Junior Management Science 8(2) (2023) 333-357

Junior Management Science

journal homepage: www.jums.academy

Innovation Performance of Family and Founder Firms: Empirical Evidence from German Listed Companies

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Abstract

Based on the agency perspective and the resource-based view of the firm, this study explores the impact of lone founder and family influence on innovation input and innovation output. By separating the lone founder and family effect into ownership, management, and governance influence dimensions, we analyze a panel data set of 165 German listed companies from 2013 through 2017. We first investigate R&D intensity in lone founder and family firms versus other firms by using investments in research and development as a measure for innovation input. Secondly, we apply a negative binomial regression model to analyze R&D productivity within the three types of firms by proxying innovation output with the filed number of granted patents within a certain year. According to the results, we mainly find that founder firms superiorly invest in innovation and strengthen their competitive position in the market through their entrepreneurial orientation. Family firms, on the other hand, might weaken future growth potential as they invest less in R&D and are not able to convert this lower input in superior innovation output.

Keywords: Lone founder firms; Family firms; Innovation performance; R&D intensity; R&D productivity.

1. Introduction

In the highly dynamic and uncertain twenty-first century, innovation is essential for survival (Ortiz-Villajos & Sotoca, 2018, p. 1433f.). Therefore, firms must establish an entrepreneurial mindset that enables them to identify and seize opportunities in times of uncertainty (Shane & Venkataraman, 2000, p. 217ff.). In this context, firms ownership structures seem to be of great importance: previous studies show that a firm's ownership structure has an impact on diversification plans (Anderson & Reeb, 2003, p. 667ff.), risk attitude (Gómez-Mejía, Haynes, Núñez-Nickel, Jacobson, & Moyano-Fuentes, 2007, p. 106ff.) and investment horizons (Miller, Le Breton-Miller, Lester, & Cannella, 2007, p. 829ff.). Since returns of innovation investments are highly skewed and uncertain (Scherer & Harhoff, 2000, p. 565), the ownership structure of firms is also likely to affect innovation investment and outcomes, as different risk preferences exist. As the influence cannot only be explained by the capital holders (Donckels & Lambrecht, 1999, p. 186), but also by the people who actively manage and monitor the firm (Filbeck & Lee, 2000, p. 212f.; Anderson & Reeb, 2003, p. 664), it is likely that, in addition to the ownership influence dimension, the management and governance dimensions also impact innovation decisions. Hereby, strong conceptual reasons suggest that family and lone founder involvement in ownership, management, and governance determines distinctive incentives (Fama & Jensen, 1983, p. 315f.), and affects resource management and deployment (Sirmon & Hitt, 2003, p. 339ff.), leading to unique advantages or disadvantages that may affect the innovation process (De Massis, Frattini, Pizzurno, & Cassia, 2015, p. 2).

Thereby, agency theory serves as a commonly used theory to explain various aspects of lone founder and family firm performance differences to other firms (Block, 2012, p. 251f.; Chrisman, Chua, & Litz, 2004, p. 337ff.). Based on agency theory, it is argued that loss-averse families prefer sure gains over risky investment opportunities when they try to protect their family-specific wealth (Chrisman & Patel, 2012, p. 981f.). This potential "creative self-destruction" is additionally explained by the fact that families accept an increased performance hazard in order to maintain discretionary power in the firm (Gómez-Mejía et al., 2007, p. 117; Kotlar, Massis, Frattini, Bianchi, & Fang, 2013, p. 1078). In

DOI: https://doi.org/10.5282/jums/v8i2pp333-357

contrast, literature suggests that the situation differs for lone founder firms as they have a proven track record in growing their own business (Miller, Le Breton-Miller, & Lester, 2011, p. 8) and therefore show an openness towards risky innovation projects (Block, Miller, Jaskiewicz, & Spiegel, 2013, p. 181). The comprehensive understanding of the firms' underlying processes and the typically high shareholdings are likely to result in less free-rider problems, as is the case with firms owned by dispersed shareholders (Maug, 1998, p. 67). The extraordinary commitment of founders in their firms may further lead to decreasing agency costs (Nelson, 2003, p. 710).

However, differences between lone founder, family and other firms do not only emerge because of agency cost differences – resources also play a major role in innovation performance. Barney (1991, p. 99ff.) provides a theoretical framework that helps to understand the effects of how unique bundles of resources and capabilities affect the way lone founder and family firms manage and deploy innovation input (Sirmon & Hitt, 2003, p. 339ff.). Based on the resource-based view of the firm, it is argued that, for family firms, these unique resources and capabilities result from the interaction of family involvement and the firms' system (Cabrera-Suárez, de Saá-Pérez, & García-Almeida, 2001, p. 38). Family firms' advantages in human and relational capital is assumed to result in valuable intangible resource advantages (Cabrera-Suárez et al., 2001, p. 39f.), which are likely to result in superior innovation output. In contrast, founders' energy, motivation, experience, and expertise flow into the daily innovation endeavors (Block et al., 2013, p. 185). They act as entrepreneurs, providing unique technical knowledge and a foundation for growth and innovation that enables them to educate next generation managers in how to implement innovations efficiently (McConaughy & Phillips, 1999, p. 130). This unique knowledge in combination with their entrepreneurial attitude is likely to result in an attitude that values growth and innovation (Block, 2012, p. 249).

Following Griliches (1998, p. 17ff.), the underlying study distinguishes between innovation input and innovation output: firms' investment in research and development (R&D) measures innovation input (Anderson, Duru, & Reeb, 2012, p. 1747), while the filed number of granted patents within a certain year serves as a proxy for innovation output (Duran, Kammerlander, van Essen, & Zellweger, 2016, p. 1235). This paper aims to analyze the differences in R&D intensity and R&D productivity in different types of firms. The question of how lone founder or family influence affects innovation behavior is addressed in the underlying study. Therefore, the study refers to three types of firms; lone founder, family and other firms. The data used for this study was obtained from various databases such as the AMADEUS database, the Hoppenstedt database and from financial reports of the respective firms to acquire extensive firm level data. Based on this data, the ownership, management, and governance effects on the 165 sample firms' R&D intensity and R&D productivity is analyzed by using panel data regression models. By applying fixed and random effects panel data regressions, the first part of the underlying study shows that founder governance has a positive effect on R&D intensity, while family management seems to be negatively correlated. In the second part, by analyzing R&D productivity, the main findings show consistent results for the founder management and governance dimension, implying that active lone founder firms are able to produce superior innovation output compared to other firms. For family firms, on the other hand, no consistent effects can be observed, such that it can be concluded that family firms do not represent efficient innovators.

The underlying study is particularly based on the paper of Block (2012, p. 248ff.) in the *Journal of Business Venturing*, which examines the R&D intensity of lone founder and family firms by drawing on the agency theory. By using a data set of 154 firms of the S&P 500 and by applying fixed and random effects panel regression models, he pursues a similar empirical strategy with a comparable data set used in the underlying study. By applying a continuous measure for the ownership influence dimension, Block (2012, p. 254) defines the management dimension in a binary manner, leaving out fine-grained analysis potential. However, the main findings of the underlying study with respect to the family management influence dimension are consistent with the study of Block (2012, p. 256f.), as a significant negative effect can be identified. Block et al. (2013, p. 180ff.) extended the study of Block (2012, 248ff.) by focusing on an innovation output proxy instead of concentrating on innovation input and thus on R&D intensity effects. By applying the same methodology for their variable definition like Block (2012, p. 253f.), they study the economic and technological importance of innovations in lone founder and family firms (Block et al., 2013, p. 180). Here, too, they use a panel data set, but with an increased sample size of 248 firms and 1,659 firm-year observations (Block et al., 2013, p. 185f.). With their negative binomial panel data regression, they find a significant positive effect for the founder management variable, while a significant negative effect is observed for the family management variable. These findings partly coincide with the main findings of the underlying study, as significant positive effects are found for both, lone founder and family management variables. However, the last key paper used in this study to develop a thorough empirical strategy suggests a potential endogeneity relationship between innovation input and innovation output (Matzler, Veider, Hautz, & Stadler, 2014, p. 326). In their study, published in the *Journal of Product Innovation Management*, Matzler et al. (2014, p. 326) focus only on family firms (136 firms and 983 firm-year observations) and apply an instrumental variable two-stage least squares (IV-2SLS) panel regression model to solve potential endogeneity problems regarding firm level R&D intensity. By using an IV-2SLS regression approach for the underlying data set, the results are consistent with the effects that can be found in the study of Block et al. (2013, p. 190). However, the underlying study is expected to be more accurate as it is controlled for potential endogeneity and the three main influence dimensions – ownership, management, and governance – are defined in a continuous manner.

With these results, the paper contributes to the growing literature on innovation behavior in lone founder and family firms (Block, 2012, p. 248ff.; Block et al., 2013, p. 180ff.; Chen & Hsu, 2009, p. 347; Chrisman & Patel, 2012, p. 976ff.; Duran et al., 2014, p. 1224ff.; Matzler et al., 2014, p. 329ff.). First, using agency theory (Fama & Jensen, 1983, p. 301ff.), mechanisms are discussed that cause differences in agency costs between lone founder and family firms. In addition, differences in innovation output are discussed by drawing on the resource-based view of the firm (Barney, 1991, p. 99ff.), thereby providing mechanisms which cause differences in the second part of the analysis. Second, the use of three different influence dimensions (ownership, management, and governance) allows for a comprehensive analysis and fine-grained comparison of the underlying effects of lone founder and family influence. It is shown that, by continuously coding the influence dimensions, the analysis is meaningful, despite the existence of potential structural differences between the different types of firms analyzed in the paper.

In order to address the gap in the literature regarding the comprehensive distinction between the innovation behavior of lone founder and family firms, this study is divided into six sections. The next section provides an overview of the relevant theoretical frameworks and the existing literature, focusing on the agency concepts and the resource-based view of the firm in order to derive hypotheses for the underlying study. As the burning question of this study is addressed empirically, section three concentrates on the description of the underlying data set and the methods used for the analyses. Section four presents the results of the analyses including several robustness checks and a model which addresses potential self-endogeneity. The fifth section provides a discussion of the main findings and shows implications, limitations, and potential directions for future research. Finally, the study is concluded in the sixth section.

2. Theoretical framework and literature review

2.1. Innovation input vs. innovation output

When studying firm level innovation, economic literature has long established that there is an important difference between input measures of innovation performance and the innovations a firm produces (innovation output) (Block et al., 2013, p. 180). Innovation input is hereby often defined as a firm's investment that is devoted to the exploitation and exploration of new possibilities (Duran et al., 2016, p. 1226f.). During the innovation process, firm's innovation input is translated into patented knowledge or newly developed products (Schmiedeberg, 2008, p. 1497) – also referred to as innovation output. While R&D investments can lead to a knowledge creation, measures of innovation output deal with the commercialization of knowledge and are therefore of relevance for the firm's economic importance and technological process (Hall, Jaffe, & Trajtenberg, 2005, p. 19; He & Wang, 2009, p. 932). Therefore, in addition to R&D intensity, which is a frequently used proxy for innovation input (Chrisman & Patel, 2012, p. 983), it is also important to capture R&D productivity – defined as the interaction between R&D input and R&D output (Block, 2012, p. 251). Studying both, innovation input and innovation output becomes particularly relevant, since firms are likely to differ in their efficiency of transforming innovation input into innovation output (Duran et al., 2016, p. 1227). Therefore, the underlying study distinguishes between the R&D intensity of firms, which serves as an indicator for innovation input, and the firm's granted patents filed per year serving as a proxy for innovation output.

For R&D investments, agency theory indicates that moral hazard problems exist due to different risk preferences or investment horizons of owners and managers (Anderson et al., 2012, p. 1746f.). Thus, the separation of ownership and management into two groups typically involves different risk preferences (Jensen & Meckling, 1976, p. 309): according to Lee and O'Neill (2003, p. 213), firm owners are more risk taking than managers as they are typically well diversified shareholders. These differences in risk propensity are particularly pronounced in the case of R&D investments, as these are high-risk and high-skewed investments with uncertain outcomes (Scherer & Harhoff, 2000, p. 565). This overall uncertainty leads to potential underinvestment in R&D where managers who make R&D investment decisions are more risk-averse than the firms' owners (Block, 2012, p. 250).[1] In addition, owners have a long-term perspective and seek for investments that ensure firms' long-term health and competitiveness (Anderson et al., 2012, p. 1746). Managers, on the other hand, want to keep their jobs and promote a high reputation and therefore often want to achieve positive short-term results (Hirshleifer & Thakor, 1992, p. 465). These two arguments are consistent with an underinvestment in R&D. Besides a resulting underinvestment, the existence of moral hazard can also lead to an overinvestment in R&D (Block, 2012, p. 250). Jensen's (1986, p. 323ff.) "free cash flow hypothesis", which primarily builds on the agency theory, sheds light on the potential positive relationship. In order to increase their overall wealth, managers could invest the firm's free cash flow in unprofitable investment opportunities instead of paying out the excess liquidity to shareholders (Jensen, 1986, p. 327; Vogt, 1994, p. 3). In short, the firm's moral hazard problem can result in under- and overinvestment in R&D projects.[2]

What agency theory cannot explain is how firms manage the transfer of innovation input into innovation output (Matzler et al., 2014, p. 320). A more appropriate theory to explain how capabilities shape the innovation output of firms is the resource-based view of the firm (Matzler et al., 2014, p. 320). The resource-based view of the firm is able to explain differences in the firm's competitive advantage due to the heterogeneous distribution of strategic resources (Barney, 1991, p. 99). Thus, these valuable, rare, inimitable,

[1] Typically, R&D investment decisions are made by firm managers and executives (Block, 2012, p. 250).

