Model 5**			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Employee:																				
Intercept	0.014	0.015	466	0.045	0.012	0.026	412	0.028	-0.013	0.016	466	0.366	-0.024	0.024	412	0.319	-0.015	0.026	412	0.318
DECe	-0.003	0.006			-0.002	0.006			-0.001	0.005			-0.001	0.005			-0.001	0.006		
UR2	0.007	0.040			0.004	0.044			-0.051	0.033			-0.039	0.038			-0.044	0.038		
UR2*DECe	-0.003	0.018			-0.002	0.020			0.020	0.015			0.014	0.017			0.016	0.017		
UR3	-0.058*	0.034			-0.058	0.036			-0.062**	0.028			-0.070**	0.030			-0.074**	0.031		
UR3*DECe	0.036**	0.015			0.034**	0.016			0.026**	0.012			0.028**	0.013			0.030**	0.014		
Pace:																				
Intercept	0.016	0.014	466	0.059	0.015	0.025	412	0.048	-0.014	0.015	468	0.369	-0.022	0.024	412	0.356	-0.014	0.026	412	0.325
DECB	-0.003	0.006			-0.004	0.006			-0.001	0.005			-0.001	0.005			-0.002	0.005		
UR2	0.014	0.031			0.010	0.035			-0.036	0.026			-0.030	0.030			-0.032	0.030		
UR2*DECB	-0.007	0.015			-0.005	0.016			0.013	0.012			0.010	0.014			0.011	0.014		
UR3	-0.073***	0.028			-0.088***	0.030			-0.064***	0.023			-0.082***	0.026			-0.085***	0.026		
UR3*DECB	0.046***	0.013			0.051***	0.014			0.029***	0.011			0.036***	0.012			0.037***	0.012		
Controls	NO				Employee				Firm				Employee and Firm				Employee, Firm and Management			

Notes: An overview of the documented coefficients (**β**), the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

5. Conclusion

This study has examined the link between institutional ownership, decentralization, union power and innovation. Based on existing literature, this study predicted that innovation in the firm increases in the percentages of shares of the firm owned by institutional investors, because of the sophistication and typical size of ownership of institutional investors. In addition, this study predicted a positive relationship between institutional ownership and decentralization, because a decentralized organizational structure might be the most optimal organizational structure in uncertain environments such as in a R&D project. The power of unions in the workplace was predicted to be positively related to decentralization, as it might be used to incentivize workers to explore new paths and opportunities that could lead to increasing future returns.

Using the WERS 2011 dataset, this study examined the views of 545 workplace managers, 545 financial managers and 21.981 employees on the organizational characteristics and performance of workplaces in the U.K. The results of the OLS regressions are broadly consistent with the hypotheses. Firms with 25% to 50% of institutional ownership seem to spend more R&D. The effect of decentralization on the percentage spend on R&D seems to be positive in these firms. Although it seems that these firms are more decentralized measured according to the employees' point of view, they are less decentralized measured according to the managers' point of view. Firms with at least 50% of institutional ownership, seem to spend less on R&D. However, these firms seem to have a higher level of decentralization and the percentage spend on R&D seems to decrease in the level of decentralization. In addition, only in firms that are highly decentralized, union power seems to increase the percentage spend on R&D.

The results do not provide clear evidence for institutional investors' focus on the short-term or on the long-term value of the firm. For firms that are owned by an institutional investor, in which it does not bear all cost of monitoring, the innovativeness of the firm seems to increase. When the institutional investor does bear all monitoring costs, the firms seem to be less innovative. In comparison, firms that are owned by a single family or individual owner seem to be less innovative and less decentralized. Which indicates that these owners are more interested in the current value of the firm. If the inconsistency in the results between firms with institutional owners and a single family or individual owner is solely due to the imprecise measure of institutional ownership, the

results of the regression with a family or individual owners seems to provide evidence in support of the idea that a higher percentage of long-term (short-term) focused owners increases (decreases) the innovativeness of the firm. However, the inconsistency might also be due to other factors that affect the relationship between ownership and innovation and decentralization. For example, the dispersion of the owners of the firm might be important to the relationship with innovation and decentralization.

