Essays on corporate structure and strategic decision making

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M. Sc. Nicola Bethmann
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Betreuer und Gutachter:	Prof. Dr. Jens Robert Schöndube
Weiterer Gutachter:	Prof. Dr. Stefan Wielenberg
Vorsitzender der Prüfungskommission:	Prof. Dr. Kay Blaufus
Weiteres Mitglied (beratend):	Dr. Svetlana Katolnik
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Abstract

Organizational structures vary significantly among firms. These differences have an important impact on the long-term success of firms and require demanding strategic decisions. This cumulative work focuses not only on the choice of the strategic decisions but also on their efficient implementation which strongly depends on underlying corporate structures and responsible decision makers.

In particular, the papers analyze:

- what financing form an entrepreneur should choose in order to realize the market launch of his business idea. Crowdinvesting as an alternative funding instrument is analyzed and how the entrepreneur handles the trade-off between better exploitation of market potential and the risk of idea stealing;
- how innovation activities of listed companies are influenced by opportunistic behavior of responsible managers. Due to the disclosure of R&D expenditures in the firm's financial statements and a stock-based compensation, incentives for real earnings management and classification shifting arise;
- how family firms manage the succession and whether a family member or external manager should run the firm afterwards. Altruistic and dynastic motives might lead to inefficient decision making of the owner, not only concerning the management choice, but also the current investment in future capital stock.

Keywords

- Crowdinvesting, equity crowdfunding, entrepreneurship, advertising, idea stealing, long-term innovation incentives, real earnings management, classification shifting, socioemotional wealth, family firm succession, altruism, inheritance taxation

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Introduction

Political instability and global competitive pressure make the survival of a firm and its long-term success noticeably difficult. Strategic decisions in order stay competitive in the future are getting complex. Combined with multiple existing corporate structures, it is a challenging task to make the right decisions and to implement them efficiently. Already new established start-ups which are mainly owner-managed are facing the problem at choosing a suitable financing form in order to realize a successful market launch. Trade-offs may arise between the loss of control due to powerful investors and an important knowledge increase by an active support.

Once established in the market it is a central issue to plan the firm's transition to the next generation. When the firm remains in family ownership, shares are usually not sold to non-family members. On the one hand this offers the advantage that strong family preferences and socioemotional aspects may lead to goal congruence in the decision-making process. On the other hand this may limit the inflow of human capital and knowledge where especially the use of family members in active management can cause inefficiencies if skills are not sufficient.

These inefficiencies can be avoided in public corporations where external managers make the decision on behalf of shareholders. Hiring the best manager available provides the desired expertise but causes problems elsewhere. Since external managers have myopic incentives in form of increasing actual compensation, the long-term success of the firm may be harmed. To disentangle differences in strategic decision making stemming from the respective corporate structure, the present cumulative work deals with three ownership structures: an owner-managed start-up, a public traded corporation and a dynastic family business. A comprehensive overview of the motivation and the results of the essays is given in the following.

Essay I:

For the first time crowdinvesting as an alternative financing form allows a large number of individuals to financially support start-ups. Via online platforms the entrepreneur is able to persuade the "crowd" to invest in his idea in exchange for equity shares. Beside the procurement of liquid funds crowdinvesting offers additional advantages for founders: it helps to create public attention and, thus, builds up or intensifies first customer relationships. For this purpose numerous details of the business ideas have to be published on the platforms which also carries risks for the entrepreneur. Due to an easy access to the platforms, potential competitors might use the product details to replicate the ideas. This article uses an analytic model from the entrepreneur's point of view to explore the trade-off between better use of market potential through advertising and the risk of idea stealing by publishing information. The results show that in some cases the entrepreneur strategically restricts his advertising activities on the crowdinvesting platform in order to prevent the risk of getting copied by another firm.

In a second step crowdinvesting is compared to the financing alternatives bank loan and venture capital. These traditional financing forms prevent the danger of idea stealing due to non-disclosure of business information but possess other disadvantages: The bank as a passive investor does not support actively and the entrepreneur looses the platform's advertising opportunity. With regard to venture capital, the entrepreneur can benefit from the capitalist's expertise and network but cannot be certain whether the venture capitalist fits best for his business vision. Furthermore, the venture capitalist receives a say in the start-up which leads to a loss of control for the entrepreneur. Overall it turns out that crowdinvesting is less suitable for highly innovative ideas than bank loan and venture capital due to its disclosure requirements.

Essay 2: The main task of mature firms is to keep or enlarge market position. For this reason an extensive innovation activity is indispensable. In order to obtain competitive advantages in the future short-term income-decreasing effects must be accepted.[1] To compensate this, myopic managers are tempted to cut R&D investments wherefore R&D expenditures are highly affected by earnings management.

To prevent a short-term orientation of the corporate management, compensation is often based on the firm's market value. However, since investors use financial statement infor-

[1] See Lerner, J. and Wulf, J. (2007). Innovation and incentives: Evidence from corporate R&D. The Review of Economics and Statistics 89(4), 634–644.

mation for their valuation, the disclosed short-term numbers still have an implicit impact on the firm's value and incentives to manipulate financial reports arise. In the literature a cut in R&D expenses is well documented as a real manipulation activity. In contrast, the misclassification of R&D expenses to affect the corresponding disclosed amount has only been slightly considered. The second essay investigates an analytical model where the manager can engage in real earnings management and classification shifting in order to increase the market value and, thus, his compensation. The results show that there is a positive relationship between an increase of disclosed R&D investment as a signal for innovation activity and the market price. This leads to incentives to misclassify operating expenses as R&D expenses.

The manager attempts to exaggerate the disclosed investment in innovation without a reduction of the accounting income. In contrast to this reclassification activity, the real earnings management strategy is determined by the duration of the R&D projects. Beside a cut in the R&D expenses, which is documented by prior research, an overinvestment can also occur if investment returns are realized in the short run. These results hold if the innovation risk is not too high. In the extreme case of a significantly high level of innovation risk higher reported R&D expenses have a negative impact on the market price. Here, underinvestment takes place and the manager uses classification shifting to reduce the disclosed R&D expenses. Moreover, if the precision of the accounting system changes there are conditions where real earnings management and classification shifting act as substitutes rather than complements.

Essay 3: An important strategic task in family firms is the regulation of the business succession. This comprises the question whether a family member or an external manager should run the firm and how much to invest in future capital stock. The literature argues that socioemotional aspects, i.e., the behavioral concept of socioemotional wealth (SEW), have an important impact on these decisions and might lead to inefficiencies.[2] The theory describes how family members derive utility from non-economic aspects of

[2] See Gómez-Mejía, L. R., Cruz, C., Berrone, P., and de Castro, J. (2011). The bind that ties. Socioemotional wealth preservation in family firms. The Academy of Management Annals, 5(1), 653–707.

the business. Especially altruistic preferences toward relatives are considered and can be found in dynastic family firms.