[2] Note that both, moral hazard driven over- and underinvestment strategies are not value maximizing for the owners of the firm (Block, 2012, p. 250).

and non-substitutable resources are able to explain differences in the innovation output of firms (Barney, 1991, p. 99), as different resources applied by firms result in different innovation outcomes (De Massis, Frattini, & Lichtenthaler, 2012, p. 21). As innovation output is not only determined by the strategic choices of a firm but also by its strategic activities, processes, and capabilities (Matzler et al., 2014, p. 322), unique family resources are likely to influence innovation output (Llach & Nordqvist, 2010, p. 394). Therefore, the underlying study draws on the agency theory when dealing with R&D intensity, while the resource-based view of the firm serves as the theoretical framework for innovation output and thus for the patent count regression in the second part of the study.

2.2. Distinction between family and lone founder firms

The distinction between family and lone founder firms was introduced by Miller et al. (2007, p. 836) and is relatively new in the literature. Depending on the respective country, the corporate governance system as well as the type of companies studied, the definition of family firms varies in the literature (Miller et al., 2007, p. 831). For example, Anderson and Reeb (2003, p. 661) and La Porta, Lopez-De-Silanes, and Shleifer (1999, p. 480f.) count firms as family firms in which the founder is involved in the business, whereas Llach and Nordqvist (2010, p. 383) base their definition of family firms on the firm's own perception. These different definitions of family firms applied in literature therefore lead to an in- or decrease in the proportion of family firms in the sample (Llach & Nordqvist, 2010, p. 383) and to a variation in the performance of these firms (Miller et al., 2007, p. 831).

To reduce these variations, Miller et al. (2007, p. 836) defined family firms as firms where multiple members of the same family are involved as major owners or managers. In contrast, lone founder firms are defined as firms in which the founder (founder team) is involved in an influencing position in the firm and no relatives of the founder are involved in the business as major owners or managers (Miller et al., 2007, p. 836).[3] To account for the peculiarity of Germany's two-tiered system (Klein, 2000, p. 167), the underlying study analyzes the impact of three influence dimensions – ownership, management, and governance.[4]

As firms mature over time, they lose part of their entrepreneurial orientation (Block, 2012, p. 249). Therefore, the development of a lone founder firm into a family firm could result in structural differences, indicating that these firms might be two distinct types of firms with regard to the influence dimensions of the underlying study (Block, 2012, p. 249). For example, in the sample dataset, lone founder firms have on average around 2,600 employees, while family firms employ on average around 24,400 employees, suggesting that family firms are around 9 times larger in terms of the number of employees. However, the continuous definition and coding of the three influence dimensions explained in more detail in section 3.2.3 allows a comprehensive analysis and thus a comparison of the effects of family and lone founder firms, although structural differences may exist.

2.3. Agency theory and innovation input

Agency theory focuses on conflicts of interest between owners and managers of public firms (Fama & Jensen, 1983, p. 301ff.). In this respect, from an agency's point of view, family and lone founder firms differ from other firms (Chrisman et al., 2004, p. 348f.; Sirmon & Hitt, 2003, p. 343).

Since family firms pursue both, economic and non-economic goals, actions can be considered as agency problems in non-family firms, whereas this may not be the case for family led companies (Chrisman et al., 2004, p. 348). Families are trying to reinforce the status quo, and therefore their primary interest is not only economic efficiency but also to maintain own, family-specific interests (Chua, Chrisman, & Steier, 2003, p. 334f.).[5] Pursuing these family-specific and non-economic goals in family firms is even present when they incur a greater performance hazard (Gómez-Mejía et al., 2007, p. 107), often leading to potential owner-owner conflicts or to family-specific agency costs like free riding of individual family members (Lubatkin, Schulze, Ling, & Dino, 2005, p. 324). In addition, families are afraid of losing control of their business and therefore avoid involving non-family investors and limiting funds to firm-generated resources and financing opportunities of financial institutions (Sirmon & Hitt, 2003, p. 339). As typically undiversified shareholders, families often avoid high-risk investments (Naldi, Nordqvist, Sjöberg, & Wiklund, 2007, p. 39), and in general families do not want to hand over control to new, outside partners (Matzler et al., 2014, p. 321).

In contrast, lone founder firms differ structurally from family firms: founders are involved in their business from the very beginning and have therefore developed an extensive understanding of the underlying processes (Block, 2012, p. 252). They have a proven track record of entrepreneurship and success in building and growing their own business (Miller et al., 2011, p. 8), and therefore show an openness towards uncertain and high-risk innovation projects (Block et al., 2013, p. 181). Since shareholdings are typically in the majority of founders and the firm is not owned by dispersed shareholders, free-rider problems do not occur with lone founder firms (Maug, 1998, p. 67).

The underlying study focuses on the fine-grained differences between the innovation activities of family and lone founder firms. To address the burning question of this study,

[3]Therefore, firms are treated as family firms if both, the founder and relatives of the founder are active in the firm as owners, managers or as supervisors.

[4]The detailed analysis of the three influence dimensions is in line with previous studies (cf. Anderson & Reeb, 2004, p. 210; Klein, 2000, p. 158f.; Matzler et al., 2014, p. 325).

[5]For example, familiness, defined as the unique bundle of resources created by the interaction between family and business (Habbershon & Williams, 1999, p. 11) often takes precedence over other goals (Sirmon & Hitt, 2003, p. 341).

the following section provides hypotheses on the influence of families and lone founders on innovation input.

2.3.1. Effect of family influence on innovation input (R&D intensity)

Agency theory suggests that loss-averse families protect their family wealth and even sacrifice economic performance to do so (Chrisman & Patel, 2012, p. 981). When this is the case and family goals take precedence over long-term economic firm goals, families prefer sure gains over risky investment opportunities (Chrisman & Patel, 2012, p. 981f.). These family specific agency costs could lead to a "creative self-destruction" as families protect the cash flow of their business and restrain innovation activities (Morck & Yeung, 2003, p. 377ff.). Often, families exhibit myopic behavior such as taking perquisites and privileges, which is beneficial for them but at the expense of outside shareholders (Schulze, Lubatkin, Dino, & Buchholtz, 2001, p. 102f.). Especially when considering the ownership influence dimension, recent studies find consistent negative effects of family ownership on R&D investments: for example, Chen and Hsu (2009, p. 358) find a significant negative effect of family ownership on R&D intensity for Taiwanese firms from the electronic industry. In accordance with Chen and Hsu (2009, p. 347ff.), Munari, Oriani, and Sobrero (2010, p. 1102) show similar results for Western European firms. In addition to Asian and European countries, empirical evidence from America show consistent effects, so that a negative family ownership effect on R&D intensity can be found for S&P 500 (and S&P 1500) firms (cf. Block, 2012, p. 256; Chrisman & Patel, 2012, p. 987).[6]

Next to the loss-aversion argument, families want to maintain the independence and control in their businesses and are therefore willing to accept an increased performance hazard (Gómez-Mejía et al., 2007, p. 117). In other words, family owners and managers give priority to maintaining discretion over improved performance (Kotlar et al., 2013, p. 1078). In order to prevent losses in family-specific goals, family managers are even willing to accept, next to financial losses, hazards to the firm's innovation performance (Kotlar et al., 2013, p. 1078). If families maintain control in their businesses, they might therefore decide against important criteria for most outside shareholders (Matzler et al., 2014, p. 321). This is consistent with the study of Villalonga and Amit (2006, p. 388), as they found worse owner-manager conflicts for family firms where a descendant of the founder serves as the chief executive officer (CEO), compared to non-family firms. There is also empirical evidence for the management influence dimension which suggests a negative effect on R&D intensity: Matzler et al. (2014, p. 328), for example, find a significant negative effect for their family management variable on R&D intensity for German listed companies. Furthermore, Kotlar et al. (2013, p. 1082) determine a negative and significant effect of family management on technology acquisition for Spanish manufacturing firms.

In addition to owners and managers, people in the supervisory organism of a firm have a substantial influence on how resources are allocated (Anderson & Reeb, 2004, p. 213f.). Independent supervisory boards of firms play an important role in mitigating diverging interests between different shareholders (Anderson & Reeb, 2004, p. 231) and building bridges between the firm owners and managers (Klein, 2000, p. 168).[7] As mentioned above, this is particularly important for family firms, as families might pursue goals other than purely economic ones (Chua et al., 2003, p. 334f.). Thus, if families are the dominant players in the supervisory board, the independence assumption is violated, as families might pursue other interests than independent members of the supervisory board (Matzler et al., 2014, p. 322). Anderson and Reeb (2003, p. 664) argue that family firms have fewer outside observers in their supervisory board and therefore there is extensive family control. This argument is in line with Anderson and Reeb (2004, p. 215), who find that an excess amount of family members within the supervisory board increases the family's likelihood of wealth expropriation. Also, Kor (2006, p. 1089) argues that independent supervisory boards are positively related to R&D intensity, even after controlling for TMT effects like the size or the average age of the TMT. Since the independence condition is violated for family firms, a negative effect of family governance on R&D intensity is assumed (Matzler et al., 2014, p. 322). This assumption was confirmed by the study of Matzler et al. (2014, p. 328) as they found a significant negative effect of family governance on R&D intensity.

Based on these arguments, the following hypothesis is proposed:

> *Hypothesis 1: Family influence has a negative effect on innovation input (R&D intensity).*

2.3.2. Effect of founder influence on innovation input (R&D intensity)

If owners and managers of a firm are separated into different groups, agency problems often exist in terms of R&D investments as different risk preferences are present in these two groups (Anderson et al., 2012, p. 1746). On the one hand, owners are interested in long term profits, while managers often shy away from uncertain and long-term R&D payoffs as they favor short-term profits, want to establish good reputation in the managers' job market and promote job security (Block, 2012, p. 252). In case of lone founder firms, these agency problems are likely to be mitigated: typically, high ownership shares and high investments in the firm lead to a strong incentive for founders to exercise good monitoring (Block, 2012, p. 252). Therefore, the free-rider problem,

[6] In the Chrisman and Patel (2012, p. 983) study, the S&P 1500, which comprises the S&P 500, the S&P 400 Mid Cap and the S&P 600 Small Cap Index, served as the index for their analysis.

[7] Supervisory boards are seen as a powerful monitor mechanism of the top management team (TMT) if there is a clear separation of top executives and supervisory boards (Kor, 2006, p. 1085).

present in firms with predominantly dispersed shareholders, does usually not exist for lone founder firms as the centralized shareholdings lead to monitoring benefits and incentives for the founder (Maug, 1998, p. 67). As found by Anderson and Reeb (2003, p. 679), these lower agency costs lead to higher firm valuations for lone founder firms and thus might also positively affect R&D intensity. This finding is consistent with Block (2012, p. 256) who identifies a significant positive effect for lone founder owned firms on R&D intensity in his empirical study of R&D intensive S&P 500 firms.

In addition to the mitigation of free-rider problems in lone founder firms, firm managers may be reluctant to invest in R&D projects as they bear employment risks for poor R&D investment choices (Kor, 2006, p. 1085). This reluctance to invest in R&D projects is inconsistent with the shareholders point of view, as their typically diversified portfolio allows them a higher exposure to risky projects (Kor, 2006, p. 1085). The opposite should be argued for lone founder firms: their willingness to invest in riskier and more uncertain innovation projects (Block et al., 2013, p. 181), as well as their high contribution to long-term firm profits (Block, 2012, p. 262) should result in a higher R&D intensity. R&D investments with uncertain long-term payoffs are not weighted heavily by lone founders, because they are interested in the long-term profitability of their firm and therefore accept potential short-term losses (Block, 2012, p. 262). Founders in the TMT therefore avoid many owner-manager principal-agent costs, which could otherwise divert resources from innovation efforts (cf. Kor, 2006, p. 1094). Consequently, the principal-agent problem is assumed to be outbalanced, so that a positive effect of founder management on R&D intensity is expected. This is in line with Kor (2006, p. 1093): in her empirical study of firms in the medical and surgical instruments industry, she finds that managers' tenure is negatively correlated with R&D investment intensity by drawing on the upper-echelons theory.[8] In other words, the presence of founders in the firms TMT is associated with higher R&D expenditures (Kor, 2006, p. 1093).