In addition, the results suggests that the direct relationship between decentralization and innovation is positive. However, decentralization in firms with institutional, a family or individual ownership might serve other purposes than increasing the innovativeness of the firm. For example, the current value of the firm might be increased at the costs of innovation by setting performance measures based on current earnings or by using decentralization strategically for the sake of the corporative strategy and the competitive interactions with other firms (e.g. Sengul, Gimeno, & Dial, 2012). In decentralizing the organizational structure to increase the innovativeness of the firm, the results suggest that only in firms that are highly decentralized, unions act as the collective voice of employees. Hence, only in highly decentralized firms, union power might be used to increase the innovative activities of the employees.

Some limitations of this study could serve as an opportunity for future research. First, the measure of decentralization is based on how employees and managers perceive the level of decentralization in the firm which makes this measure highly subjective. A more objective measure of decentralization, such as a formal contract between the employee and manager in which the level of decentralization is recognized, could provide more consistent evidence. The measure of institutional ownership is also limited as it asked the managers whether an institutional investor owns *at least* 25% or 50% of shares. This measure of institutional ownership establishes two critical values of institutional ownership. A continuous measure of institutional ownership that measures the exact percentage of ownership per workplace might improve the precision of the results.

Second, the analysis of this study is limited to workplaces in the U.K.. This makes it difficult to generalize the results to firms that have workplaces located outside the U.K. Firms in other countries might have a different culture or a different governmental policy which might affect the relationships found in this study (see for example Fang & Ying, 2012). Therefore, future research could perform a similar analysis in a cross-country dataset. Examples of datasets that could be used for such study are the French COI and the International WMS[7].

Another limitation is that the questionnaires of the WERS 2011 have been distributed only once in every workplace between 2004 and 2011. Therefore, the analysis of this study does not capture any time effects on the workplaces that were interviewed. For example, policy changes in the firms might have had a substantial effect on the level of decentralization in the firm. Or any lagged effects of decentralization on the percentage spend on R&D are not captured in this study. Future research could construct a panel dataset where the workplace characteristics and performance have been documented over a length of time.

[7] For more information about the French COI see http://enquetecoi.net and for information about the WMS see http://worldmanagementsurvey.org.

APPENDIX A: CONTROL VARIABLES

Table 18. Definitions of the control variables.

Variable	Definition
Firm controls	
Firm Size	Number of employees in firm *i*
Firm Age	A categorization of the age of the firm ranging from is 25 year or older (6) to younger than 5 years (1)
PubC	Public Limited Company (PLC)
PriC	Private limited company
Guar	Company limited by guarantee
Part	Partnership (Inc. Limited Liability Partnership) / Self-proprietorship
Trust	Trust / Charity
Chart	Body established by Royal Charter
Coop	Co-operative / Mutual / Friendly society
Gov	Government-owned limited company / Nationalized industry / Trading Public Corporation
Local	Local/Central Government
MULTI	One of a number of different workplaces in the UK belonging to the same organization
SINGLE	Single independent establishment not belonging to another body
SOLEUK	Sole UK establishment of a foreign organization
Workplace is HO	Whether the interviewed workplace is the head-office of the firm (1)
HO Located in UK	Whether the head-office is located in the UK (1)
Computer Usage	The computer usage in the workplace in percentages, where 100 is equal to 100%
Competition	The degree of competition in the market, ranging from 'no' competition (6) to a 'very high' level of competition (1)
Management controls	
Gender	Dummy variable for the gender (percentage of males) of the workplace manager
Responsibilities	The number of responsibilities of the workplace manager
Job Tenure	The number of years the workplace manager has been doing his present job
Employee controls	
Academic Level	The academic degree of the responding employees in firm *i*, where 0 is no academic degree
Professional Qualification	The professional qualification of the employees in firm *i*, where 0 is no professional qualification
Health	Health condition of the respondents of each workplace
Gender	Percentage of male respondent in every workplace

Table 19. Descriptive statistics of the dummy control variables.