For this purpose, the third essay analyzes earnings management incentives during a family firm succession in a two-period model with two different succession scenarios. In both successions the junior receives all firm shares where it varies whether he also manages the firm or hires an external manager. The results show that the senior undertakes earnings management in favor for the junior. On the one hand an overinvestment in future capital stock takes place. On the other hand the senior uses accrual earnings management to shift earnings to the second period. The reasoning behind is identical: in order to relieve the junior from inheritance tax payment the senior reduces the tax base by using earnings management. Whether the successor manages the firm or hires an external manager has no impact on accrual earnings management. The investment decision, however, is influenced by the possession of the future management position. If an external manager manages the firm in the second period, then overinvestment is softened.

Beside manipulation incentives for lowering the successor's tax payments, SEW also influences the senior's decision regarding future management. Our results show that there are cases where the senior prefers the junior to take over the operational business even though more capable external managers are available.

Taken together, the essays provide the following results:

1. Entrepreneurs with highly innovative ideas should be cautious to use crowdinvesting. Even though crowdinvesting offers the possibility to advertise the idea before the market launch, this opportunity is not completely exploited since it bears the risk that competitors are attracted to copy the idea. Due to the disclosure of the product details, other financing forms like venture capital and bank loan might be beneficial by being discrete until the market launch takes place.

2. The disclosure of innovation activities might be manipulated by responsible managers. On the one hand a real manipulation might lead to an under- or overinvestment. On the other hand the disclosure of investment in R&D can also be influenced

by misclassificating expenses. The manipulation strategy by the management is critically determined by the duration of the R&D phase and the innovation risk.

3. In family firms seniors have incentives to undertake real and accrual earnings management in favor of the junior. They do so in order to reduce future inheritance tax payment of the successor which is driven by the socioemotional concerns of the seniors. If their degree of socioemotional wealth is significantly high, the accounting income is reduced by real earnings management and accrual management. Additionally, seniors frequently decide that the junior can run the firm even though more capable managers are available.

Essay I

Title

An analytical approach to crowdinvesting:

The impact of marketing and idea stealing on the entrepreneur’s decision making

Co-author

Matthias Frieden

An analytical approach to crowdinvesting: The impact of marketing and idea stealing on the entrepreneur's decision making

ABSTRACT

In a game-theoretic setting this paper studies the entrepreneur's decision making by using a new financing opportunity referred to as crowdinvesting. In this model the entrepreneur can collect money and advertise his innovative idea. However, crowdinvesting carries the risk of being copied by a potential competitor. Faced with this trade-off, the entrepreneur strategically diminishes his marketing activity under certain circumstances to remain monopolist in the market. In the second part, the paper compares crowdinvesting with two alternative financing opportunities, bank loans and venture capital. We show that crowdinvesting, often mentioned as a financing instrument for drastic innovations, is generally not appropriate for these ideas because the danger of being copied is too high for the entrepreneur.

1 Introduction

The new start-up financing instrument crowdinvesting[1] has been established as a funding alternative for highly innovative ideas in their growing phase (Röthler and Wenzlaff, 2011). Having its starting point in 2007, the number of platforms as well as the raised amounts have increased steadily.[2] Beside its obtained attention as a financing opportunity, collecting money is not the only incentive for using crowdinvesting. As Michael Gerbert, Chairman of the German Crowdsourcing Association, states[3], the smallest part of crowdinvesting is funding, and the largest part is access to a community. Issues like advertisement prior to a market launch of new products are important and should be considered when analyzing crowdinvesting.

Crowdinvesting enables the entrepreneur to raise capital from a large group of people ("crowd") via a platform. Each investor contributes only small amounts in return for firm shares (Belleflamme et al., 2014). To increase awareness of the business idea the entrepreneur provides a business plan as well as detailed personnel information. Furthermore, videos, chats, forums or other social media channels can be used to interact with potential investors (Sixt et al., 2014; Block et al., 2018). This helps to build and strengthen relationships with investors and can establish a first customer base in the initial stage of the start-up. The simultaneous access to money and public attention is the key feature of crowdinvesting and is one of the advantages over existing start-up financing opportunities (Sixt et al., 2014; Ordanini et al., 2011; Agrawal et al., 2014; Belleflamme et al., 2010).

Nevertheless, crowdinvesting also carries elementary risks for the entrepreneur. The greatest risk stems from the disclosure requirement. As mentioned above, in order to attract money via crowdinvesting, the entrepreneur must disclose detailed information because no one is willing to invest in a firm without knowing its value. However, platform users might have other interests than supporting the entrepreneur. Most likely, they might use the disclosed information for other purposes, e.g., copying the idea (Agrawal et al., 2014; Hornuf and Schwienbacher, 2016). The danger of being copied mainly arises

[1] Crowdinvesting is also called equity-based crowdfunding in the literature.
[2] See Hornuf and Schwienbacher (2014) for an extensive overview of the emergence of crowdinvesting in Europe.
[3] The interview can be found at n-tv.de; the title is "Geld sammeln per Crowdfunding".

because many inventors and founders do not have the money to protect their idea while collecting money on the platform (O'Connor, 2014). Traditional sources of funding for young firms, such as family members, friends, angel investors, venture capitalists and banks, have the advantage of being able to conceal the innovation from the public before selling the product.

Losing the idea to another market participant is not the only risk; published information concerning the cost structure or other financial data can also lead to a weaker bargaining position with respect to potential suppliers and customers (Agrawal et al., 2014). Although platform providers screen the personal details of each member at registration and emphasize the obligation of confidentiality to diminish the risks, these obstacles are easy to circumvent (Kortleben and Vollmar, 2012). Cooter and Edlin (2013) refer to the phenomena of publishing information to attract capital and the risk of ideas being stolen as the "double trust dilemma of innovation".

Building on the trade-off between marketing, i.e., better exploitation of market potential, and the risk of ideas being stolen by competitors, it remains unclear whether crowdinvesting can be a catalyst for highly innovative ideas. To investigate this question, our analytical study is twofold: In the first step, we analyze the payoffs generated due to crowdinvesting for different types of innovation. In the second step, we compare the entrepreneurial gain from crowdinvesting with two alternative financing instruments, bank loans and venture capital.

In order to address the question of the best financing option for innovations, we consider start-ups during the launch of the product. Moreover, we model the market as a price competition. Marketing[4] during the crowdinvesting process produces costs on the entrepreneur's side but also increases the net margin of the product due to an enhanced market demand. Idea theft leads to market entry by a competitor. We find that the entrepreneur strategically diminishes his marketing activity in some cases, such that no competitor enters and the monopoly profit can be ensured. Furthermore, we can show that crowdinvesting, originally considered as a financing instrument for drastic innovations, is for the most part not appropriate for these types of ideas. Drastic innovations

[4] Throughout the article, marketing and advertising are used as synonyms.

are able to create new markets and new value. However, these innovations are copied by other market participants since margins are high enough to profitably share the market output. Due to the fear of losing market power, it seems reasonable that entrepreneurs with lucrative ideas will avoid using crowdinvesting as a financing tool because of the obligatory information disclosure.