Finally, the governance influence dimension also affects R&D investment decisions for lone founder firms. The extraordinary commitment of founders in the governance system of a firm may lead to decreasing agency costs or, put differently, to "anti-agency costs" (Fama & Jensen, 1983, p. 322; Nelson, 2003, p. 710). As found by Nelson (2003, p. 722), lone founder firms in the U.S. seem to have more independent governance boards than other firms because founder CEOs are less likely to simultaneously serve in the board of supervisors (the so-called CEO duality). This independence leads to fewer shareholder-value destroying decisions as the board can effectively perform its monitoring task (Chen & Hsu, 2009, p. 351). Therefore, lone founders in the supervisory board can act as effective monitors, since they are familiar with their business and the underlying processes as well as invested heavily in the firm (Block, 2012, p. 252). With monitoring efforts, lone founder firms do not face coordination problems comparable to those of family firms (Block, 2012, p. 253), since in family firms rivalries between siblings, different goals of different family members or identity conflicts may be present (Dyer, 1994, p. 118; Eddleston & Kellermanns, 2007, p. 547; Schulze et al., 2001, p. 102f.; Schulze, Lubatkin, & Dino, 2003, p. 184f.). Consequently, family firms are described in literature as businesses with several potential fields of conflict (Harvey & Evans, 1994, p. 331), which in turn should not be present for lone founder firms. Therefore, next to founder ownership and management, a positive effect for founder governance on R&D intensity is assumed.

Consequently, the following hypothesis is stated:

Hypothesis 2: Founder influence has a positive effect on innovation input (R&D intensity).

2.4. Resource-based view of the firm and innovation output

While innovation input is a primarily matter of strategic decisions (Sirmon & Hitt, 2003, p. 352f.), innovation output is also determined by different strategic activities, processes, and capabilities (Matzler et al., 2014, p. 322). When drawing on the resource-based view of the firm, unique family and founder resources are likely to have an impact on innovation output (Llach & Nordqvist, 2010, p. 394), as managing resources is crucial for maintaining competitive advantages in uncertain market environments (Sirmon & Hitt, 2003, p. 352).

Competitive advantages therefore derive from unique resources and capabilities which firms control and which make them better compared to their competitors (Cabrera-Suárez et al., 2001, p. 38). For family firms, these unique resources, also known as familiness, result from the interaction of family involvement and the family firms' system (Cabrera-Suárez et al., 2001, p. 38). With regard to innovation output, the underlying governance structure of family firms particularly accounts for family-related advantages and disadvantages (Carney, 2005, p. 249ff.). As argued by Zahra (2005, p. 23), family firms' long-term horizon enables them to maintain lasting relationships with internal and external stakeholders. In addition to tight relationships with key stakeholders, family firms have more flexible decision-making structures and use less formal monitoring mechanisms, resulting in a more efficient translation of their resources in innovation output (Craig & Dibrell, 2006, p. 278). Also, advantages in human and relational capital in family firms should lead to unique benefits with respect to innovation output (Cabrera-Suárez et al., 2001, p. 38).

To reach a considerable size in R&D intensive industries, firms need to invest heavily in innovation efforts (Block et al., 2013, p. 184). Since founders build up their business from the beginning and have typically overseen innovation processes within the firm, lone founder firms are likely to generate significant innovation outcome (Block et al., 2013,

[8] According to the upper-echelons theory, firms actions are reflections of their top managers (Hambrick & Mason, 1984, p. 193ff.). Thereby, different observable and psychological characteristics of managers lead to different management decisions and strategic choices (Hambrick & Mason, 1984, p. 198).

p. 184). With their alertness, optimism, creativity, and their prior knowledge, they bring distinct resources and characteristics into the firm (Ardichvili, Cardozo, & Ray, 2003, p. 116; Langlois, 2007, p. 1120f.), which are likely to shape firms' innovation behavior. This entrepreneurial perspective of founders enables them to lead their firm through uncertain and challenging environments (Kroll & Walters, 2007, p. 1199). Since entrepreneurial firms do not draw on existing knowledge or capabilities, they are sources of novelty and innovation (Langlois, 2007, p. 1120).

Since both, family and lone founder firms are likely to have distinct resources affecting innovation output, the purpose of the following section is to provide hypotheses for the effect of family and lone founder influence on innovation output.

2.4.1. Effect of family influence on innovation output (granted patents)

High investment levels in the firm by family owners make them more cautious and conservative in their strategic decisions, leading to potentially lower R&D investments (Anderson et al., 2012, p. 1746; Miller & Le Breton-Miller, 2006, p. 81). In contrast, however, these contributions create a strong incentive to ensure the long-term viability of the company, which in turn depends on successful innovation (Anderson et al., 2012, p. 1746). Since families typically have high ownership stakes, they are effective monitors in place: they can intervene against short-sighted management behavior and influence important investment decisions (Anderson et al., 2012, p. 1747). Regarding resources, family ownership can promote unique forms of human and social capital (Chen & Hsu, 2009, p. 349). Family firms are often passed over to descendants, thereby creating a loyal and skilled set of personnel and long-term external relationships that facilitate this process (Miller & Le Breton-Miller, 2006, p. 82). By investing time and money in sustaining associations, they foster long-term relationships with resource providers such as financial institutions, customers, or suppliers (Miller & Le Breton-Miller, 2005, p. 6; Miller & Le Breton-Miller, 2006, p. 81f.). In order to strengthen corporate culture, employee commitment and motivation, family firms invest heavily in their employees through employee participation programs, outstanding social benefits and high salaries (Chen & Hsu, 2009, p. 349f.). Family owners further benefit from strong relationships to the TMT and supervisory board resulting in a command unity and in aligned interests (Braun & Sharma, 2007, p. 116). In sum, family ownership resources are likely to increase innovation output.

In addition, family firms may be reluctant to hire outside managers for their TMT (Schulze et al., 2001, p. 104). This reluctance, coupled with difficulties in attracting qualified managers, could result in fewer resources of human capital (Sirmon & Hitt, 2003, p. 342). However, the family managers' extraordinary commitment in the firm (Sirmon & Hitt, 2003, p. 343) and their potentially deep family-specific tacit knowledge that can be transferred across generations (Sirmon & Hitt, 2003, p. 342), is likely to have a positive effect on the success of family firms. This argument is supported by the study of Llach and Nordqvist (2010, p. 393f.) who find a significantly higher proportion of qualified employees in family firms as well as a higher propensity to devote human capital towards innovation tasks. The relative safety of family managers jobs compared to outside managers allows them to adapt a long-term approach instead of being concerned about short-term results (Matzler et al., 2014, p. 322f.). Also, as shown by Gómez-Mejía et al. (2008, p. 131), family firms are willing to pursue risky and long-term decisions, and there is no difference in risk tolerance compared to non-family firms. These arguments are in line with empirical studies that find positive effects of family management on innovation output: for example, Craig and Dibrell (2006, p. 281) identify a significant positive effect for family managed firms on innovation output in their survey data analysis. Furthermore, as mentioned above, Llach and Nordqvist (2010, p. 394) find a positive relationship between family managed firms and innovation output by drawing on the resource-based view of the firm. Finally, Matzler et al. (2014, p. 328) support these results by taking forward patent citation intensity as a proxy for innovation output.

Supervisory boards provide firms important board capital, consisting of both, human capital such as experience, expertise, and reputation as well as relational capital (network ties to other firms and external contingencies) (Hillman & Dalziel, 2003, p. 383). When making R&D decisions, boards do not only question or advise, but also assist to identify opportunities, needs, and problems in the R&D process (Chen & Hsu, 2009, p. 351). Especially in family firms, the primary function of the supervisory board is to serve and advice rather than to discipline and monitor (Corbetta & Salvato, 2004, p. 123). Thus, boards can also enable innovation even when family board members stress the preservation of socioemotional wealth (Matzler et al., 2014, p. 323). In line with these arguments, Matzler et al. (2014, p. 328) report a significant positive relationship of family governance on their dependent variable patent intensity, defined as firms' patent applications per year scaled by firms' total sales. Thus, in addition to family ownership and management, a positive effect for family governance on innovation output is assumed.

Based on the arguments stated above, the following is hypothesized:

Hypothesis 3: Family influence has a positive effect on innovation output (granted patents).

2.4.2. Effect of founder influence on innovation output (granted patents)

Owning founders, building up large entrepreneurial firms through an innovation-oriented approach, are unlikely to abandon this strategy (Block et al., 2013, p. 184). Hereby, founders have unique characteristics that set them apart from other individuals – earlier studies demonstrate that they have a sense that they can take their fate into their own hands (Boone, Brabander, & Witteloostuijn, 1996, p. 668), and they show a high need of performance (McCelland, 1961, p.

205ff.). They see themselves as an entrepreneur and thus as individuals with risk-taking preferences who value growth and innovation (Block, 2012, p. 249). Founder's charismatic authority described by Langlois (2007, p. 1121) is one way of reducing dynamic transaction costs by packaging complex knowledge and information in a form that others can absorb cheaply. As argued by Block et al. (2013, p. 184), the identification of founders belonging to the social entrepreneur group may foster their efforts towards taking significant innovation projects that lead to growth for the firm. Hereby, the founders' focus is not on R&D investment but on the outcome of innovation (e.g. granted patents), which underpin the credibility of growing firms seeking to raise capital (de Rassenfosse, 2012, p. 439). Therefore, a positive effect for founder ownership on innovation output is assumed.

In addition to the ownership dimension, founder management is likely to have an impact on innovation output. Active founders are the longest tenured members within the firm, which may lead to a strengthening of the dominant firm logic, or collective mentality (Nelson, 2003, p. 711). They are highly committed to their firms, build extensive knowledge and experience and therefore actively shape the firms' future with their unique resource endowment at an early initial public offering (IPO) stage (Nelson, 2003, p. 714f.). In line with this argument, Kroll and Walters (2007, p. 1211) find a positive relationship between incumbent founder managers and firm performance. They argue, that incumbent founder managers are able to maintain the entrepreneurial perception in the firm in order to run their firms in uncertain times after the IPO stage (Kroll & Walters, 2007, p. 1199). Thus, the energy, the motivation, the experience, and the expertise of founders flow into the daily innovation endeavors (Block et al., 2013, p. 185). Empirical evidence, supporting the above arguments, is provided by Block et al. (2013, p. 187), who find a significant positive effect for founders in management positions on innovation output proxied by patent citations for S&P 500 firms.

Firms board of directors provides access to human and financial capabilities and resources that enable a firm to become more capable and willing to engage in innovative practices (Matzler et al., 2014, p. 322). Founders act as entrepreneurs with special business or technical knowledge and a foundation for growth and innovation (McConaughy & Phillips, 1999, p. 130). To maintain this entrepreneurial foundation, founders may educate next generation managers on how to innovate and exploit growth opportunities profitably (McConaughy & Phillips, 1999, p. 130). In this context, founders can play an essential role in influencing the board structure through exerting influence through the board of directors (Anderson & Reeb, 2004, p. 218). As the board of directors of lone founder firms is usually small, there are more efficient decision-making processes as the relationships between the members are easier to manage (cf. Nelson, 2003, p. 710). Since in the case of lone founder firms, boards serve more as a consulting mechanism rather than a pure monitoring mechanism (Chen & Hsu, 2009, p. 351), founders can use their unique knowledge to advise the board of directors in order to preserve the sources of novelty and innovation in the firm (Langlois, 2007, p. 1120). Thus, not only for founder ownership and management, but also for founder governance a positive effect on innovation output is assumed.

Accordingly, the following hypothesis is proposed:

Hypothesis 4: Founder influence has a positive effect on innovation output (granted patents).

3. Data and sample

3.1. The setting: the German CDAX

The burning question of the underlying study is to investigate the impact of family and founder ownership, management, and governance on firms' innovation performance. More precisely, the study aims to investigate innovation input and innovation output separately in order to obtain a comprehensive understanding of family and founder influence on firms' innovativeness. To address this burning question, the sample was selected according to a stock index, which is consistent with many previous studies (cf. Anderson & Reeb, 2003, p. 660; Block, 2012, p. 253; Chen & Hsu, 2009, p. 352). Thereby, the empirical analysis focuses on German firms listed in the CDAX from 2013 through 2017. The CDAX is an index which is established by the *Deutsche Börse AG* and comprises all German firms in the Prime Standard and the General Standard. Thus, the CDAX presents the entire breadth of the German stock market by serving as a meaningful benchmark for economic growth and performance of the entire German stock market (Deutsche Börse, 2020, n.p.). As the CDAX contains a mixture of founder, family, and other firms, it is the ideal index to address the purpose of the underlying study (Matzler et al., 2014, p. 324).

The German context is well suited for this study, as the purpose of the empirical analysis is to make a clear distinction between the three different influence dimensions of families and founders on firms' innovation performance – ownership, management, and governance. Regarding management and supervision of a firm, Germany's system is two-tiered and therefore clearly distinguishes between these two influence dimensions (Klein, 2000, p. 167): this mutual exclusivity reduces distortions in the interpretation of the independent variables in the analysis part in section 4 and 5 and allows for a comprehensive interpretation of the family and founder effects on innovation input and innovation output.