Dummy Variable		Frequency	Percentage
Firm controls			
	PubC	84	15.41
	PriC	273	50.09
	Guar	28	5.14
	Part	41	7.52
	Trust	92	16.88
	Chart	8	1.47
	Coop	5	0.92
	Gov	9	1.65
	Local	5	0.92
	MULTI	291	53.39
	SINGLE	235	43.12
	SOLEUK	19	3.49
	Workplace is HO	476	87.34
	HO Located in UK	124	22.75
Management controls			
	Gender (male)	285	52.29

Notes: The table shows the number of firms and the percentage of total firms for each dummy variable.

Table 20. Descriptive statistics of the continuous control variables.

Variable	N	Median	Mean	SD	Minimum	Maximum
Firm controls						
Firm Size	545	48	336	1021.471	5	11562
Firm Age	545	5	4.372	1.747	1	6
Computer Usage	545	80	65.744	35.923	0	100
Competition	545	2	2.35	1.421	1	6
Management controls						
Responsibilities	545	12	10.545	2.899	0	13
Job Tenure	545	5	6.996	6.59	0	37
Employee controls						
Academic Level	480	2.87	2.961	1.257	0	6
Professional Qualification	480	1.73	1.838	1.363	0	6
Health	480	0.056	0.112	0.184	0	1.5
Gender	480	0.5	0.497	0.298	0	1

Notes: The table shows the number of observations (N), the median, the mean, the standard deviation (SD), the minimum level and the maximum level for each variable.

APPENDIX B: ROBUSTNESS CHECK

6. Family and Individual Ownership.

The distribution of the workplaces among the three categories of the measure of institutional ownership (INST*ci*) raises some concerns. As there is a relatively low percentage of firms in categories INST2 and INST3, the estimated relationships with the measure of institutional ownership might be imprecise. To check the precision of the relationships between institutional ownership, decentralization and innovation, this study takes advantage of the information provided by the managers of the observed workplaces about the distribution of the percentages of shares of the firm. Recall from section 3.4 that the questions that are used to construct the measures of institutional ownership asked whether *a single individual or family, or an investment institution owns at least 25 per cent of* the firm and whether *a single individual or family, or an investment institution owns at least 50 per cent of* the firm.

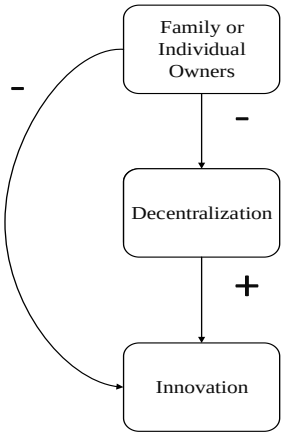
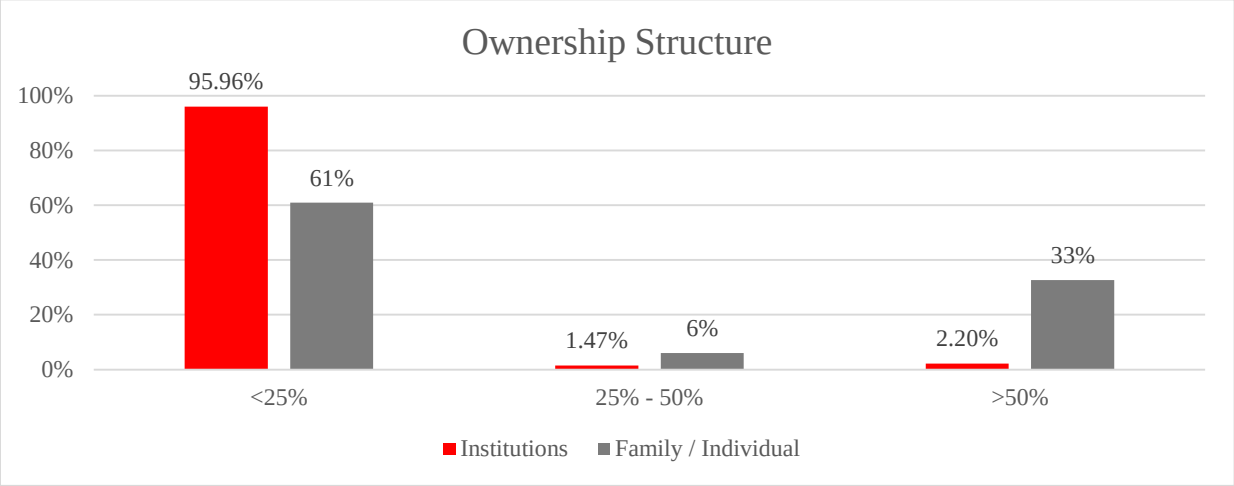