The literature dealing with crowdfunding mainly addresses the following questions:[5] What motivates the entrepreneur to use crowdfunding? What motivates capital providers to participate? What is the role of the intermediary platform? We investigate the economics from the entrepreneur's side and analyze whether crowdinvesting, as one form of crowdfunding, is preferred to other funding instruments. Existing works such as Belleflamme et al. (2010, 2013) or Gerber et al. (2012) analyze the motivation to use crowdinvesting by interviewing participants. According to these works, collecting money, attracting public attention, creating connections and networks and soliciting feedback for the idea are the main motives for entrepreneurs. Furthermore, Block et al. (2018) empirically investigate the influence of posting updates during a crowdinvesting campaign. Updates are an instrument to signal the start-up value and to help build credibility and legitimacy. They find a significantly positive effect from posts on the number of investments and on the amount collected. The benefits of networks (crowdinvesting platform and its members) on the success of start-ups during their funding process is extensively discussed in Brüderl and Preisendörfer (1998). According to this study, networks function as a channel to gain information. Second, as modeled in our paper, networks provide access to potential customers and can help to increase market demand.

Within an analytical context, Belleflamme et al. (2014) compare the crowdfunding opportunities pre-ordering (reward-based crowdfunding) and profit-sharing (crowdinvesting) where pre-ordering allows the crowd to get access to the product before the market launch takes place.[6] They include community benefits on the investor's side and find that the entrepreneur prefers profit-sharing if the capital requirement of the start-up is

[5] Block et al. (2018) provide a literature overview of the different directions.

[6] By using pre-ordering the entrepreneur undertakes price discrimination between the "crowd" on the platform who pre-orders the product and consumers after the market launch. The benefits for the crowd are the early consumption of the product and no monetary benefits. See Belleflamme et al. (2014) for an extensive overview.

relatively large related to the market size, and pre-ordering is preferred otherwise. Their analysis is limited to the monopoly case and does not take into account the possibility of a competitor's market entry as in our model. In a further analytical model, the same authors (Belleflamme et al., 2010) compare crowdfunding with traditional funding forms, where the entrepreneur uses crowdfunding in order to increase consumer awareness of the idea. Moreover, they distinguish between for-profit and non-profit firms but do not consider the possibility of idea stealing or market entry by a competitor.

Idea stealing is considered in the work of Schwienbacher (2018) within a pre-ordering crowdfunding setting. The entrepreneur can create awareness for his product by exerting costly efforts and can learn the true market demand for the idea. Further, he can show that more effort always creates a greater aftermarket share of the product even though the entrepreneur faces the risk that a competitor might steal the idea. In contrast to Schwienbacher (2018), we focus on different types of innovation, which endogenously determine the market entry of a competitor. Therefore, we are able to show that the entrepreneurs' effort not only increases awareness but may also cause a strategic market deterrence.

In addition to the crowdfunding and crowdinvesting literature, there is a large body of literature dealing with alternative start-up financing opportunities. For example, De Bettignies and Brander (2007) focus on the entrepreneur's choice between venture capital and bank loans. They assume that a venture capitalist provides managerial knowledge to the start-up, whereby this effort must be compensated with a higher equity share. On the other hand, bank funding does not dilute the entrepreneur's ownership and leaves him with full control.

The remainder of this paper is structured as follows. Section 2 outlines a typical crowdinvesting process as seen in reality. Section 3 presents the crowdinvesting model. Section 4 analyzes the economics of crowdinvesting introduced by marketing and the risk of idea stealing. Section 5 compares crowdinvesting with alternative financing instruments. Section 6 discusses the results, and section 7 concludes.

2 The crowdinvesting process

This chapter provides an overview of the crowdinvesting process in order to understand the model structure as described below. In the beginning of the process, the entrepreneur submits the idea to the platform. The platform provider evaluates the idea and decides whether to accept the investment project or not. Projects are selected based on criteria such as uniqueness and innovativeness, scalability and usefulness (Hagedorn and Pinkwart, 2016). After being accepted, the investment offer is announced, and the roadshow phase starts. Typically, platform members can invest within an agreed time span of 60 days in which a pre-defined threshold of investment must be reached. Otherwise, the project is considered to have failed, and the invested amounts are transferred back. During the roadshow phase, the entrepreneur publishes information containing a business plan with financial information and explanations of the product, target groups, strengths and weaknesses as well as the founders vita. Furthermore, the entrepreneur can develop a public-relations concept. He might convince potential investors using an image video in which he conveys emotions in addition to communicating the product idea. In addition, he can post updates at the platform. This can be milestones, new developments or new contracts with suppliers. Moreover, he can interact with platform members in a forum.

Crowdinvesting contains various contractual forms, which differ in their characteristics. Typical forms are subordinated participating profit loans, silent partnerships and registered shares with limited transferability. All the contracts have in common that investors participate in the future revenues and losses of the company. Furthermore, (except stock shares) they have monitoring opportunities but no participation rights. Therefore, the entrepreneur can be sure that the investors cannot enforce a new management. Moreover, all described contracts have unlimited duration but can be terminated by both parties after a contractual holding phase. This phase is typically determined to be between five and ten years (Hagedorn and Pinkwart, 2016).

3 The crowdinvesting game

We consider a strategic two-stage game. At the beginning, product details and market potential of the business idea are disclosed by the entrepreneur and observable for all players.[7]

In the first stage, the entrepreneur can undertake marketing activities on the platform in order to increase demand for the product. In the second stage, the market launch takes place. Either the entrepreneur $(i = 1)$ is the only supplier in the market or a competitor $(i = 2)$ enters, and price competition ensues. Figure 1 illustrates the game.

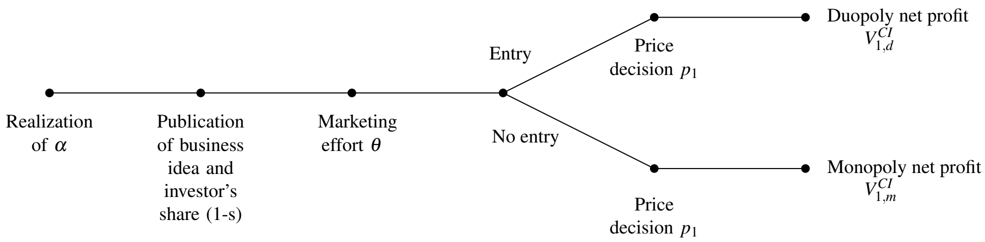


Figure 1: Crowdinvesting game

Using crowdinvesting, the entrepreneur finds himself in a one-sided advertising game. The idea behind this assumptions is based on the point in time where advertising takes place: We investigate the time before the market launch of the new developed product of the entrepreneur. While he is promoting his idea on the platform, no other competitor holds an identical/ similar product.[8] Marketing is labeled by θ, with $\theta \geq 0$, and has a real effect on the demand for the entrepreneur.

[7] See for a similar approach in the sense of strategic investment games De Bondt and Veugelers (1991). We assume that the entrepreneur always publishes a truthful and complete business plan even if he is aware of potential competitors. In accordance to the disclosure requirements one can say that the information are verifiable. Here, a signaling game could take place in that sense that the entrepreneur could withhold parts of his information in order to keep competitors away. However as Grossman (1981) and Milgrom (1981) state in their works, the entrepreneur reveals truthfully the information since otherwise investors would pessimistically value the idea without investing at all.

[8] In comparison, a two-sided advertising game would be relevant in analyzing the time after the market launch where both competitors are active on the market. This is usually modelled as a differential game. For an overview, see Erickson (1995).