By focusing only on German firms in the analysis, the study also automatically controls for cross-country institutional differences which may influence the innovation behavior of firms (Acemoglu, Johnson, & Robinson, 2005, p. 389).

3.2. Data and variables

The underlying study includes an empirical data analysis performed by the statistic software STATA to answer the burning question. Therefore, the following section provides an overview of the sample and data sources, the dependent, independent, and control variables used.

3.2.1. Data and sample

In order to obtain financial data for the sample firms for the years 2013 through 2017 (5-year panel data structure, with each firm representing a separate panel), the starting point for data acquisition was the AMADEUS database of the Bureau van Dijk (Siedschlag, Smith, Turcu, & Zhang, 2013, p. 1424).[9] Financial data was collected through the Wharton Research Data Service website provided by the Data room of the Goethe-University in Frankfurt/Main. In order to ensure comparability to previous studies, standard industrial classification (SIC) codes are used to clean the dataset with financial enterprises (SIC codes 600 through 616, 650 through 653, and 671 through 679), public utilities (SIC codes 480 through 494), and foreign companies as they have different accounting standards and government regulation (Anderson et al., 2012, p. 1747). The structure of these companies potentially affects the investment choice of the firms and the structure of equity ownership and therefore it would not be appropriate to compare these particular types of firms with the rest of the sample (Anderson et al., 2012, p. 1747; Block, 2012, p. 253). A special issue when dealing with R&D data is that several databases have missing datapoints for firms' R&D expenditures (Anderson et al., 2012, p. 1751). With regard to the sample firms, the AMADEUS database already includes R&D expenditure data for firms, but datapoints were missing for around 65% of the sample. However, in order to still obtain a large sample of firms, missing data on R&D expenditures were manually collected through the yearly financial statements and annual reports of the sample firms (Czarnitzki & Kraft, 2009, p. 376).

Data on firm's ownership, management, and governance, on the other hand, were obtained manually from firm websites and annual reports as well as through the Hoppenstedt database of the University of Mannheim (Hoppenstedt Aktienführer yearbook) (Klein, 2000, p. 159). Here, the Hoppenstedt database provides comprehensive information on ownership, management, and governance and allows the identification of founders and family members of the sample firms (Matzler et al., 2014, p. 324).

Finally, the existing data set was matched with patent count data of the PATSTAT database provided by the European Patent Office (EPO), which provides data for granted patents for the years 2013 through 2017.[10] The PATSTAT database provides comprehensive information on patents for countries around the world, thus enabling a comprehensive analysis of the patent information provided (Block et al., 2013, p. 185).

During the various steps of data acquisition, firms for which reliable data did not exist were excluded from the final dataset (Matzler et al., 2014, p. 324). Also, the data set was cross-checked to exclude firms with implausible data (Matzler et al., 2014, p. 324). In total, this resulted in an unbalanced panel data set of 165 firms and in an maximum of 804 firm-year observations for both, the empirical innovation input as well as innovation output analysis.

3.2.2. Dependent variables

In order to adequately address the burning question of this study, two empirical analyses – an innovation input and an innovation output regression analysis – are conducted. Therefore, the study deals with two dependent variables, which are described in the following section.

For the innovation input regression, R&D intensity serves as dependent variable, defined as R&D expenditures over total sales of the respective firm. R&D intensity is a widely accepted variable for innovation input that has been used in many previous studies (cf. Chen & Hsu, 2009, p. 353; Chrisman & Patel, 2012, p. 983; Matzler et al., 2014, p. 324). R&D intensity is preferred over R&D expenditures as dependent variable, since scaling R&D expenditures by total sales controls for heteroskedasticity and size effects as well as allows for a relative comparison between firms (Chen & Hsu, 2009, p. 353). The ratio used in the underlying study also factors out the inflation effect and is therefore preferred over other R&D intensity measures like R&D expenditures scaled by the number of employees (G. S. Hansen & Hill, 1991, p. 4). It thus better reflects the firm's innovation effort and serves as a suitable indicator for measuring innovation input (Chen & Hsu, 2009, p. 353). Following Matzler et al. (2014, p. 324), the natural logarithm of R&D intensity is used for the empirical analysis to reduce the skewness of the variable and to simplify the interpretation of the coefficients in the regression analysis. The ratio of R&D intensity is considered to be well suited to test assumptions derived from the agency theory, since the ratio is an indication for the firm's long term economic orientation (Chrisman & Patel, 2012, p. 983). As discussed in sections 2.3.1 and 2.3.2, hypotheses were developed by drawing on the agency theory in such a way that the ratio serves as the ideal proxy for innovation input in the underlying study.

In the second part of this study, (intermediate) innovation output is captured by patent counts, which is in line with many previous studies (cf. Block et al., 2013, p. 186; Czarnitzki & Kraft, 2009, p. 377; Duran et al., 2016, p. 1235). In the empirical analysis, patent count is defined as the filed number of granted patents of a firm within a certain year (Duran et al., 2016, p. 1235). The number of granted patents is preferred over the number of patents applied for by a firm, as the latter has some disadvantages: for example, some knowledge firms apply for will never be implemented (Czarnitzki & Kraft, 2009, p. 377). Although the innovation output measure in this study does not take into account the quality of the granted patents (as for example patent forward citations do), it controls for the gap between applied and granted patents and appropriately reflects the commercial value of the knowledge for the underlying study (Block et al., 2013, p. 181).

Both dependent variables used in the underlying study

[9]The AMADEUS database comprises comprehensive firm-level data on over 18 million firms in 43 European countries (Siedschlag et al., 2013, p. 1421).

[10]A query used to retrieve patent data for the filed number of applied and granted patents from PATSTAT is shown in Appendix 1.

are widely accepted indicators for measuring firm's innovation activity (Czarnitzki & Kraft, 2009, p. 377).

3.2.3. Independent variables

There exists no universal definition of the term family firm in the literature (López-Gracia & Sánchez-Andújar, 2007, p. 275). Like in previous studies, the underlying empirical analysis distinguishes between lone founder firms and family firms (cf. Anderson et al., 2012, p. 1747; Block, 2012, p. 255). Thereby, a lone founder firm is a special form of a family firm in which only the respective founder (founder team) holds an influential position in the firm and no relatives of the founder are involved as owners, managers, or in the firms board of supervisors (Anderson et al., 2012, p. 1747). Family or founder influence can be explained through the capital holders of the firm (Donckels & Lambrecht, 1999, p. 186), by the people who manage the firms activities (Filbeck & Lee, 2000, p. 212f.), as well as by the people monitoring the firm (Anderson & Reeb, 2003, p. 664). In order to take all three influence dimensions into account, family and lone founder firms are not only defined by a dichotomous dummy variable in the underlying study (Matzler et al., 2014, p. 325). Instead, a distinction is made between three different influence dimensions: ownership, management, and governance, as families or founders can exert influence over each of these dimensions (López-Gracia & Sánchez-Andújar, 2007, p. 275f.). Furthermore, there is empirical evidence that German CEOs have less influence on firm's performance and have less discretion compared to other countries such as the USA (Crossland & Hambrick, 2007, p. 785). Therefore, it would not be appropriate to use the mere presence of a founder or a family member, as CEO for the basis for the categorization of a lone founder firm or a family business, respectively. Consequently, following Klein (2000, p. 158ff.) and Matzler et al. (2014, p. 325), family firms (lone founder firms) are defined in the three dimensions of the Substantial Family Influence scale:

1. *Ownership:* shares held by family members (founders) in relation to the total outstanding shares
2. *Management:* number of family members (founders) active in the TMT in relation to the total members in the TMT (percentage of seats in the firm's TMT)
3. *Governance:* number of family members (founders) active in the supervisory board in relation to the total members in the supervisory board (percentage of seats in the firm's supervisory board)[11]

Therefore, this underlying study defines family and lone founder firms in a modular way to make the definition more transparent (Klein, 2000, p. 158).[12] Following Block et al. (2013, p. 186), family and lone founder firms are mutually exclusive in the underlying study, meaning that a family firm cannot be a lone founder firm and vice versa. A lone founder firm therefore only exists if the founder holds shares or is present in the management or the supervisory board where simultaneously no relatives of the founder are active as shareholders, managers, or supervisors of the firm (Block, 2012, p. 253). In the case that a founder and relatives of a founder are in an influential position in the firm, the firm is treated as a family firm in the empirical analysis (Block, 2012, p. 253). The base category for both, family and lone founder firms is a nonfamily firm and thus a firm in which neither a founder nor a relative of a founder is present in an influential position (Block, 2012, p. 253f.). Consequently, all three dimensions report the value 0 in this case. In short, the underlying study deals with three types of firms: lone founder firms, family firms, and other firms.

3.2.4. Control variables

Several variables are included in the empirical analyses in order to control for factors that potentially have an effect on a firm's investment decision as well as on the respective innovation input and innovation output (Anderson et al., 2012, p. 1748). In line with many previous studies, it is controlled for the size of a firm by taking a firm's total sales into account (cf. Chrisman & Patel, 2012, p. 985; Matzler et al., 2014, p. 325). The reason for the control variable size is, that the innovation process has interrelationships between innovation input and innovation output and there may be differences in investment activity due to firm size (Anderson et al., 2012, p. 1748).[13] In addition to size it is also controlled for the age of a firm – defined by the years since the firm's incorporation (Zahra, 2005, p. 32) – in order to take into account potential entrenchment in family and founder firms (Chrisman & Patel, 2012, p. 985). Anderson et al. (2012, p. 1748) also point out that it is important to control for age, because of different investment alternatives during the firm's life cycle. Since both, total sales and firm age, are highly skewed, log-transformations (natural logarithm) are applied (Block et al., 2013, p. 188; Chen & Hsu, 2009, p. 354; Chrisman & Patel, 2012, p. 985). In addition to size and age, the firm's return of assets is included as well, as the firm's past performance could influence R&D spending (Barker & Mueller, 2002, p. 791). Furthermore, firm leverage – defined as the firm's total debt over total assets

[11]A common problem with a sample of German firms might be, that some firms have no supervisory board implemented (Klein, 2000, p. 167). However, this problem is not an issue in the underlying study since all firms in the data set have a supervisory board.

[12]Each module of the definition (ownership, management, and governance) is a continuous measure, ranging from 0 to 1 (Matzler et al., 2014, p. 325). Therefore, structural differences between the respective firms do not play a role in the underlying study: for example, the relative measure of the management variable controls for the size of the TMT and allows for a comparison between firms. Also, through the relative definition, the variables control for founders' (descendants') presence in the TMT and their influence relative to the size of the TMT (Kor, 2003, p. 712).

[13]Note that there are also other possibilities of controlling for size effects, such as taking the firms number of employees or total assets into account (cf. Lee & O'Neill, 2003, p. 217; Zahra, 2005, p. 32).

(Lee & O'Neill, 2003, p. 217; Maury, 2006, p. 326) – is included, as the firm's debt levels could influence the investment choice of firms (Barker & Mueller, 2002, p. 791). As suggested by Chen and Hsu (2009, p. 353), a log transformation (log(leverage/(1-leverage)) is used to correct for skewness. As the funds which are currently available are likely to influence R&D decisions (Baysinger & Hoskisson, 1989, p. 319), a measure of liquidity is inserted. Thereby, cash flow divided by total sales serves as a proxy for the firm's liquidity state in each period (Block, 2012, p. 255). Since also the investment propensity of a firm is likely to influence R&D decisions, capital intensity – defined as fixed assets divided by the number of employees – is included in the analyses (Chrisman & Patel, 2012, p. 985; Matzler et al., 2014, p. 325). To complete firm-level controls, intangible asset intensity is used to take already available innovation capital (such as existing patents, trademarks, or bookplates) into account (Matzler et al., 2014, p. 325). In this underlying study, intangible asset intensity is defined as the stock of intangible fixed assets in relation to a firm's total assets (Matzler et al., 2014, p. 325). Firm-level data was obtained from the AMADEUS database of the Bureau van Dijk accessed through the data room of the Goethe-University Frankfurt/Main as well as from the Hoppenstedt Database (Hoppenstedt Aktienführer yearbook) provided by the University of Mannheim.

Next to firm-level controls, time dummies are included to account for time-specific factors and macroeconomic shocks influencing firms R&D intensity (Matzler et al., 2014, p. 325).[14] Finally, in order to take into account industry-specific effects that could influence R&D choices, industry dummies are included using three-digit SIC codes (Chrisman & Patel, 2012, p. 985; Lee & O'Neill, 2003, p. 217).[15,16]

Table 1 provides a summary of the variables definitions used in the underlying study.