Figure 4. An overview of the expected relationships with family or individual owners

While this study predicted a positive relationship between institutional ownership and innovation, the bulk of the research on family or individual owners suggests a negative relationship between the involvement of a family owner or an individual owner in the firm and the R&D expenditure (see for example, De Massi, Frattini, & Lichtenthaler, 2012). Therefore, this section tests the relationship between family or individual ownership, decentralization and innovation as presented in Figure 4. First, this section tests whether the percentage spend R&D by firms with family or individual owners decreases with a higher percentage of ownership. Second, as the effect of decentralization on innovation is expected to be positive, this section tests whether the level of decentralization in these firms decreases with the percentage of ownership of a single family or individual.

Figure 5. Comparison of the ownership structure of the observed firms.



Notes: The graph shows the percentage of the workplaces in the sample that are owned for less than 25% by an investment institution, an individual or a single family. The workplaces of which an investment institution, an individual or single family owns between 25% and 50% of the shares. And the workplaces of which an investment institution, and individual or a single family owns more than 50% of the shares of the firm.

The analysis in this section considers a dummy variable that measures the percentage of the firm *i* that is owned by a single *family* and/or *individual (*OWN*ci*) divided the firms into categories *c*. The distribution of the firms among these categories are presented in Figure 5[8]. The first category of OWN*ci* (OWN*1i*) consists of 61% of the 545 workplaces. These workplaces are part of a governmental organization, or are part of a company that does not have any shares for sale, or the workplace manager did *not* confirm that a single family or individual owns any percentages of the firm's shares. The second category of OWN*ci* (OWN*2i*) includes 6% of the observed workplaces. This category consists of workplaces in which the manager answered the first question with 'yes - an individual or a single family owns at least 25 per cent of the firm' and did not confirm that an individual or a single family owns at least 50 per cent of the firm. About 33% of the observed workplaces are in the last category (OWN*3i*). The manager of these workplaces answered the second question with 'yes- an individual or a single family owns at least 50 per cent of the firm'

[8] Figure 5 also presents the distribution of the firms among the categories of INST*ci*, see section 3.1 for the construction of these categories.

6.1 Correlations

The results of the Pearson Correlation-Test and the Spearman Rank-Test are presented in Table 21 and Table 22. These tests show how the correlation of family or individual ownership with decentralization and innovation compares to the correlation of institutional ownership with decentralization and innovation.

The correlation between individual or family ownership and R&D expenditure seems to be more negative at lower percentages of ownership compared to the correlation of institutional ownership. Firms with at least 25% of individual or family ownership are negatively related to the percentage spend on R&D. For instance, the correlation coefficients of OWN2 with R&Dexp is -0.041 and the correlation coefficient of OWN3 with R&Dexp is -0.102 in Table 21. The only positive correlation coefficients of institutional ownership is that of INST2 with R&Dexp. This coefficients of 0.057 seems to indicate that there is a weak negative relationship between firms with less than 25% or at least 50% of institutional ownership.