We obtain the entrepreneur's demand function:

$$q_1 = a + \theta - bp_1 + dp_2,$$

where a labels the saturation quantity. Parameter b and d describe the sensitivity of the demand on a price change in p_1 and p_2. The demand-specific parameters are given by:[9]

$$a = \frac{\alpha(1-\gamma)}{1-\gamma^2};\ b = \frac{1}{1-\gamma^2};\ d = \frac{\gamma}{1-\gamma^2}.$$

The included parameter $\alpha > 0$ stands for the prohibitive price, i.e., the highest possible price of the product at which the quantity equals zero, and $\gamma \in [0,1)$ labels the heterogeneity of the products. In the extreme case of $\gamma = 0$ products are completely heterogeneous and two separated markets with monopoly power exist. If $\gamma \to 1$ products become substitutes and the firms share the same market. In other words, γ can be interpreted as the ability of the competitor to differentiate the copied idea. The higher the competitor's ability, the higher the heterogeneity and vice versa. Thus, a high (low) ability implies a low (high) value of γ.

The profit of the entrepreneur is given by:

$$\pi_1 = (p_1 - c_1)\, q_1 - \frac{1}{2}\theta^2.$$

Advertising is not free for the entrepreneur. Since it is time intense to promote the business idea, advertising produces quadratic disutility ($\frac{1}{2}\theta^2$).

A potential competitor who enters the market has the following demand:

$$q_2 = a - bp_2 + dp_1,$$

and the corresponding profit function:

$$\pi_2 = (p_2 - c_2)\, q_2.$$

9 See Shy (1995) for exemplary applications and Lambertini et al. (2003) for an application in the context of marketing.

Marginal costs are the same for both firms $c_1 = c_2 = c$. In the following, we neglect the costs c without loss of generality and interpret α as the (highest possible) net margin for the product.[10]

To bring the idea to market, both participants have to bear set-up costs F. In contrast to the competitor, the entrepreneur is not endowed with any initial equity and has to collect the entire amount F by crowdinvesting.

Using crowdinvesting, the entrepreneur has to give up a share of the start-up to the crowd to obtain the required capital. The share is published together with the business plan on the platform and is determined by $(1-s)$. The share is set as a fair price based on the profit to cover the set-up costs:

$$(1-s)\pi_1 = F \Leftrightarrow s = 1 - \frac{F}{\pi_1}.$$

Consequently, the entrepreneur's net profit is as follows:

$$V_1 = s\pi_1 = \pi_1 - F.$$

4 Closed-loop equilibrium

The strategy set comprises the optimal price for a potential competitor and the optimal price as well as optimal advertising for the entrepreneur. We solve the game by backward induction and begin with price competition in the second stage when a competitor enters the market.

[10] If marginal costs are positive, we can include them later in the optimized results. We then may replace α by $\alpha - c$ and a by $a - bc + dc$. See Singh and Vives (1984) and Sakai (1986) for an identical approach.

By optimizing net profits with respect to p_i and equalizing both reaction functions, we get the optimal pricing strategies and the corresponding net profits of the second stage:

$$\begin{aligned}
p_1(\theta) &= \frac{(1-\gamma)\left[\alpha(2+\gamma)+2(1+\gamma)\theta\right]}{4-\gamma^2}, \\
p_2(\theta) &= \frac{(1-\gamma)\left[\alpha(2+\gamma)+\gamma(1+\gamma)\theta\right]}{4-\gamma^2}, \\
V_1(\theta) &= \frac{2\alpha^2(1-\gamma)(2+\gamma)^2-(1+\gamma)\theta\left(8\alpha\left(\gamma^2+\gamma-2\right)+\left(\gamma^4+8\right)\theta\right)}{2(1+\gamma)\left(4-\gamma^2\right)^2}-F, \\
V_2(\theta) &= \frac{(1-\gamma)\left[\alpha(2+\gamma)+\gamma(1+\gamma)\theta\right]^2}{(1+\gamma)\left(4-\gamma^2\right)^2}-F.
\end{aligned} \tag{1}$$

Even if the advertising activity solely increases the demand q_1 of the entrepreneur, it also influences the price setting behavior of the competitor. Therefore, both prices depend on the marketing activity of the entrepreneur and are increasing in θ. Since prices are strategic complements, the competitor can raise his price when the entrepreneur sets a higher price due to a larger demand. Thus, both firms profit from the one-sided marketing activity.[11]

[11] Another option for modeling the strategic marketing would be to consider individual demand parameters and spillover effects. However, we follow the literature concerning strategic investment. See Dixit (1979) as a pioneer in the literature for entry barriers in this context. In contrast to the existing literature, the entrepreneur cannot invest strategically in cost reduction in order to deter market entry. The strategic decision that he can make is a reduction in marketing. Otherwise, all participants profit from his marketing activity.

In the first stage, the entrepreneur decides on the extent of his marketing activity. To determine the optimal marketing effort of the entrepreneur, we maximize the net profit $V_1(\theta)$, given by (1), with respect to θ and obtain the equilibrium values if market entry occurs:[12]

$$\theta_d^C = \frac{4(1-\gamma)(2+\gamma)}{\gamma^4+8}\alpha, \tag{2}$$

$$p_{1,d}^C = \frac{(2-\gamma)(1-\gamma)(2+\gamma)^2}{\gamma^4+8}\alpha, \tag{3}$$

$$p_{2,d}^C = \frac{((\gamma-3)\gamma-2)\gamma^2+4}{\gamma^4+8}\alpha, \tag{4}$$

$$V_{1,d}^C = \frac{(1-\gamma)(2+\gamma)^2}{(1+\gamma)(\gamma^4+8)}\alpha^2 - F, \tag{5}$$

$$V_{2,d}^C = \frac{(1-\gamma)(\gamma((\gamma-2)\gamma-4)-4)^2}{(1+\gamma)(\gamma^4+8)^2}\alpha^2 - F. \tag{6}$$

It is easy to see that the marketing effort, as well as all prices and profits, increase with the product net margin α. Furthermore, more heterogeneous products (lower γ) increase the marketing effort and lead to higher prices and profits.[13]

In order to determine the entrepreneur's monopoly output when no competitor enters, we set $\gamma = 0$ in the equilibrium values (2), (3) and (5):[14]

$$\theta_m^C = \alpha, \tag{7}$$

$$p_{1,m}^C = \alpha,$$

$$V_{1,m}^C = \frac{\alpha^2}{2} - F. \tag{8}$$

Which equilibrium outcome occurs depends on the competitor's decision to enter the

[12] For a later comparison, equilibrium values in case of crowdinvesting are labeled by the superscript C and have the additional subscript d indicating the *duopoly* scenario. The subscript 1 is omitted for the marketing activity since the entrepreneur is the only one who can undertake this action.

[13] Since it is a standard result that heterogeneity of the products softens price competition and leads to higher profits, comparative statics are omitted.