3.3. Methods

In a first step, the R&D intensity regression is the focus of the underlying study. To answer the burning question, whether family and lone founder firms differ in their R&D intensity from other firms, both, fixed as well as random effects panel regression models are estimated (Block, 2012, p. 256). Since data is available for the same firms over several years, panel regression models are chosen to control for unobserved individual heterogeneity and thus mitigate the risk of obtaining biased results (Batalgi, 2012, p. 6; Wooldridge, 2015, p. 403). For interpretation purposes, the random effects model will be used, since the research question primarily deals with cross-sectional results (Block, 2012, p. 256), and has the advantage of allowing for time constant explanatory variables (Wooldridge, 2015, p. 442). Therefore, the following regression equation for R&D intensity is used to test Hypothesis 1 and Hypothesis 2:

$$\log(R\&Dintensity)_{it} = \beta_0 + \beta_1 ownership_{it-1} + \beta_2 management_{it-1} + \beta_3 governance_{it-1} + \boldsymbol{\beta_4} controls_{it-1} \quad (1)$$

Note that the ownership, management as well as governance variables are coded for family and lone founder firms separately with the base category of other firms. To obtain heteroscedastic and autocorrelation robust estimations, the command *-xtreg, robust-* was performed in STATA, since the dependent variable is likely to be auto-correlated within a panel (Matzler et al., 2014, p. 326).[17,18,19] Since both models are estimated with heteroscedastic and autocorrelation robust standard errors, a Hausman (1978, p. 1251ff.) test cannot be used as an indicator for model selection for a fixed or a random effects model. Therefore, results are presented for both, fixed and random panel regression models.[20]

For the second step, granted patents serve as the dependent variable. Since granted patents are (non-negative) integer data, the appropriate model choice is a Poisson model or a negative binomial model, depending on the (over)dispersion of the dependent variable (Block et al., 2013, p. 187).[21] The main assumption for using a Poisson model is that the mean of the dependent variable is equal to the variance (so that

[14] Although a joint significance test for time fixed effects through the testparm command in STATA shows no significant result, the underlying study includes time fixed effects in the empirical analysis to be consistent with previous literature (cf. Block, 2012, p. 258; Chen & Hsu, 2009, p. 357; Chrisman & Patel, 2012, p. 985). Also note that when removing the lag between the dependent and the independent and control variables, the year fixed effects become significant and therefore justify an inclusion in the model.

[15] Industry fixed effects are only included in the random effects regression model (and not in the fixed effects regression model) because of their low variation across years Block et al., 2013, p. 187. As they do not provide any additional explanatory power in the fixed effects specification, they would be automatically dropped out by STATA.

[16] The testparm command for joint significance indicates that industry dummies are highly significantly different from zero (p<0.000 for the hypothesis that all industry dummies are equal to zero) and therefore industry dummies are included in the random effects estimation models (cf. Block, 2012, p. 258; Block et al., 2013, p. 188).

[17] Autocorrelation is assumed to be present between panels, because each firm is considered a panel in the underlying study and the autocorrelation coefficient is likely to differ across panels (Matzler et al., 2014, p. 326).

[18] Note that the robust specification in STATA is technically the same as to cluster standard errors at the entity level (cluster(id) specification) for the xtreg command.

[19] Also note that heteroscedasticity and autocorrelation robust standard errors are used in the R&D intensity models, since the null hypothesis that homoscedasticity (or constant variances) are present can be rejected at any conventional significance level (p<0.000) (Wooldridge, 2015, p. 250f.). In addition, a Lagrange-Multiplier test for serial autocorrelation (command xtserial) was executed and the null hypotheses that no serial correlation exists is rejected (p<0.01) (Batalgi, 2012, p. 93ff.). Therefore, heteroscedasticity and autocorrelation robust standard errors are taken into account in the empirical specification.

[20] Note that the Breusch-Pagan Lagrange multiplier test indicates that a random effects regression model should be preferred over a simple Ordinary Least Squares, since the null hypotheses that the variance across entities is zero (i.e. no panel effects) is rejected at any conventional significance level (p<0.000) (Wooldridge, 2015, p. 251).

[21] Poisson or negative binomial regression models are generally preferred over ordinary linear regressions because the former models have the advantage of being more precisely tailored to the distribution of the dependent count variable (Allison, 2012, p. 265).

Table 1: Summary of variable definition.

Variable name	Definition
Log(R&D intensity)	Natural logarithm of a firm's R&D expenditures over total sales
Patents granted	Filed number of granted patents per year (count data)
Ownership founder	Shares hold by the founder (founder team) over total shares outstanding
Management founder	Number of founders in the TMT over total number of members in the TMT
Governance founder	Number of founders in the supervisory board over total number of members in the supervisory board
Ownership family	Shares hold by relatives of the founder over total shares outstanding
Management family	Number of relatives of the founders in the TMT over total number of members in the TMT
Governance family	Number of relatives of the founders in the supervisory board over total number of members in the supervisory board
Return on assets	Earnings before interest and taxes (EBIT) over a firm's total assets
Log(sales)	Natural logarithm of a firm's total sales
Log(firm age)	Natural logarithm of firm age defined as the number of years the firm exists since incorporation
Log(capital intensity)	Natural logarithm of a firm's capital intensity defined as a firm's fixed assets over the total number of employees
Log(leverage)	Natural logarithm transformation of a firm's leverage defined as total debt over total assets
Cash flow/sales	A Firm's cash flow over total sales
Log(intangible asset intensity)	Natural logarithm of a firm's stock of intangible fixed assets over total assets
Year dummies	Five dummy variables accounting for the years 2013 through 2017
Industry dummies	Seven dummy variables indicating observations in a certain industry (defined through three-digit SIC codes)

Source: own presentation.

there is no overdispersion of the data) (Wooldridge, 2015, p. 545). As the Standard Deviation of the variable granted patents is around 3.43 times larger than the mean, the dependent variable is clearly overdispersed (cf. Block et al., 2013, p. 187). When comparing the mean with the variance the overdispersion becomes even more present – the variance is around 929 times larger than the mean. Since the dispersion of the unconditional mean is only a first indication that the negative binomial regression model should be used for the data, the likelihood ratio chi-square test was carried out through the *lrtest* command (Wooldridge, 2015, p. 529). With regard to the Akaike and the Bayesian information criteria, the model choice according to the likelihood ratio chi-squared test is consistent with the unconditional mean overdispersion, as both methods favor the negative binomial estimation. Therefore, the main assumption for using the Poisson model is violated, and a negative binomial regression model is preferred (Block et al., 2013, p. 187). Zero truncation issues do not occur in the data set since the patent count data were obtained directly from the PATSTAT database and the coded zeros were not due to missing data but due to missing patent activity in the respective year (Block et al., 2013, p. 187). Although around 46% firm-year observations in the data set report a zero in the dependent variable, the negative binomial regression is preferred to the zero-inflated specification in order to avoid conceptual complexities and since the population does not consist of two groups (Allison, 2012, p. 283). In other words, the coded zeros are not due to a mixture of two data-generating processes. Finally, to account for the panel data structure and to increase the robustness of the results, both, a fixed effects as well as a random effects negative binomial model are estimated. By estimating both, fixed and random effects regression models, the possibility of endogeneity and omitted variable bias is mitigated (Block et al., 2013, p. 187). Therefore, the *xtnbreg* command was executed to estimate negative binomial regressions for panel data.

Following Chen and Hsu (2009, p. 354) and Chrisman and Patel (2012, p. 985), control variables are included lagged at t-1 in both regression analyses. The rationale is that control variables in t-1 jointly determine the context for R&D expenditures in period t (G. S. Hansen & Hill, 1991, p. 4). In addition, a one-year lag between the dependent and independent variables is chosen to avoid potential simultaneity problems and to simplify causal inference (Matzler et al., 2014, p. 326).

4. Results

4.1. Descriptive statistics

Using the definition for family and lone founder firms described in section 3.2.3, 28.73% of the firm-year observations of the sample are classified as lone founder firms, while 23.38% fall into the category of family firms. Consequently, 47.89% of the firm-year observations report a zero in all three dimensions and are therefore neither classified as a lone founder nor as a family firm. Comparing these numbers with previous studies shows that the proportion of lone founder and family firms is comparable (cf. Anderson et al., 2012, p. 1748; Block, 2012, p. 255; Chrisman & Patel, 2012, p. 986).

Tables 2 and 3 show descriptive statistics of the variables used in the underlying study. Table 2 presents the means, standard deviations as well as minima and maxima of the key variables. As can be seen, the number of observations range from a minimum of 727 firm-year observations to a maximum of 804 firm-year observations. The average R&D intensity is 0.153 and the three dimensions of lone founder and family influence (ownership, management, and governance) are scaled from 0 to 1, as mentioned above. Lone founders therefore own on average 8.33%, while an average family owns 9.63% of their firm's shares. The management founder variable indicates that 8.88% of the TMT is made up of the founders of the company. The same logic applies for the management family, the governance founder, and the governance family variable. On average, there are around 79 granted patents per firm, while the standard deviation accounts for around 271, indicating an overdispersion of the dependent variable in the second part of the study. Interestingly, both dependent variables – R&D intensity and granted patents – have a minimum value of 0, indicating that there are firms in the data set that do not innovate at all. The average return on assets of the sample firms is around 4%, whereas in terms of firm size (measured in total sales), the sample mean is around € 6.9 billion. The average firm is almost 50 years old, with the minimum and maximum firm age being 1 and 269 years, respectively. With regard to capital intensity, there are approximately 291,000 fixed assets per employee. Finally, firms' intangible asset intensity ranges from 0 to 0.84, again indicating that there might be firms that are not innovative at all, as there are firms in the data set that do not have existing innovation capital.

Table 3 presents the Pearson correlation coefficients between the key variables used in the underlying study. As expected, some control variables show significant coefficients, indicating a certain degree of multicollinearity among these variables (Chen & Hsu, 2009, p. 354). For example, there are significant correlations between the return on assets and the cash flow over sales ratio ($r=0.483$, $p<0.05$), between the logarithm of sales and the logarithm of firm age ($r=0.367$, $p<0.05$) as well as between the logarithm of capital intensity and the intangible asset intensity of a firm ($r=0.340$, $p<0.05$).

Therefore, variance inflation factors (VIFs) of independent and control variables were calculated to ensure that multicollinearity does not pose a problem in the underlying data set (Chen & Hsu, 2009, p. 354). VIFs are a widely used method to detect multicollinearity problems in data sets (Kutner, Nachtsheim, Neter, & Li, 1974, p. 408) and are used in many previous studies dealing with innovation performance regressions (cf. Block, 2012, p. 258; Chrisman & Patel, 2012, p. 987; Muñoz-Bullón & Sanchez-Bueno, 2011, p. 66). Typically, a threshold of 10 is taken as an indicator for multicollinearity and therefore serves as the cutoff in the underlying study (Kutner et al., 1974, p. 409). For the correlation of the key control variables with the explanatory variables, VIFs range from 1.11 to 1.63 and thus do not support a multicollinearity problem, as they are far below the cutoff value of 10 (cf. Chrisman & Patel, 2012, p. 987; Matzler et al., 2014, p. 326).

As can be seen in table 3, there is also a strong correlation between the founder ownership and the founder management variables ($r=0.577$ and $p<0.05$). Furthermore, the matrix shows significant correlations between the founder ownership and the founder governance variables ($r=0.478$ and $p<0.05$). The same pattern can be found for the correlations between family ownership, management, and governance variables with significant Pearson correlation coefficients of $r=0.342$ ($p<0.05$) and $r=0.503$ ($p<0.05$), respectively. Finally, the family management variable seems to be significantly correlated with the governance influence dimension ($r=0.273$, $p<0.05$). To tackle potential multicollinearity concerns of the independent variables, regressions are estimated by using different specifications (fixed effects and random effects models) to ensure the robustness of the results (cf. Block, 2012, p. 256). Furthermore, a number of robustness checks are carried out in section 4.4 to ensure that multicollinearity does not pose a problem in the underlying data set.

4.2. Innovation input (R&D intensity) regression

The results of the R&D intensity regression are reported in table 4. Hereby, model Ia and IIa are fixed effects panel regression models, whereas model Ib and IIb are random effects regressions. The effects of the control variables are as expected. As found in the study of Chrisman and Patel (2012, p. 988), the effect of the variable return on assets is positive, suggesting that firms with higher return on assets also have a higher R&D intensity. In line with previous studies, R&D intensity increases less proportionally with a firm's size, measured by the logarithm of total sales (cf. Anderson et al., 2012, p. 1748; Block, 2012, p. 259; Matzler et al., 2014, p. 326). In addition, older firms and firms with a higher capital intensity in the sample invest on average more in R&D expenditures and therefore positive effects can be found (Matzler et al., 2014, p. 326ff.). Leverage, on the other hand, is negatively correlated with R&D expenditures, indicating that high leveraged firms reduce R&D investments in order to service their debt (G. S. Hansen & Hill, 1991, p. 4). With

Table 2: Descriptive statistics.