In addition, the correlation tests seem to indicate that the correlation between INST2 and INST3 and the measures of decentralization are opposed to the correlations between OWN2 and OWN3 and the measures of decentralization. For instance, the correlation between INST2 and DECe in Table 22 is -0.017, while the correlation between OWN2 and DECe is 0.060. These correlation coefficients indicate that where firms with 25% to 50% of institutional ownership have a weak negative relationship with R&D expenditure, firm with 20% to 50% of family or individual ownership have a weak positive relationship with R&D expenditure. For firms with less than 25% of institutional, individual or family ownership, the documented correlation coefficients with DECe and DECm are highly similar. These coefficients suggests that DECm is positively correlated with INST1, while DECe is negatively correlated with INST1.

Table 21. Pearson correlation matrix for the key variables.

Variable	INST1	INST2	INST3	OWN1	OWN2	OWN3	DECm	DECe	R&Dexp
INST1	1								
INST2	-0.680	1							
INST3	-0.718	-0.022	1						
OWN1	-0.107	0.119	0.033	1					
OWN2	-0.083	-0.037	0.148	-0.311	1				
OWN3	0.153	-0.104	-0.110	-0.875	-0.188	1			
DECm	0.067	-0.105	0.009	0.089	0.019	-0.102	1		
DECe	-0.031	-0.007	0.048	-0.023	0.039	0.004	0.270	1	
R&Dexp	-0.015	0.057	-0.034	0.118	-0.041	-0.102	0.106	0.014	1

Notes: This matrix shows the Pearson correlation coefficients of the key measures used in the study. The darkest grey color indicates a correlation coefficient of 1 between the variables. The weaker the correlation between two variables the less grey the color becomes. The color changes at a critical absolute value of 1, 0.5, 0.3, 0.2 and 0.1.

Table 22. Spearman rank correlation matrix for the key variables.

Variable	INST1	INST2	INST3	OWN1	OWN2	OWN3	DECm	DECe	R&Dexp
INST1	1								
INST2	-0.680***	1							
INST3	-0.718***	-0.022	1						
OWN1	-0.107**	0.119**	0.033	1					
OWN2	-0.083*	-0.037	0.148***	-0.311***	1				
OWN3	0.153***	-0.104**	-0.110**	-0.875***	-0.188***	1			
DECe	-0.028	-0.017	0.055	-0.022	0.060	-0.008	1		
DECm	0.054	-0.084*	0.006	0.089*	0.015	-0.100**	0.270***	1	
R&Dexp	0.001	0.04	-0.039	0.039	-0.022	-0.029	-0.057	0.036	1

Notes: This matrix shows the Spearman Rank correlation coefficients of the key measures used in the study. The darkest grey color indicates a correlation coefficient of 1 between the variables. The weaker the correlation between two variables the less grey the color becomes; the color changes at a critical absolute value of 1, 0.5, 0.3, 0.2 and 0.1. And: *p<0.1, **p<0.05, ***p<0.01.

6.2 Family and Individual Owners and Innovation.

To test whether the relationship between a single family or individual owner (i.e. OWNc*i*) and the R&D expenditure of the firm is truly linear, OLS regression (10) is designed. Because a negative relationship with R&D expenditure is predicted, the coefficient of OWNc*i* is expected to be negative as well. Finding a negative coefficient, would provide more clear evidence in support of the prediction of a negative linear relationship between the percentage of family or individual ownership and the percentage spend on R&D by the firm.

$$\mathbf{R\&Dexp}i = \boldsymbol{\beta 0}\ \boldsymbol{\alpha i} + \boldsymbol{\beta 1}\ \mathbf{OWNc}i + \boldsymbol{\beta 2}\ \boldsymbol{\omega i} + \boldsymbol{\varepsilon i} \quad \textbf{(10)}$$

where:

-**R&Dexp*i*:** The percentage of the current expenditure spend on R&D by firm *i*

-$\boldsymbol{\alpha i}$: The intercept of the regression model.

-**OWNc*i***: The dummy variable that separates the observed firms in categories c, where a single family or individual hold between 0% - 25%, 25% - 50% or at least 50% of the shares.