[14] The subscript m describes the *monopoly* case.

market. Thus, he enters the market in the second stage if a duopoly generates positive profits, i.e., the profits exceed the set-up costs F:

$$V_2(\theta) = \pi_2(\theta) - F > 0.$$

Rearranging this condition with respect to α shows how profitable the product must be for a competitor and how the entrepreneur can influence the market entry:

$$\alpha > -\frac{\gamma(1+\gamma)}{(2+\gamma)}\theta^C + \frac{\sqrt{(\gamma-2)^2(2+\gamma)^4(1-\gamma^2)F}}{(\gamma-1)(\gamma+2)^2}. \tag{9}$$

As we can see, more marketing lowers the market barrier for a competitor such that already small margins generate positive profits in duopoly. Similarly, higher heterogeneity leads to a higher profit for the competitor and, therefore, to easier market entry.

Depending on the net margin α, we identify three areas for equilibrium, which are characterized as follows:

1. *Monopoly market:* The entrepreneur maximizes the monopoly outcome because the market is not profitable enough for two firms. He chooses the optimal marketing effort θ_m^C .

2. *Monopoly market with adjusted marketing effort:* The entrepreneur remains monopolist. Even though the market is large enough for a competitor, the entrepreneur adjusts his marketing effort θ_{ma}^C downwards in order to deter market entry.

3. *Duopoly market:* The entrepreneur maximizes the duopoly outcome because he has no opportunity to deter market entry. He chooses the optimal duopoly marketing effort θ_d^C.

Proposition 1 formally states the profits for the entrepreneur.

Proposition 1 *The net profit of the start-up can be described by:*

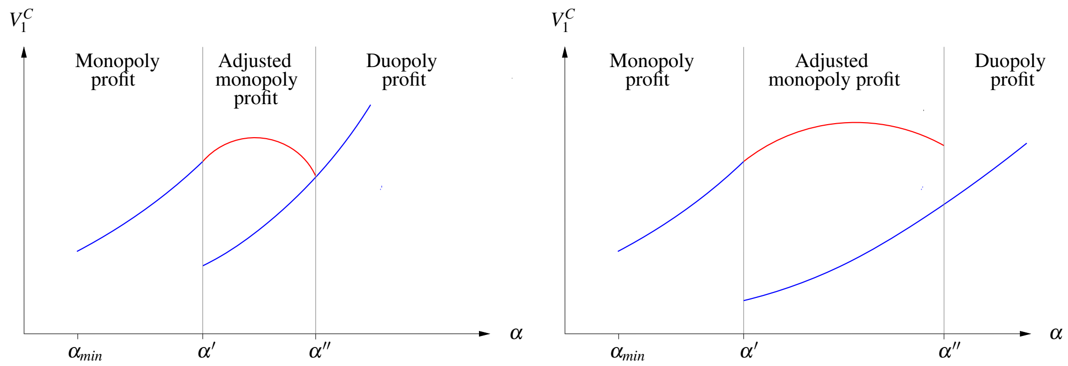
1. *Monopoly area* $(\alpha_{min} < \alpha \leq \alpha')$*:* $V^C_{1,m} = \frac{\alpha^2}{2} - F$,

2. *Monopoly area with adjusted marketing effort* $(\alpha' < \alpha \leq \alpha'')$*:*
$V^C_{1,ma} = \frac{1}{4}\left(\alpha^2 + 2\alpha\theta^C_{ma} - (\theta^C_{ma})^2\right) - F$ *with*
$\theta^C_{ma} = -\frac{(\gamma+2)}{\gamma(\gamma+1)}\alpha + \frac{\sqrt{(1-\gamma)(\gamma+1)^3\left(\gamma^3-4\gamma\right)^2 F}}{(1-\gamma)\gamma^2(\gamma+1)^2}$,

3. *Duopoly area* $(\alpha > \alpha'')$*:* $V^C_{1,d} = \frac{\alpha^2(1-\gamma)(\gamma+2)^2}{(\gamma+1)\left(\gamma^4+8\right)} - F$.

Proof: See the Appendix.

Proposition 1 is illustrated in Figure 2 with profits for high $(\gamma = 0.3)$ and low $(\gamma = 0.6)$ heterogeneity.



(a) $\gamma = 0.3$ (b) $\gamma = 0.6$

Figure 2: Net profit entrepreneur depending on α for a given γ

For margins smaller/equal than α_{min}, neither the entrepreneur nor a competitor brings the idea to the market because it does not lead to positive net profits. Between the range α_{min} and α', the entrepreneur gains the monopoly profit. Even though the idea generates positive net profits, the market profitability is too small for an additional competitor.

Profits increase in α, and therefore the market becomes more attractive to the competitor. At α' it is large enough for two firms. However, between α' and α'' the entrepreneur strategically decreases his marketing activity in order to limit the profit of the competitor and to deter market entry. In this case, the extent of heterogeneity is crucial to the strength of the adjustment, i.e., the aggressiveness with which the entrepreneur lowers his marketing. The more heterogeneous the products, the more profitable the market for two firms even at low margins. This demands a stronger downward adjustment of marketing in order to make it less profitable for two firms to stay in the market (see condition (9)). For decreasing heterogeneity this argument is reverse.

At α'', the area of monopoly profits with strategically adjusted marketing ends for two different reasons: As we can see in case of high heterogeneity (Figure 2(a)), net profits of adjusted monopoly and duopoly are identical at this point. Therefore, it is not worthwile for the entrepreneur to further reduce his marketing activity as this would further reduce his profit. Thus, for $\alpha > \alpha''$, he allows market entry because the high degree of heterogeneity ensures him higher net profits in duopoly than the monopoly with adjusted marketing would do. For low heterogeneity (Figure 2(b)), a different reasoning occurs. Here, the entrepreneur uses at α'' already the minimum adjusted marketing level $\theta^C_{ma} = 0$, which is the minimal public relationship activity demanded by the platform. Therefore, he has no opportunity to prevent the market entry and falls down to lower profits. From now on ($\alpha > \alpha''$), he exerts the marketing effort θ^C_d which is positive but cannot compensate for the loss of market power ($V^C_{1,m} > V^C_{1,d}$). Due to these both scenarios, the bound α'' differs with respect to the heterogeneity where the critical value of heterogeneity is given by $\gamma = 0.5168$. Values below (above) describe high (low) heterogeneity.[15] As shown in Figure 2(a), the bound α'' is earlier reached in case of high heterogeneity. Even though the downward adjustment of marketing is more aggressive, the entrepreneur is earlier better off to accommodate market entry.

5 Crowdinvesting versus other forms of financing

According to Tirole (2010), four stages of corporate financing exist: In the first stage, capital is only provided by the founders themselves, their families and friends. Thereafter, capital is mainly provided by banks, venture capitalists and business angels. Stage three and four are initial and secondary public offerings. Crowdinvesting is best classified as

[15] See the Appendix, proof of Proposition 1.

a financing instrument of the second stage because the entrepreneur has already invested his private savings. In order to carry out the product launch, the entrepreneur is now dependent on additional capital from outside investors. Even though there are various financing forms for a start-up of the second stage, the following analysis concentrates on bank and venture capital. In accordance to Belleflamme et al. (2010), most other financing forms share similar characteristics why they are not explicitly modeled.

To compare crowdinvesting with other financing opportunities of stage two, it is necessary to understand their specific characteristics. The bank typically provides debt capital in form of loans. Projects financed by the bank remain secret until the market launch takes place, such that there is no initial risk of idea stealing. Moreover, the bank monitors the start-up based on formal corporate information and does not provide any managerial knowledge. The entrepreneur maintains full control of the start-up. Therefore, the bank is characterized as a relatively passive investor.