	Obs	Mean	SD	Min	Max
R&D intensity	727	0.15	0.52	0.00	5.15
Patents granted	786	78.82	270.64	0.00	3,131
Ownership founder	804	0.08	0.19	0.00	0.81
Management founder	804	0.09	0.21	0.00	1.00
Governance founder	804	0.04	0.12	0.00	1.00
Ownership family	804	0.10	0.20	0.00	0.89
Management family	804	0.02	0.10	0.00	1.00
Governance family	804	0.02	0.06	0.00	0.50
Return on assets	776	0.04	0.17	-1.99	1.17
Sales (in million)	803	6,916	23,857	0.39	229,550
Firm age	799	49.95	51.36	1.00	269.00
Capital intensity (in thousands)	800	291.34	1,550	0.72	22,200
Leverage	772	0.44	0.58	0.01	10.59
Cash flow/sales	801	-0.02	0.92	-14.64	9.36
Intangible asset intensity	803	0.19	0.17	0.00	0.84

Source: own presentation based on STATA data analysis.

regard to the liquidity measure (cash flow in relation to total sales), data suggests a significant negative effect, indicating that higher liquidity in period t-1 leads to lower R&D intensity in period t (ceteris paribus), which is consistent with previous studies (cf. Anderson et al., 2012, p. 1751; Block, 2012, p. 259; Chen & Hsu, 2009, p. 356). For firm's intangible asset intensity, a positive effect is found, indicating that firms with a higher stock of intangible assets also have a higher R&D intensity (on average). Finally, industry fixed effects used in the random effects regression models are significant, because a joint test for significance that all industry dummies are equal to zero can be rejected at all conventional significance levels ($p<0.000$; Block, 2012, p. 258).

By looking at the independent variables of Model Ia and Ib, no significant effects for the ownership and the management variables can be observed. However, a significant positive effect for the governance variable ($\beta = 0.546$, $p<0.05$) can be found in model Ib, thereby partially supporting Hypothesis 1 of the underlying analysis. Therefore, a 10% increase of founders in the governance board is associated with an increase in the R&D intensity of around 5.46% (on average, ceteris paribus).[22,23] With regard to family firms, a significant negative effect for the management variable is found in model IIb ($\beta = -0.645$, $p<0.10$). Therefore, there is a partial support for Hypothesis 2 in the analysis. In contrast to lone founder firms, ceteris paribus, a 10% increase in family presence in the management board is associated with an decrease in the R&D intensity on average of around 6.45%. Finally, for the influence dimensions ownership and governance there are no significant effects for family firms. Both random effects models approximately perform equally well, since they explain around 43% (for model Ib) and 44% (for model IIb) of the differences in R&D intensity between firms.

[22]Note that for an one unit (100%) increase, the effect on R&D intensity is around 54.60%.

[23]Also note that although a panel regression with lagged variables is carried out here, the interpretation of the effects should be taken in a correlational rather than in a causal manner.

4.3. Innovation output (granted patents) regression

The results of the patent count regression analyses are presented in table 5 of the underlying study. As pointed out in section 4.2, model Ia and IIa are fixed effects regressions, whereas model Ib and IIb are random effects regressions. Since the dependent variable patents granted is a (non-negative) count variable, the output of negative binomial regression models is presented.[24]

Again, the effects of the control variables in the second regression model meet the expectations. Firms past performance is likely to have a negative effect on innovation output (Matzler et al., 2014, p. 328). A significant positive effect on firm size can be found, indicating that larger firms generate more innovation output in terms of granted patents (Block et al., 2013, p. 188). As can be seen, older firms seem to file less granted patents, since the effect of firm age is, despite the lack of significance, negative in all four models of the patent regression analysis. Both, a firm's capital intensity and leverage show a significant negative effect, suggesting that firms with higher capital intensity as well as with higher leverage file less granted patents per year (Matzler et al., 2014, p. 328). Finally, R&D intensity shows the expected positive effect – firms with higher R&D intensity also file a significant higher number of granted patents (on average; J. A. Hansen, 1992, p. 40f.). No consistent effects could be found for either the liquidity variable (cash flow in relation to

[24]The model choice in favor of the negative binomial regression is discussed in section 3.3.

Table 3: Correlations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
(1) R&D intensity	1																				
(2) Log(R&D intensity)	.537*	1																			
(3) Patents granted	-.055	.065	1																		
(4) Ownership founder	-.066	.022	-.127*	1																	
(5) Management founder	-.028	.006	-.125*	.577*	1																
(6) Governance founder	.036	.039	-.092*	.478*	.028	1															
(7) Ownership family	-.096*	-.035	.058	-.222*	-.198*	-.153*	1														
(8) Management family	-.052	-.141*	-.056	-.096*	-.086*	-.066	.342*	1													
(9) Governance family	-.054	.036	.002	-.135*	-.121*	-.093*	.503*	.273*	1												
(10) Return on assets	-.521*	-.301*	.069	.179*	.072	.033	.098*	.028	.123*	1											
(11) Sales	-.067	-.051	.454*	-.125*	-.116*	-.092*	-.069	-.059	-.064	.029	1										
(12) Log(sales)	-.404*	-.371*	.504*	-.238*	-.246*	-.198*	.195*	-.003	.072	.300*	.582*	1									
(13) Firm age	-.134*	-.165*	.262*	-.253*	-.241*	-.173*	.188*	.136*	.169*	.146*	.211*	.409*	1								
(14) Log(firm age)	-.122*	-.134*	.213*	-.242*	-.248*	-.151*	.176*	.089*	.173*	.183*	.216*	.367*	.905*	1							
(15) Capital intensity	.053	-.027	.034	.028	-.073	.122*	-.045	-.023	-.040	-.038	.088*	.068	-.037	-.054	1						
(16) Log(capital intensity)	.143*	.059	.163*	-.072	-.229*	.077	.026	-.001	-.010	-.076	.267*	.282*	.048	.027	.597*	1					
(17) Leverage	-.141*	-.217*	.102*	-.041	-.111*	.044	.037	-.084*	-.011	-.096*	.221*	.275*	-.032	-.029	.013	.025	1				
(18) Log(leverage)	-.139*	-.201*	.107*	-.053	-.123*	.047	.054	-.071	-.002	-.091*	.202*	.279*	-.014	-.013	-.011	.008	.977*	1			
(19) Cash flow/sales	-.684*	-.314*	.059	.078	.000	.000	.076	.027	.051	.483*	.051	.307*	.106*	.120*	-.133*	-.152*	.110*	.111*	1		
(20) Intangible asset intensity	.238*	.368*	.040	.014	-.049	-.039	-.045	-.146*	-.050	-.176*	-.037	-.139*	-.233*	-.213*	.082*	.340*	-.008	.012	-.114*	1	
(21) Log(intangible asset intensity)	.160*	.333*	.081*	-.136*	-.084*	-.174*	-.095*	-.236*	-.095*	-.188*	.036	-.051	-.134*	-.122*	-.118*	.066	-.020	.018	.001	.747*	1

Source: own presentation based on STATA data analysis, * p<0.05.

Table 4: Fixed and random effects regressions on R&D intensity (log).

	Model Ia	Model Ib	Model IIa	Model IIb
	log(R&D intensity)			
Ownership founder	-0.037	-0.268		
	(0.344)	(0.391)		
Management founder	0.010	0.032		
	(0.199)	(0.212)		
Governance founder	0.492	0.546**		
	(0.317)	(0.278)		
Ownership family			0.051	-0.150
			(0.264)	(0.349)
Management family			-0.100	-0.645*
			(0.127)	(0.373)
Governance family			-0.058	-0.162
			(0.093)	(0.155)
Return on assets	0.339	0.270	0.306	0.233
	(0.322)	(0.303)	(0.336)	(0.315)
Log(sales)	-0.014	-0.201***	0.002	-0.203***
	(0.157)	(0.061)	(0.157)	(0.060)
Log(firm age)	0.445	0.114	0.449	0.128
	(0.295)	(0.120)	(0.296)	(0.122)
Log(capital intensity)	0.076	0.032	0.083	0.038
	(0.055)	(0.060)	(0.054)	(0.058)
Log(leverage)	-0.020	-0.048	-0.021	-0.047
	(0.060)	(0.059)	(0.060)	(0.059)
Cash flow/sales	-0.317***	-0.290***	-0.319***	-0.288***
	(0.092)	(0.084)	(0.093)	(0.082)
Log(intangible asset int.)	0.019	0.142***	0.011	0.133***
	(0.060)	(0.048)	(0.059)	(0.045)
Constant	-5.417	1.764	-5.819	1.773
	(3.842)	(1.602)	(3.806)	(1.544)
Year Dummies	Yes	Yes	Yes	Yes
Industry Dummies	No	Yes	No	Yes
R^{2a}	0.1207	0.4256	0.1151	0.4429
N	508	508	508	508

Source: own presentation based on STATA data analysis.
Models Ia and IIa are fixed effects panel regression models, Models Ib and IIb are random effects panel regression models, Heteroscedasticity and autocorrelation robust standard errors in parentheses,
[a] For fixed effects models (Ia and IIa) the within R^2 and for random effects models (Ib and IIb) the between R^2 is presented, * p<0.10, ** p<0.05, *** p<0.01.

total sales) or for the intangible asset intensity. This may well be because the data set is not robust enough to capture these effects properly. Finally, time and industry fixed effects are significant, since a joint test for either of the dummy variables is significant at the 5% confidence level (Block et al., 2013, p. 188).

With regard to the independent variables, significant positive effects can be observed for both, lone founder as well as family variables. Therefore, in terms of the underlying hypotheses, there is partial empirical evidence for Hypothesis 3 and Hypothesis 4. Although no significant effect can be found for the ownership variables for lone founder firms, management and governance seem to have a significant positive effect on innovation output in lone founder firms (p<0.10 for all three variables in model Ia and Ib).

Furthermore, there is empirical evidence for the family ownership variable – a significant positive effect on granted patents is found ($\beta = 1.235$, p<0.05 for model IIa and $\beta = 1.400$, p<0.01 for model IIb). Family management also has a significant positive effect in the fixed effects regression, indicating that more family members in the TMT are on average associated with a higher innovation output in terms of

Table 5: Fixed and random effects negative binomial regressions on granted patents (count variable).

	Model Ia	Model Ib	Model IIa	Model IIb
	Patents Granted			
Ownership founder	-1.716	-1.513		
	(1.424)	(0.923)		
Management founder	1.466	1.469*		
	(1.061)	(0.755)		
Governance founder	2.153*	1.652*		
	(1.247)	(0.885)		
Ownership family			1.235**	1.400***
			(0.616)	(0.477)
Management family			2.503**	1.262
			(1.255)	(0.835)
Governance family			-0.670	-0.741
			(0.972)	(0.854)
Return on assets	-0.226	-0.842	-0.376	-0.945
	(0.878)	(0.721)	(0.875)	(0.700)
Log(sales)	0.420***	0.609***	0.427***	0.619***
	(0.072)	(0.062)	(0.070)	(0.059)
Log(firm age)	-0.151	-0.158*	-0.152	-0.184*
	(0.110)	(0.095)	(0.115)	(0.096)
Log(capital intensity)	-0.371**	-0.345***	-0.336**	-0.323***
	(0.154)	(0.110)	(0.147)	(0.109)
Log(leverage)	-0.061	-0.146*	-0.093	-0.145**
	(0.085)	(0.083)	(0.075)	(0.069)
Cash flow/sales	-0.034	-0.034	0.013	-0.037
	(0.239)	(0.133)	(0.246)	(0.142)
Log(intangible asset int.)	-0.038	0.023	-0.009	0.041
	(0.092)	(0.071)	(0.095)	(0.072)
Log(R&D intensity)	0.326***	0.512***	0.386***	0.556***
	(0.124)	(0.087)	(0.123)	(0.088)
Constant	-1.041	-4.245**	-1.442	-5.074***
	(1.783)	(1.978)	(1.767)	(1.948)
Year Dummies	Yes	Yes	Yes	Yes
Industry Dummies	No	Yes	No	Yes
Loglikelihood value	-805.90	-1,409.17	-803.72	-1,406.15
Wald χ^2	339.17***	529.14***	361.35***	584.05***
N	358	507	358	507

Source: own presentation based on STATA data analysis.
Models Ia and IIa are fixed effects negative binomial regressions, Models Ib and IIb are random effects negative binomial regressions,
Standard errors in parentheses,
* p<0.10, ** p<0.05, *** p<0.01.

granted patents ($\beta = 2.503$, p<0.05).

4.4. Robustness checks

To examine the robustness of the main findings of the underlying study, the following section provides additional estimates.

First of all, the R&D intensity and patent regressions are performed without including time fixed effects, since technically a joint significance test carried out through the *testparm* command in STATA does not indicate a significant joint influence of time effects in the underlying study. Omitting time fixed effects, however, leads to supporting results of the main findings regarding the R&D intensity regression. Apart from a negative significant effect for the founder ownership dimension in the patent regression, similar effects can be observed for the remaining influence dimensions for lone founder and family firms. However, the results from the main model are expected to be more precise, as previous literature suggests implementing time effects to control for time invariant heterogeneity and for common shocks (cf. Block, 2012, p. 258; Chen & Hsu, 2009, p. 357; Chrisman & Patel, 2012, p. 985; Matzler et al., 2014, p. 325).