-$\boldsymbol{\omega i}$: Firm and management control variables.

-$\boldsymbol{\varepsilon i}$: The standard errors of the OLS regression model.

The regression results, presented in Table 23, suggests that firms in which a single family or individual owns at least 25% of the shares spend less on R&D than firms with less than 25% of family or individual ownership. For instance, although none the documented coefficients of OWN2 and OWN3 in Model 4 are significant, they seem to indicate that firms that have a single family or an individual with 25% to 50% of ownership, spend 0.6% (i.e. -0.006 in Model 4) less on R&D and that firms with at least 50% of such ownership spend 0.8% (i.e. –0.008 in Model 4) *less* on R&D. Thus, as expected, the direct relationship between family or individual ownership and innovation seems to be negative.

Table 23. Results of the OLS regression that tests the relationship between a single family or individual owners and innovation.

	Model 1		**Model 2**		**Model 3**		**Model 4**	
R&Dexp	*β*	*SD*	*β*	*SD*	*β*	*SD*	*β*	*SD*
Intercept	0.019***	0.003	0.006	0.014	0.000	0.016	-0.015	0.020
OWN2	-0.014	0.011	-0.013	0.011	-0.007	0.010	-0.006	0.010
OWN3	-0.012**	0.005	-0.013**	0.006	-0.007	0.006	-0.008	0.006
Management	NO		YES		NO		YES	
Firm	NO		NO		YES		YES	
N	531		511		511		511	
ADJ-R^2	0.007		0.005		0.155		0.156	

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

6.3 Family and Individual Owners, Decentralization and Innovation

To get a greater understanding of the relationship between the percentage of family or individual ownership of the firm and the effect of decentralization on innovation, this section considers two OLS regression models. The first OLS regression is designed to test the prediction of a negative linear relationship between the percentage of shares of the firm owned by a single family or individual and the level of decentralization in the firm. The second OLS regression is designed to test for the effect of a decentralized organizational on the percentage spend on R&D in firms that are owned by a single family or individual. The latter regression tests the possibility that the effect of decentralization on the percentage spend on R&D might be dependent on the size of single of individual ownership.

6.3.1 Family and Individual Owners and Decentralization

OLS regression model (11) tests whether there is a linear relationship between the percentage of shares owned by a single family or individual and the level of decentralization in the firm. Because the percentage spend on R&D by firms seems to decrease with the percentage of family or individual ownership, it is expected that the level of decentralization also decreases with the percentage of family or individual ownership. Thus, the coefficient of OWNc*i* in regression (11) is expected to be negative in the regression models with the measures the level of decentralization according to the managers of firm i (i.e. DECmi) and the measures of the level of decentralization according to the employees of firm i (i.e. DECei).

$$\mathbf{DEC}\boldsymbol{i} = \boldsymbol{\beta}\mathbf{0}\ \boldsymbol{\alpha i} + \ \boldsymbol{\beta}\mathbf{1}\ \mathbf{OWNc}\boldsymbol{i} + \boldsymbol{\beta}\mathbf{2}\boldsymbol{\omega i} + \boldsymbol{\varepsilon i} \qquad \textbf{(11)}$$

where:

-$\mathbf{DEC}\boldsymbol{i}$: The general measure of decentralization in firm *i*

-$\boldsymbol{\alpha i}$: The intercept of the regression model.

-$\mathbf{OWNc}\boldsymbol{i}$: The dummy variable that separates the observed firms in categories c, where a single family or individual hold between 0% - 25%, 25% - 50% or at least 50% of the shares.

-$\boldsymbol{\omega i}$: Firm and management control variables.

-$\boldsymbol{\varepsilon i}$: The standard errors of the OLS regression model.

Table 24. The results of the regression that analysis the relationship between ownership of a single family or individual and the different measures of decentralization.