In contrast, the venture capitalist is actively involved in the management of the start-up. He monitors the start-up frequently and assists inexperienced entrepreneurs in operational and strategic decisions. Moreover, he provides access to his network and helps to find potential partners, clients and suppliers (Hochberg et al., 2007; Hellmann and Puri, 2002; Lerner, 1995; Alperovych and Hübner, 2013). In exchange for his work the venture capitalist claims equity capital. This leads to a loss of entrepreneurial control and a dilution of ownership. Similar to the bank, the product idea remains secret until the product launch.

The following analysis about the entrepreneur's optimal financing decision includes the characteristics described above.

Figure 3 illustrates the game.[16]

5.1 Crowdinvesting versus bank financing

As mentioned above, banks offer debt instruments such as loans. In exchange for the set-up costs F, the bank charges a repayment amount D. The bank market is perfectly

[16] We do not consider the case where the start-up might be rejected by one of the financiers.

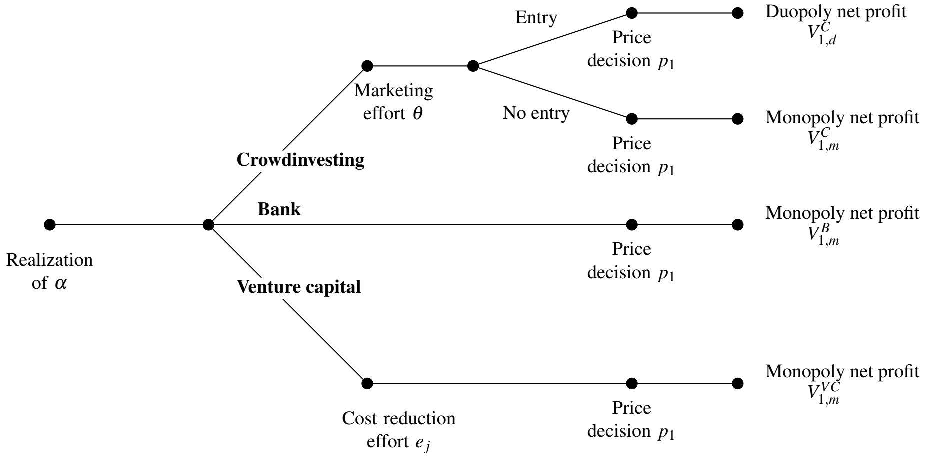


Figure 3: Decision tree for the financing alternatives crowdinvesting, venture capital and bank

competitive and therefore banks offer credits to a minimum repayment, i.e., $D = F$, which leads to zero-profits for them. By taking a bank loan, the entrepreneur does not have the platform opportunities to promote his product. In reverse, it is assured that monopoly revenues $\left[\pi_{1,m}^B = \frac{\alpha^2}{4}\right]$ are obtained.[17]

Thus, the entrepreneur's net profit is:

$$V_{1,m}^B = \pi_{1,m}^B - D = \frac{\alpha^2}{4} - F.$$

To analyze whether crowdinvesting or bank financing is preferred from the entrepreneur's perspective, we compare the net profits V_1^C and $V_{1,m}^B$. Proposition 2 summarizes the results:

Proposition 2 *The entrepreneur always prefers crowdinvesting to the bank, except for the case of a high product net margin* $[\alpha > \alpha'']$ *and a low heterogeneity* $[\gamma > 0.5168]$.

Proof: See the Appendix.

[17] For obtaining the monopoly profit in case of the bank, we take equation (1) and set θ additionally to γ to zero, since no advertising is possible and the first stage of the game is omitted.

Figure 4 presents the results graphically.

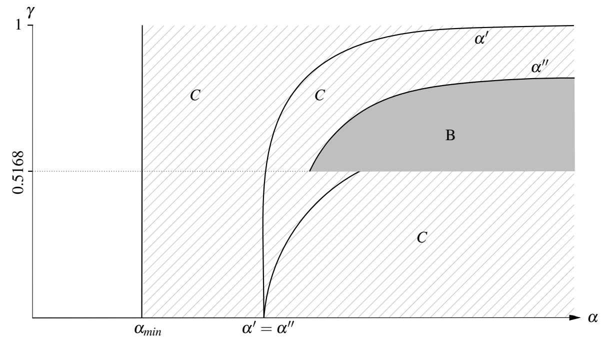


Figure 4: Comparison of crowdinvesting (C) and bank (B)

Crowdinvesting is better for all $\alpha_{min} < \alpha \leq \alpha''$. Here, the entrepreneur receives monopoly profits in both alternatives but obtains additional profits while using crowdinvesting due to the marketing activity. Even though the marketing activity is downward adjusted for the region $\alpha' < \alpha \leq \alpha''$, the net profit is still higher than $V^B_{1,m}$. For the duopoly case $\alpha > \alpha''$, the result is ambiguous by reason of the degree of heterogeneity: given low heterogeneity [$\gamma > 0.5168$], the duopoly profit is relatively low and further the net margin-enhancing marketing effect of the entrepreneur is also relatively low.[18] In this case, the margin-enhancing marketing effect is not able to overcompensate the loss by a market entry and therefore the bank loan is preferred since monopoly profits can be obtained. Given high heterogeneity [$\gamma < 0.5168$], the reverse is true. Crowdinvesting is preferred because duopoly profits are high by reason of more separated markets and are increased additionally by the marketing effort. Thus, the duopoly profit is higher than the obtained monopoly profit by taking a bank loan.

5.2 Crowdinvesting versus venture capital financing

When choosing venture capital the entrepreneur has the advantage to obtain active support. Especially the exploitation of the venture capitalist's networks and managerial

[18] Keep in mind that the marketing activity increases (decreases) with a higher (lower) heterogeneity and that the point of discontinuity in the function is the result of Proposition 1, i.e., that α'' differs for $\gamma \gtrless 0.5168$.

knowledge can help the entrepreneur to establish the new business idea to less costs. However, innovative ideas are very specific and not each venture capitalist has the appropriate experience in the particular sector (Keuschnigg and Nielsen, 2004). Therefore, the venture capitalist's support can be more or less productive which means that it might be very costly for the venture capitalist to provide the needed support. As a consequence, it is a challenging task for the entrepreneur to find the most appropriate venture capitalist and to offer the right contract. Since the competence, i.e., the venture capitalist's productivity is unknown to the entrepreneur before the contractual relationship starts he aims to create different contracts for different types of venture capitalists.[19]

Here, we assume two different types, $j = L, H$, where L describes a low productive venture capitalist and H a high productive one.

In return for start-up shares $(1 - s_j)$ the venture capitalist bears the set-up costs F and is demanded to exert effort in form of active support e_j. With his effort he is able to reduce marginal production costs which increases the net margin $(\alpha + e_j)$ of the idea.[20] As mentioned above, venture capitalists possess differing productivities for the respective start-up. Therefore, the disutility for the contractual effort $\frac{1}{2}k_j e_j^2$ is affected such that the growth rate of marginal effort costs k_j is larger for a less productive type L:

$$\text{Low productive VC: } k_L > 1,$$
$$\text{High productive VC: } k_H \leq 1.$$

Because the entrepreneur and the venture capitalist keep the idea secret until the market launch, the monopoly profit can be obtained:

$$\pi_{j,m}^{VC} = \left(\frac{\alpha + e_j}{2}\right)^2.$$

[19] See Macho-Stadler and Pérez-Castrillo (2001) for a detailed analysis of adverse selection problems.