Second, the regressions were estimated by using a binary rather than a continuous measure. Therefore, firms were coded as lone founder firms, if one of the three influence dimensions takes a value greater than zero and as other firms if all three dimensions are equal to zero. The same procedure was carried out for the family influence dimensions of the sample firms. Therefore, all three influence dimensions were compressed into one binary variable, which is likely to be more inaccurate than the specification carried out in the main model. Even though not significant, the main result of the underlying study could be supported on a qualitative basis as the unreported model results show similar effects.[25] These results are also confirmed if a minority shareholder threshold of 25% for the ownership influence dimension is implemented.[26] Here, the unreported results indicate the same qualitative effects like those pointed out in the main findings. Finally, for the binary specification robustness check, the model was estimated by using binary variables for each influence dimension in lone founder and family firms. The corresponding results are again supported and foster robustness of the main findings of the underlying study.

Third, the robustness of the results is examined by an alternative definition of R&D intensity. Consistent with Block (2012, p. 254), R&D intensity was defined as the ratio of R&D expenditures in relation to a firm's total assets in this robustness check. In addition, the natural logarithm of total assets serves as a control variable for firm size, as carried out by Block (2012, p. 255). The unreported regression results are hereby consistent with the main findings in tables 4 and 5 for both analyses, R&D intensity and patent analysis. Furthermore, a third R&D intensity measure – defined as R&D expenditure in relation to the firm's number of employees (Barker & Mueller, 2002, p. 788) – was introduced. Again, the unreported results support the main findings of the underlying study, indicating the robustness of the main regression models.

Fourth, a special focus is placed on the innovation output regression by exchanging the dependent variable: instead of the filed number of granted patents, the filed number of applied patents served as the dependent variable in this robustness check. The remaining model was fitted analogous to the main model as described above. Again, the unreported effects of the fourth robustness check are qualitatively similar to the main findings displayed in table 5.

Lastly, the analysis was run by only taking lone founder and family firms into account and therefore, firms which are neither lone founder nor family firms were excluded from the sample. The unreported results of the last robustness check support the main findings in table 4 and 5. For the R&D intensity regression, similar significant effects can be found with this specification. Comparable significant effects can also be found in the patent regression for the founder influence dimensions, while in the case of family firms the effects can be confirmed on a qualitative basis. To sum up, including nonfamily firms in the main specification provides more conservative effects (Matzler et al., 2014, p. 329).

4.5. Controlling for potential self-endogeneity

In order to conclude the robustness checks of the empirical analysis of the underlying study, the following section discusses potential endogeneity problems that may occur in the patent regression model. Possible endogeneity problems arise when the relationship between innovation input and output is examined more closely: as discussed by Leten, Belderbos, and Looy (2007, p. 568ff.), firms learn to use their resources more efficiently and use these excess resources – such as R&D capacities – to invest into promising ideas and new technologies. To test for a potential endogeneity bias in the underlying data set, a Durbin Wu-Hausman test was performed. The unreported test statistic confirms an endogeneity problem with regard to the innovation input and output relationship for the sample data set. Therefore, firms' R&D intensity should not be considered as predetermined and the use of lagged independent and control variables may be not sufficient to avoid endogeneity in the analysis (cf. Czarnitzki & Kraft, 2009, p. 380). Thus, to control for potential endogeneity problems in the robustness check, an IV-2SLS regression was performed (Wooldridge, 2015, p. 461ff.).[27]

Since firms R&D intensity is to be instrumented, the challenge is to find an instrument that is on the one hand (positively or negatively) related to the omitted explanatory variable and on the other hand has no partial effect on the dependent variable granted patents (Wooldridge, 2015, p. 463). For the purposes of this robustness check, industry R&D intensity is expected to serve as a valid instrument for the first stage regression, as it determines the investment environment of the firm in the respective industry (Czarnitzki & Kraft, 2009, p. 375), and controls for systematic differences in firms innovation behavior (Matzler et al., 2014, p. 326). Therefore, industry R&D intensity is defined as R&D expenditure within an industry in relation to overall industry production (Matzler et al., 2014, p. 326). Since firms R&D intensity is instrumented by one variable (industry R&D intensity), the estimation model is just-identified.

Also, the instrument variable is strongly correlated with innovation input, but uncorrelated with the dependent variable of the innovation output regression (Matzler et al., 2014,

[25]Note that the binary variable for lone founder firms still displays a significant positive effect ($\beta = 0.2764$, $p<0.1$) in the unreported R&D intensity regression (random effects specification).

[26]For Germany, 25% is the threshold for blocking minority (in German "Sperrminorität"), when according to the stock cooperation law, fundamental decisions can be made and substantial influence can be exerted (Czarnitzki & Kraft, 2009, p. 377).

[27]The random effects generalized least squares estimation method is presented (command *xtivreg*, *re*), as a Hausman (1978, p. 1251ff.) test prefers the use of a random effects model over a fixed effects model.

Table 6: Random effects instrumental variable regressions on granted patents over total sales (log).

	Model I	Model II	Model III
	log(granted patents/sales)		
Ownership founder		-2.986***	
		(1.016)	
Management founder		2.082**	
		(0.915)	
Governance founder		2.209**	
		(0.859)	
Ownership family			-0.092
			(0.543)
Management family			1.051
			(0.888)
Governance family			-1.175
			(0.944)
Return on assets	0.972	0.992	1.033
	(1.039)	(0.973)	(1.050)
Log(sales)	-0.098	-0.084	-0.092
	(0.078)	(0.076)	(0.081)
Log(firm age)	-0.279**	-0.287**	-0.298**
	(0.129)	(0.125)	(0.134)
Log(capital intensity)	-0.358**	-0.359**	-0.355**
	(0.163)	(0.157)	(0.166)
Log(leverage)	0.059	0.046	0.067
	(0.114)	(0.111)	(0.114)
Cash flow/sales	0.049	0.040	0.037
	(0.206)	(0.195)	(0.204)
Log(intangible asset int.)	-0.066	-0.052	-0.062
	(0.123)	(0.116)	(0.125)
Log(R&D intensity)[a]	1.019***	0.972***	1.008***
	(0.347)	(0.311)	(0.349)
Constant	-9.029***	-9.299***	-8.851***
	(2.260)	(2.183)	(2.330)
Year Dummies	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes
R^{2b}	0.5769	0.6273	0.5747
N	301	301	301

Source: own presentation based on STATA data analysis.
All models (I, II, and III) are random effects instrumental variable panel regression models,
Standard errors in parentheses,
[a] Instrumented through log(industry R&D intensity),
[b] For all models, the between R^2 is reported,
* p<0.10, ** p<0.05, *** p<0.01.

p. 326) and therefore serves as an adequate instrument for the analysis. For defining industry R&D intensity, industry level data was obtained through the structural analysis databases on the organization for economic co-operation and development (OECD) website (OECD, 2020, n.p.). In contrast to the main model, where the dependent variable granted patents was treated as count data, for the IV-2SLS regression the treatment is continuous. Therefore, the dependent variable for the last robustness check is defined as the relation between the number of granted patents filed per year by a firm and the respective total sales in order to capture size effects and allow for a comparison between firms (Matzler et al., 2014, p. 324). The log (natural logarithm) of the dependent variable is applied in this empirical analysis in order to account for the skewness of the variable.

The results of the patent regression with firms R&D intensity being instrumented is presented in table 6. The remaining model is fitted in the same manner like in the main empirical analysis. Model I is only fitted with control variables, while Model II includes the independent variables for lone founder firms and Model III for family firms, respectively. With regard to the first-stage predictions of the instrumented R&D intensity a significant positive effect is reported in all three models. Interestingly, the ownership dimension for lone founder firms is significantly negative ($\beta = -2.99$, $p<0.01$), therefore supporting the qualitative effect of the main findings of the underlying study. With regard to the management and governance variables, significant positive effects can be found for lone founder firms ($\beta = 2.08$, $p<0.05$ and $\beta = 2.21$ and $p<0.05$, respectively), supporting the main findings in section 4.3. In contrast, no significant effects can be found for the family variables of interest.

5. Discussion

5.1. Discussion of the results

This study makes an empirical contribution to the field of lone founder and family firms' innovation behavior. The results presented above show that founder influence is positively correlated with the innovation input proxy R&D intensity. In particular, a significant positive effect for the governance influence dimension for lone founder firms was found in the underlying study. In contrast, for family firms, a negative effect on R&D intensity was identified, especially when considering the management influence dimension. Moreover, it seems that both, lone founder and family firms produce more innovations compared to other firms, if granted patents are used as a proxy for innovation outcome. While the effect for family firms becomes insignificant once controlled for potential endogeneity, a robust positive effect of the founder influence dimensions management and governance can be found.

With regard to R&D investments in lone founder firms, the results are similar to Block (2012, p. 256): this special type of firm with a founder in an influential position in the firm invests more in R&D than other firms. Moreover, consistent results can also be identified for the effects of R&D investment in family firms, as many previous studies have found a negative effect of family influence on the level of firm's R&D intensity. (cf. Chen & Hsu, 2009, p. 355f.; Chrisman & Patel, 2012, p. 987; Matzler et al., 2014, p. 328; Muñoz-Bullón & Sanchez-Bueno, 2011, p. 67). Therefore, from an agency point of view, it seems that agency costs are not as severe for lone founder firms as for family firms when considering R&D investments (Block, 2012, p. 260). With regard to the ownership influence dimension, it is remarkable that recent studies treat the ownership influence dimension as a synonym with the power a family can exert in the firm (Chen & Hsu, 2009, p. 347f.). However, a more direct way of influencing the firm's behavior is through the management and governance influence dimension (Matzler et al., 2014, p. 329), since especially board representation seems to have a strong influence on the allocation of R&D resources: the substantial influence on firms' investment decisions implies that they will be the main depositors of family interests (Matzler et al., 2014, p. 329). In line with this explanation, the ownership influence dimension does not seem to have a significant impact on the level of R&D investment in the underlying study. In contrast, the significant negative coefficient for family management indicates that family firms suffer from problems of management entrenchment (Morck & Yeung, 2003, p. 370ff.). At an early stage, managers invest heavily in R&D activities to produce good results and demonstrate competencies in management positions, whereas in later stages managers may pursue a more risk-averse investment strategy with regard to R&D, as they have less pressure to prove themselves (Kor, 2006, p. 1083). This reluctance to invest in R&D is not to be expected for lone founder firms: unlike long-tenured members in the TMT who may be reluctant to invest in R&D, founders as typically short-tenured managers of a firm, act as potential protectors of ongoing innovation efforts (Kor, 2006, p. 1093).

With regard to the entrepreneurial orientation of firms, it appears that family firms seem to lose part of their entrepreneurial orientation through the transition from a lone founder to a family firm (Block, 2012, p. 261f.). As a result, family firms may become more hostile to change over time and adopt more conservative investment strategies that may limit their future growth (Miller et al., 2011, p. 4). This tendency to limit future growth potential can be seen as a form of agency costs, more precisely as altruism agency costs (Schulze et al., 2001, p. 102f.).[28] In summary, family firms seem to follow a more conservative and less risky strategy with regard to R&D investments, as they are less concerned about the firms future growth (Block, 2012, p. 262).

The second part of the underlying study focused on the impact on innovation output. In contrast to most studies on innovation input (De Massis et al., 2012, p. 15), the empirical evidence is very mixed in this context (Classen, Carree, Gils, & Peters, 2014, p. 596). As Classen et al. (2014, p. 597) argue, these variations are partly due to the different proxies of innovation output in the respective studies. For example, Czarnitzki and Kraft (2009, p. 382) find in their analysis of German joint-stock companies that firms with a dispersed ownership structure file for more patents than firms with concentrated shares, as it is particularly the case for family firms (Classen et al., 2014, p. 596). In contrast, Anderson et al. (2012, p. 1745) find a similar number of patents for family and non-family firms by investigating large American companies in their investigation period from 2003 until 2007. Moreover, Matzler et al. (2014, p. 328) find positive effects for the family management and governance influence dimension for German listed companies by applying an IV-2SLS regression approach. On the other hand, Block et al. (2013, p. 190f.) examine the difference between family and lone

[28] Altruism in terms of family firms postulates that family members could overstate their actual needs and could thus withdraw resources from the firm (Block, 2012, p. 251).

founder firms in terms of patent citations for S&P 500 firms: they find a positive relationship for the influence dimensions of lone founder firms, whereas family participation is negatively correlated with their innovation output proxy.

Interestingly, the definition of lone founder and family firms varies heavily across these studies: for example, Anderson et al. (2012, p. 1747) define family firms by using a binary variable that takes the value one if the family holds 5% or more of the firms' ownership stake. In line with this approach, Czarnitzki and Kraft (2009, p. 376f.) identify firms' dominant capital holders through a binary variable where the threshold for taking the value one is 25% of the shareholdings, in order to account for Germany's peculiarity of blocking minority. Block et al. (2013, p. 186) decide to apply a mixed definition approach: on the one hand, they define the management variable of lone founder and family firms in a binary manner, while they use a continuous measure for the ownership influence dimension. Lastly, Matzler et al. (2014, p. 325) apply a continuous measure for the three influence dimensions ownership, management, and governance, providing the most accurate and comprehensive measure for family firms. Nevertheless, they do not distinguish between lone founder and family firms in their empirical analysis, ignoring the fact that lone founder and family firms have different characteristics and that they might be two distinct types of firms (Block, 2012, p. 249).