PANEL A

	Model 1				Model 2				Model 3				Model 4			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
DECm																
Intercept	1.919***	0.043	545	0.002	2.091***	0.183	545	0.006	1.411***	0.227	545	0.02	1.696***	0.291	545	0.023
OWN2	-0.071	0.144			-0.065	0.143			-0.013	0.148			-0.012	0.148		
OWN3	-0.127	0.073			-0.158**	0.074			-0.081	0.084			-0.105	0.085		
Controls	NO				Management				Firm				Management and Firm			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

PANEL B

	Model 1				Model 2				Model 3				Model 4				Model 5			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
DECe																				
Intercept	2.264***	0.021	480	-0.003	2.335***	0.189	424	-0.005	2.243***	0.106	480	0.055	2.289***	0.214	424	0.048	2.323***	0.238	424	0.048
OWN2	0.035	0.068			0.050	0.072			-0.028	0.069			-0.017	0.073			-0.015	0.073		
OWN3	0.016	0.035			0.002	0.038			-0.041	0.040			-0.054	0.043			-0.067	0.044		
Controls	NO				Employee				Firm				Employee and Firm				Employee, Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

The results of the regression in Table 24 suggest that the level of decentralization in the firm is decreasing with the percentage of the shares owned by a single family or individual. For instance, the non-significant coefficients of OWN2 and OWN3 in Model 4 indicate that firms with a single family or individual that owns between 25% and 50% of the shares of the firm, the level of DECm is 0.012 levels lower than firms with less than 25% of such ownership. For firms with a single family or individual that owns at least 50% of the shares, the level of DECm seems to be 0.105 lower than in firms with less than 50% of such ownership. The positive coefficients of OWN2 and OWN3 in Model 1 and Model 2 might be explained by the design of these regression models. The adjusted-R^2 of -0.003 and -0.005 indicate that these models are of relatively low fit. Therefore, it seems that in line with the expectation, a lower level of decentralization in firms with at least 25% of family or individual ownership might be explained by lower percentage spend on R&D in these firms.

6.3.2 Decentralization and Innovation in Firms with Family and Individual Owners

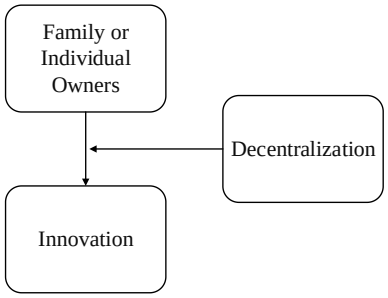


Figure 6. The effect of decentralization in the firm with family or individual owners

As presented in Figure 6, this section investigates the direct effect of decentralization in the relationship between family or individual ownership and innovation. It might be possible that firms in which at least 50% of the shares are owned by a single family or individual and are more decentralization are less innovative. While more decentralized firms in which less than 50% of the shares are owned by a single family or individual are more innovative. Regression model (12) is designed to formally test the effect of decentralization in the firm on the relationship between family or individual owners and innovation.

$$\mathbf{R\&Dexp}i = \beta 0\ \alpha i + \beta 1\ \mathbf{OWN}ci + \beta 2\ \mathbf{OWN}ci * \mathbf{DEC}i + \beta 3\mathbf{DEC}i + \beta 4\omega i + \varepsilon i \qquad (12)$$

where:

-$\mathbf{R\&Dexp}i$: The percentage of the current expenditure spend on R&D by firm *i*

-αi: The intercept of the regression model.

- $\mathbf{OWN}ci$: The dummy variable that separates the observed firms in categories c, where a single family or individual hold between 0% - 25%, 25% - 50% or at least 50% of the shares.

- $\mathbf{OWN}ci * \mathbf{DEC}i$: The interaction variable consisting of dummy variable that separates the observed firms in accordance to the percentage of the firm owned by a single family or individual and the measure of the level of decentralization of firm *i*

-$\mathbf{DEC}i$: The general measure of decentralization in firm *i*

-ωi: Firm and management control variables.

-εi: The standard errors of the OLS regression model.