[20] Existing works often model the venture capitalist's effort as the possibility of increasing the start-up's probability of success (e.g., De Bettignies and Brander (2007); Casamatta (2003); Repullo and Suarez (2004); Kanniainen and Keuschnigg (2004)). Similar to our model, Keuschnigg and Nielsen (2004) assume that advisory efforts lead to a premium over the market price.

The venture capitalist's utility is:

$$U_j = (1 - s_j)\pi^{VC}_{j,m} - F - \frac{1}{2}k_j e_j^2.$$

Correspondingly, the net profit of the entrepreneur is given by:

$$V_{1,m} = s_j \pi^{VC}_{j,m} - v\pi^{VC}_{j,m}. \tag{10}$$

Beside the dilution of ownership, the entrepreneur also has to relinquish control rights which is captured by $v\pi^{VC}_{j,m}$ with $v \in [0,1)$. The entrepreneur loses decision-making power and is exposed to an expropriation risk while using venture capital. Within a contractual relationship and in the ongoing business venture capitalists have powerful controlling rights, e.g. control over the board, redemption and anti-dilution rights. Due to these rights, the venture capitalist is able to make decisions which are not well-aligned with the entrepreneur's interests. The venture capitalist exerts self-interested effort especially concerning future financing and liquidation preferences which is not for the benefit of the entrepreneur (Atanasov et al., 2006).[21] Therefore, the loss of control rights is described by a portion of the profit which the entrepreneur additionally looses while using venture capital.

The entrepreneur offers two separate contracts depending on the type of venture capitalist. To make sure that the revelation principle holds, i.e., that each type selects the contract intended for him, the entrepreneur's full optimization problem contains the participation constraints (PC) as well as the incentive compatibility constraints (IC).

[21] Another interpretation is chosen by Berglöf (1994) who labels this loss as a loss of private benefits. Due to the interference of the venture capitalist, the entrepreneur is limited in taking decisions on his own which harms his benefits.

$$\max_{e_H,e_L,s_H,s_L} E[V_{1,m}(e_j,s_j)] = \phi\left(s_L\pi^{VC}_{L,m} - v\pi^{VC}_{L,m}\right) + (1-\phi)\left(s_H\pi^{VC}_{H,m} - v\pi^{VC}_{H,m}\right)$$

subject to

$$U_L(e_L,s_L) \geq 0, \tag{PC1}$$

$$U_H(e_H,s_H) \geq 0, \tag{PC2}$$

$$U_L(e_L,s_L) \geq U_L(e_H,s_H), \tag{IC1}$$

$$U_H(e_H,s_H) \geq U_H(e_L,s_L). \tag{IC2}$$

Due to the private information of the venture capitalist about his type, the entrepreneur maximizes his expected net profit. He obtains with probability ϕ the net profit from a low productive type and with $(1-\phi)$ from a high productive type. The entrepreneur has to ensure that the venture capitalist, no matter of which type, is willing to enter the contractual relationship (participation constraints PC1 and PC2) why the utility must be at least as high as the reservation utility which is zero in our model. Additionally, the obtained utility from taking the right contract must be at least as high as from the contract intended for the other type (incentive constraints IC1 and IC2).

In the separating equilibrium, the participation constraint of type L as well as the incentive compatibility constraint of type H is binding, whereby the other constraints are negligible. Since it is too costly for type L to imitate the high productive type, the incentive constraint (IC1) is fulfilled and the entrepreneur pays the minimum required by the binding participation constraint (PC1). However, type H has an incentive to imitate the low type why his incentive constraint (IC2) is binding in order to guarantee him the same utility as by choosing the other contract. Rearranging (PC1) and (IC2), we obtain the entrepreneur's shares that negatively depend on the effort levels e_L and e_H, i.e., the higher the venture capitalist's effort the higher his compensation and the lower the entrepreneur's shares:[22]

$$s_L = \frac{\alpha^2 - 4F + (1-2k_L)\, e_L^2 + 2\alpha e_L}{(\alpha + e_L)^2}, \tag{11}$$

$$s_H = \frac{\alpha^2 - 4F + 2\alpha e_H + 2e_L^2\,(1-k_L) + (1-2k_H)\, e_H^2}{(\alpha + e_H)^2}. \tag{12}$$

Inserting the shares into the entrepreneur's objective function brings us the reduced optimization problem:

$$\max_{e_H, e_L} E[V_{1,m}(e_h, e_L)] = \phi \left((s_L - v)\pi_{L,m}^{VC} \right) + (1-\phi) \left((s_H - v)\pi_{H,m}^{VC} \right),$$

where s_L and s_H are given by (11) and (12).

Optimization with respect to e_L and e_H yields the equilibrium values:

$$e_L^{VC} = \frac{\alpha(1-\phi)(1-v)}{(1-\phi)\,v + 2k_L - (1+\phi)}, \tag{13}$$

$$e_H^{VC} = \frac{\alpha(1-v)}{v + 2k_H - 1}, \tag{14}$$

and we obtain the menu of contracts:[23]

$$M(k_j) = \begin{cases} e_L^{VC}, (1 - s_L^{VC}) & \text{for } k_L \\ e_H^{VC}, (1 - s_H^{VC}) & \text{for } k_H. \end{cases}$$

The higher the venture capitalist's productivity (smaller k_j) all the more he is asked to work $\left(\frac{\delta e_j^{VC}}{\delta k_j} < 0 \right)$. Here, the effort level of the highly productive venture capitalist is the same as in case types are known to all parties before the contract is signed (first-best).[24] For a productivity of $k_H < \frac{1-v}{2}$, the venture capitalist is not asked to work at all because it is too expensive for the entrepreneur to hire him. Thus, for $k_H \in (\frac{1-v}{2}, 1]$ the contractual effort level e_H^{VC} is positive. To incentivize effort and to make sure that the good venture capitalist does not choose the other contract, the entrepreneur must commit paying him

[22] For all comparative statics of this section, see the Appendix.
[23] See A.1 and A.2 in the Appendix for the full expressions of the equilibrium shares s_L^{VC} and s_H^{VC}.
[24] For the results of the first-best solution, see the Appendix.

a rent above his reservation utility $((1-s_H^{FB}) < (1-s_H^{VC}))$. The low type has to work less than in the first-best solution. Besides his productivity the effort also depends on the probability ϕ. The share remains the same as in the first best solution. Independent of the type of venture capitalist, the loss of control has a negative impact on both contracts. Knowing that the venture capitalist uses his power in order to increase the profit which does not correspond to the entrepreneur's gain $(v\pi_{j,m}^{VC})$ the entrepreneur anticipates this behavior. Thus, the contractual effort given by (13) and (14) decreases in the cost parameter v. Correspondingly, an effort reduction leads to lower shares for the venture capitalist as given in (11) and (12). However, after the contract is signed, the entrepreneur is still better off by having a productive venture capitalist, i.e., $\left[V_{1,m}^{VC}(k_H) > V_{1,m}^{VC}(k_L)\right]$, even though it costs him more and the venture capitalist works more for self-interested issues $(v\pi_{H,m}^{VC} > v\pi_{L,m}^{VC})$.