In contrast to all those studies, the empirical analysis presented tried to capture all three relevant influence dimensions (ownership, management, and governance) through a continuous measure, thus enabling a comprehensive analysis between lone founder, family and other firms. Following the resource-based view of the firm, which postulates that the use of unique idiosyncratic resources requires an active involvement in the firm (Matzler et al., 2014, p. 329f.), especially the management and governance influence dimension should be highly relevant. More precisely, a higher number of founders or family member in the respective TMT or supervisory board should result in a higher likelihood in using these unique resources (Matzler et al., 2014, p. 330). Therefore, as argued by Maury (2006, p. 322), the distinction between actively and passively managed firms might be of high relevance. These arguments support the mixed empirical results of the underlying study with regard to the ownership influence dimensions for both, lone founder and family firms. As can be seen from the comparison of tables 5 and 6, the coefficient for the ownership dimension for lone founder firms is insignificant for the count method while it becomes significantly negative when applying the IV-2SLS regression approach and therefore when controlling for potential endogeneity ($\beta = -2.99$, p<0.01). Since the ownership effect for family firms changes from a highly significant positive correlation ($\beta = 1,40$, p<0.01) in the count model to an insignificant effect in the IV-2SLS regression, similar inconsistencies can be found for family firms. Consequently, a passive management of the firm might not be sufficient to deploy founder- and family-specific resources to achieve a significantly higher innovation output compared to other firms (cf. Matzler et al., 2014, p. 330).

Consistent and robust effects could only be identified for the management and governance variable of lone founder firms, indicating that actively managed lone founder firms are able to produce more innovation output compared to other firms (Block et al., 2013, p. 192).[29] Consequently it can be concluded that only founders in the TMT and in the supervisory board are able to create an unique interaction between themselves and the firm, through which resource advantages and capabilities emerge (cf. Matzler et al., 2014, p. 330). These bridges between founders and their firm therefore generate distinctive resources, that enable an efficient exploitation of the innovation input (cf. Matzler et al., 2014, p. 330). In addition, lone founder firms have the advantage that no family members claim resources that could be used to finance fruitful innovation projects (Miller et al., 2011, p. 4). These family priorities, such as maintaining control of the business, can lead to actions that limit a firm's resources and capabilities (Block et al., 2013, p. 182f.). Another contribution to the resource-based view of the firm with regard to the inconsistent effects for family firms can be found by an in-depth look at the human capital employed in these firms. A recent study by Thornhill (2006, p. 699f.) shows that in innovative and technological environments, firm performance is heavily dependent on retaining a highly skilled workforce. However, as shown by Pérez-González (2006, p. 1585), family firms that promote family CEOs in their firms do significantly hurt their performance when family CEOs did not attend a selective undergraduate institution. Family firms might therefore tolerate below optimal human capital in strategic positions and thus possibly harm the effective management of resources (Block et al., 2013, p. 192). In summary, from this study's perspective, founders in active management and supervisory positions are able to produce superior innovation input and output, while family members lacked in being productive innovators.

5.2. Theoretical and managerial implications

As the results of the underlying study show, lone founder firms invest more in R&D compared to other firms, while family firms invest less. Since certain family members might no longer be actively engaged in the firm, they could view the firm as a source of private income (Block, 2012, p. 263). As a result, family firms may become hostile over time and pursue more conservative investment strategies that limit future growth potential (Miller et al., 2011, p. 7). The lack of active involvement of some family members could lead to a lack of understanding of the underlying processes and the industry, especially in rapidly changing environments they may no longer be able to carry out effective monitoring (Block,

[29] Note that the management variable for family firms becomes insignificant when the IV-2SLS regression method is applied. However, this change of significance may be due to the decreasing number of observations, so the data may not be able to capture the effects adequately. Qualitatively, the family firm management variable is positive as in the results of the main model.

2012, p. 263). This resulting ineffective R&D monitoring may consequently pose a threat to the competitiveness of the firm (Block, 2012, p. 263). From a managerial point of view, however, the overall effect of innovation on firm performance is an aggregate effect resulting from both, positive as well as negative mediating effects (Rosenbusch, Brinckmann, & Bausch, 2011, p. 444). Thus, higher innovation input does not necessarily mean higher innovation output in a similar way (Matzler et al., 2014, p. 330), and vice versa. Rather, it seems that firms need to develop, communicate, and establish an innovation orientation and mentality within the firm in order to fully exploit their innovation potential (Rosenbusch et al., 2011, p. 452). This innovation orientation can thus leverage the innovation potential to develop more sophisticated firm goals and could shift resources to areas where they create more value (Rosenbusch et al., 2011, p. 452).

Likewise, since managers are the main decision makers in the firm and therefore often decide on R&D investments, improved communication between the TMT and other people who may contribute important insights, expertise, and experience with innovation projects is important (Chen & Hsu, 2009, p. 359). As R&D projects are complex and require the knowledge of several experts, it is important to foster fruitful communication between managers and supervisory boards (Kor, 2006, p. 1081ff.). This complexity is particularly difficult to manage for relatively new and small firms, so they should consider seeking the advice of independent outsiders (Chen & Hsu, 2009, p. 359), as is the case with consultancies specializing in R&D or innovation projects. In line with this argument, Block et al. (2013, p. 193) suggest appointing academic or industry experts to review the innovation portfolio of the firm in order to reduce the complexity of R&D investment decisions for the TMT.

5.3. Limitations

A number of limitations apply for the underlying study, which provide opportunities for future research. First, the results of this empirical study are limited to German listed companies with its distinct governance and two-tiered system (Matzler et al., 2014, p. 330). Therefore, non-listed, privately held firms were not subject to this study. Second, an omitted variable bias could be present in the underlying study, since there are factors which could have an effect on the family or founder influence dimensions. For example, Chen and Hsu (2009, p. 353f.) consider institutional stock ownership – defined as the number of shares hold by institutional investors in relation to the total number of shares outstanding – as it is likely to have an effect on firms' innovation activities (Bushee, 1998, p. 330). However, institutional ownership was not taken into account in the underlying study because detailed data were not available. In addition, firm risk is likely to influence firms' investment decisions and therefore the firms' beta obtained from the capital asset pricing model can be used as an additional control variable (Miller et al., 2007, p. 838). Third, the sample could be subject to the survival bias: assuming that founders are willing to take higher risks than families, founder firms also have a higher risk of failure (Block et al., 2013, p. 191). Since the sample only includes firms listed in the CDAX from 2013 through 2017, the underlying sample period could lead to distorted results. Fourth, in the case of the patent regression, the count data granted patents served as the dependent variable. As argued in previous studies, this measure could have some drawback since firms might patent for strategic reasons and it is generally perceived as noisy (cf. Block et al., 2013, p. 186). Therefore, patent (forward) citations or sales generated with new product innovations could be taken into account as alternative measures to mitigate these disadvantages (Matzler et al., 2014, p. 331). The variable granted patents in this study only serves as a rough approximation for (intermediate) innovation output und further studies could focus on taking an alternative dependent variable in the empirical analysis to account for the quality of the firms' innovation output. Fifth, the moderating effect of lone founder and family influence on innovation input and innovation output was not considered in this study, as argued by Liang, Li, Yang, Lin, and Zheng (2013, p. 680). Note that the study is also limited by the availability of data, as firms were excluded from the data set when reliable data were not available. Finally note that the interaction effect of CEO duality, as considered by Chen and Hsu (2009, p. 351), is not the subject of the underlying study, as Germany's system is two-tiered and therefore the management and governance influence dimensions are strictly separated and mutually exclusive (Klein, 2000, p. 167).

5.4. Directions for future research

As mentioned in section 5.3, future research should focus on different samples in terms of geography and firm size in order to account for cross-country differences in ownership structures, TMT as well as supervisory board composition (Matzler et al., 2014, p. 331). In addition, the influencing factors of the underlying study (ownership, management, and governance) are only three factors that influence R&D expenditure and innovation output: the degree of technological diversification (Garcia-Vega, 2006, p. 242) and the participation of star scientists in firms (Zucker, Darby, & Brewer, 1998, p. 302) could also be included as control variables in the empirical analysis to account for a potential omitted variable bias. Moreover, the number of granted patents in the second part of the underlying study does not take into account quality aspects, so the focus should be on other dependent variable for innovation output. One proposal for future research would be to use of patent citations or, if available, the sales generated with newly introduced and developed products. As also mentioned by Anderson and Reeb (2004, p. 234), the question arises whether different families communicate with each other and thus whether families consult and advise other families with their experience and expertise. In addition, the composition of the TMT is likely to affect the innovation performance of lone founder and family firms (Baysinger & Hoskisson, 1990, p. 74). Including these two arguments in an empirical analysis would be another promising research approach. As mentioned several times in the study, family businesses could pursue other than purely economic goals. The closer integration of family-specific goals in future research could provide an explanation for the importance of innovation performance. This raises the interesting question, what type of agency costs are likely to have the greatest impact on innovation performance for lone founder and family firms. Finally, the transition of lone founder to family firms results in lower R&D spending. A more fine-grained view of this transition and thus a distinction between first-generation family firm, second- or third-generation family firms would be a promising stream of future literature. The empirical implementation would require a more detailed dataset with a large sample size, but this fine-grained differentiation within the area of family firms would allow an investigation of (multi-) generational family effect on the innovation performance of firms.

6. Conclusion

Drawing on the agency perspective and the resource-based view of the firm, this study examines the impact of lone founder and family influence on innovation input and innovation output. Using a panel data set of 165 German listed companies from 2013 through 2017, the innovation behavior was analyzed by means of regression analyses. In contrast to most previous studies, contextual heterogeneity factors are taken into account to provide a better understanding of how different firms characteristics influence their propensity towards innovation (De Massis et al., 2012, p. 20f.). By separating the lone founder and family effect into ownership, management, and governance, the purpose of this study was to reduce conceptual shortcomings and empirical uncertainties (De Massis et al., 2012, p. 20), thereby extending the growing literature in the field of family and lone founder firms. In this context, the study examines three different types of companies: lone founder, family and other firms. In order to answer the burning question of whether lone founder and family firms differ in terms of innovation behavior, the paper focused on examining the differences between family and lone founder firms in the context of innovation input and output.

In the first part of the underlying study, the main findings regarding innovation input indicate that, similar to many previous studies, a negative effect was found for the influence dimension of family management (cf. Chen & Hsu, 2009, p. 355f.; Chrisman & Patel, 2012, p. 987; Muñoz-Bullón & Sanchez-Bueno, 2011, p. 67). In contrast, lone founder firms seem to invest more in R&D than other firms: a positive relationship was found for the founder governance dimension in the random effects panel regression model for innovation input. Thus, it was concluded that, that from an agency point of view, agency costs seem to be less severe for lone founder firms than for family firms when considering R&D investment strategies (Block, 2012, p. 260). While founders act as potential protectors of ongoing innovation efforts (Kor, 2006, p. 1093), it has been argued that family firms seem to follow a more conservative and less risky strategy thereby limiting the firms future growth potential (Block, 2012, p. 262).

These results of the innovation input regression do not necessarily mean that family firms are less productive in terms of innovation activities: as long as they manage the transition from lower innovation input to superior innovation output, they can still be superior innovators. This idea was the reason for the second analysis regarding innovation output. In the second part of the underlying study, a negative binomial regression model was applied to account for the count nature of the dependent variable granted patents. The results of the main findings indicate a consistent influence of founders in management and supervisory positions in their firm: a significant positive effect for the management and governance variable of lone founder firms was found in both, the count regression model as well as after controlling for potential self-endogeneity by applying an IV-2SLS regression approach. Therefore, it seems that founders in active positions in their firm are able to translate their superior innovation input into superior innovation output. By drawing on the resource-based view of the firm, it was argued that only founders in active positions in the firm are able to create an unique interaction between themselves and the firm, through which resource advantages are likely to emerge.

In contrast, it was found that family members are apparently incapable of achieving unique resource advantages, as no consistent effects were found for the three influence dimensions ownership, management, and governance. It was argued that family priorities, such as maintaining control of the firm, can lead to actions by family members that limit the firm's resources and capabilities (Block et al., 2013, p. 182f.). Another explanation was found by the human capital employed in family firms: as family firms regularly employ family CEOs, they might tolerate suboptimal human capital in strategic positions in their firm and thus possibly harm the effective management of the firm's resources.

In summary, the results of the underlying study imply that founder firms superiorly invest in innovation and strengthen their competitive position in the market through their entrepreneurial orientation. Family firms, on the other hand, might weaken future growth potential as they invest less in R&D and are not able to convert this lower input in superior innovation output.

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