In Table 25, the regression results indicate that the effect of decentralization on innovation is negative. For every extra level of decentralization in firms with family or individual ownership of 25% to 50% the percentage spend on R&D seems to decrease. For example, although none of the documented coefficients are found to be significant, the effect of DECm in Model 4 of PANEL A in Table 25 is -0.004 (i.e. -0.004 = -0.008 + 0.004). In the same model, the relationship between OWN2 and R&Dexp seems to be -0.008 (i.e. -0.008 = 0.008 + 2*-0.008) when DECm = 2. This might suggest that firms in which a single family or individual holds 25% to 50% of the shares of the firm, decentralization could be used to decrease the percentage spend on R&D. For example, although firms are decentralized, the output performance measures might not be related to increasing the percentage spend on R&D.

More decentralization firms with at least 50% of family or individual ownership seem to be less innovative compared to more decentralized firms with less than 50% of family or individual ownership. For instance, the coefficient of OWN3 in Model 3 of PANEL A of Table 25 is -0.001. This indicates that firms with at least 50% of family or individual ownership and no decentralization spend 0.1% less on R&D compared to firms with less than 50% of family or individual ownership and no decentralization. As the coefficient of OWN3*DECm is -0.003 in the

same model, the negative relationship with R&Dexp increases in strength with every level increase in DECm in the firms with at least 50% of family or individual ownership. Given DECm=2, the percentage spend on R&D by these firms is 0.7% (i.e. -0.007 = -0.001 + 2*-0.003) less than firms with less than 50% of such ownership. However, using a Wald Test, this relationship is not found to be significant. Thus, when the negative effect of decentralization in firms with at least 50% of family or individual ownership seems to be stronger, decentralization might be used to decrease the percentage spend on R&D even more often compared to firms with 25% to 50% of family or individual ownership.

Table 25. The results of the regression that analysis the relationship between ownership of a single family or individual, the different measures of decentralization and innovation.

PANEL A

R&Dexp	Model 1				Model 2				Model 3				Model 4			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Management:																
Intercept	0.003	0.009	531	0.009	-0.009	0.016	531	0.006	-0.008	0.017	531	0.157	-0.024	0.021	531	0.154
DECm	0.008*	0.004			0.008*	0.004			0.004	0.004			0.004	0.004		
OWN2	0.008	0.026			0.008	0.026			0.009	0.025			0.008	0.025		
OWN2*DECm	-0.011	0.013			-0.011	0.013			-0.008	0.012			-0.008	0.012		
OWN3	0.004	0.014			0.002	0.014			-0.001	0.014			-0.003	0.014		
OWN3*DECm	-0.008	0.007			-0.008	0.007			-0.003	0.007			-0.002	0.007		
Controls	NO				Management				Firm				Management and Firm			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

PANEL B

R&Dexp	Model 1				Model 2				Model 3				Model 4				Model 5			
	β	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*	*β*	*SD*	*N*	*Adj-R^2*
Employee:																				
Intercept	0.004	0.016	466	0.006	0.005	0.027	412	0.003	-0.045***	0.017	466	0.360	-0.049*	0.025	412	0.311	-0.045	0.028	412	0.307
DECe	0.006	0.007			0.007	0.007			0.012**	0.006			0.011*	0.006			0.011*	0.006		
OWN2	0.043	0.053			0.047	0.054			0.065	0.043			0.066	0.045			0.064	0.045		
OWN2*DECe	-0.023	0.023			-0.025	0.023			-0.028	0.018			-0.029	0.019			-0.028	0.019		
OWN3	0.013	0.027			0.014	0.028			0.031	0.022			0.025	0.024			0.025	0.024		
OWN3*DECe	-0.010	0.012			-0.010	0.012			-0.013	0.009			-0.011	0.010			-0.011	0.010		
Controls	NO				Employee				Firm				Employee and Firm				Employee, Firm and Management			

Notes: An overview of the documented coefficients (β**)**, the standard deviations (SD), the number of observations (N), the adjusted R^2 (Adj-R^2) and the controls that are included in the regression. And: *p<0.1, **p<0.05, ***p<0.01.

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