To analyze whether crowdinvesting or venture capital is preferred ex ante from the entrepreneur's perspective, we compare the equilibrium net profits V_1^C and $E[V_{1,m}^{VC}]$. Proposition 3 defines the conditions under which crowdinvesting is the dominant funding form.

Proposition 3 *From the entrepreneur's perspective and without loss of control ($v = 0$), crowdinvesting is preferred to venture capital if the productivity of the low type of venture capitalist is small (high k_L) and the population consists of too many low-type venture capitalists (high ϕ):*

1. *Monopoly market ($\alpha_{min} < \alpha \leq \alpha'$): $k_L > k_L^1$ and $\phi > \phi^1$,*
2. *Monopoly market with adjusted marketing ($\alpha' < \alpha \leq \alpha''$): $k_L > k_L^2$ and $\phi > \phi^2$,*
3. *Duopoly market ($\alpha > \alpha''$): $k_L > k_L^3$; $\phi > \phi^3$ and $\gamma < 0.5168$,*

where k_L^1, k_L^2 and k_L^3 are critical values that are provided in the proof of Proposition 3.

Proof: See the Appendix.

The results of Proposition 3 are illustrated in Figure 5 and discussed in more detail in the following enumeration.

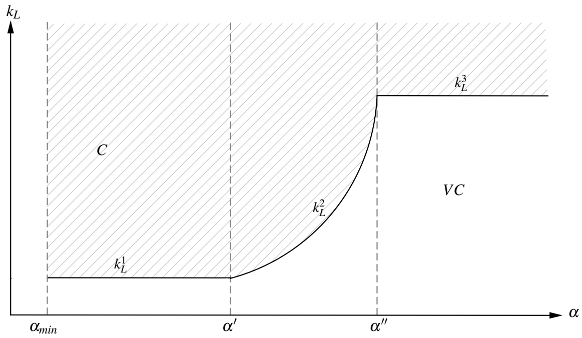


Figure 5: Threshold values k_L of crowdinvesting (C) and venture capital (VC) $(\phi = 0.9;\ k_H = 0.8;\ \gamma = 0.3;\ F = 0.1)$

The figure shows regions where either crowdinvesting $(V_1^C - E[V_{1,m}^{VC}] > 0)$ or venture capital $(V_1^C - E[V_{1,m}^{VC}] < 0)$ is preferred dependent on α and k_L.

1. *Monopoly market:* The entrepreneur prefers crowdinvesting if the low-type venture capitalist is relatively inefficient. Further, the share of low types within the population of venture capitalists has to be above a minimum level. In this case, the entrepreneur is better-off with his marketing activity by using crowdinvesting than with the venture capitalist's support.

2. *Monopoly market with adjusted marketing effort:* The effect of the venture capitalist's productivity is similar. Moreover, heterogeneity γ additionally influences the results. High heterogeneity increases the marketing effort θ_{ma}^C, whereby θ_{ma}^C moves closer to the optimal θ_m^C. Thus, the marketing effect from crowdinvesting has a higher positive impact on profits than the venture capitalists' effort where his productivity is unknown.

3. *Duopoly market:* For the case where a duopoly is not avoidable due to high margins α, the decision in favor of crowdinvesting is ambiguous. Crowdinvesting is preferred only if the low-type venture capitalist's productivity is extremely low and the share of the bad type within the population is extremely high. Furthermore, the heterogeneity of the duopoly products must be high $(\gamma < 0.5168)$ such that markets become more separated.

The results above are obtained without the loss of control rights for the entrepreneur. Already without additional costs occuring by using venture capital, crowdinvesting is preferred in some cases. If we add control loss $v > 0$, the cases for which crowdinvesting is advantageous increase. Allover, the results show that the main driver for crowdinvesting to be advantageous is the market for venture capitalists. If there are only few specialists for the entrepreneur's sector available, the venture capitalist's support does not increase the profit significantly such that the entrepreneur's marketing effect by using crowdinvesting is more beneficial.

6 Crowdinvesting and innovation

Start-ups are highly responsible for innovation activities and future growth of an industry. However, innovation is not a one-dimensional concept, and thus, not every innovation really leads to future growth. The existing literature categorizes innovation into incremental and radical types.[25] The first one is an improvement in existing products or processes, whereas the second one creates a completely new value.[26] According to Grossman and Shapiro (1987), only drastic innovation allows an industry to grow, and further, it is empirically proven that exactly these innovations come with high margins.[27]

Crowdinvesting is often mentioned as a funding instrument of these drastic and growth-enhancing ideas. However, in our model, the findings are ambiguous if margins in the new market are high. In comparison with the bank, crowdinvesting is preferred except for the combination of high net margins and homogeneous products. The results for crowdinvesting and venture capital are more diverse. With high margins, it is more difficult for an entrepreneur to decide for crowdinvesting.

Empirical studies show that venture capital funds are largely concentrated in highly profitable sectors such as e-business or the bio-tech sector (De Bettignies and Brander, 2007). Therefore, they built up know-how and networks in these markets, which makes it difficult

[25] The terms radical and drastic are used as synonyms in the literature.
[26] For an extensive overview of the classification of innovation, see Coccia (2006).
[27] See Rubera and Kirca (2012) for an empirical study. They focus on the correlation between the innovativeness of a firm and its performance outcome.

for crowdinvesting to be advantageous. While many venture capitalists are experienced in the high-margin field, they ignore sectors that are often characterized by incremental ideas with low margins. Here, crowdinvesting gains against venture capital.

In sum, crowdinvesting cannot be seen as a catalyst for drastic innovations. Instead, it prevents entrepreneurs from going public with really good projects since the danger of being copied is too high. Crucial for our result is the loss of the inventor's first mover advantage. In the future, we expect to observe entrepreneurs with mostly incremental innovation projects seeking money via crowdinvesting platforms.

7 Concluding remarks

This paper is the first to investigate the economics of crowdinvesting, including the entrepreneur's aggressiveness and performance on a platform. The entrepreneur has to deal with the trade-off between marketing on the platform, corresponding with better exploitation of market potential, and the risk of the idea being stolen by competitors. We show that in some cases, the entrepreneur strategically diminishes his marketing activities in order to deter a competitor's market entry. In the second part of the paper, we compare crowdinvesting, bank loans and venture capital from the entrepreneur's perspective. We note that crowdinvesting, often mentioned as a funding instrument for drastic innovations, is generally not appropriate. Instead, we expect that in the future, mainly incremental innovative projects will collect money via crowdinvesting. Our model can be extended in several directions that address the main limitations: Since the model investigates the stage of the market launch, it might be useful to analyze the ongoing business activities of the start-up as well. Several problems might arise and influence decisions in the financing process. For example, the entrepreneur's ability to run the business affects the crowdinvesting process, as investors might not be able to vet his skills. This could lead to failing investments and an adverse selection process on the platform. In the case of the bank, lack of knowledge regarding ability might result in higher interest rates or even a rejection of the loan. Also in cooperation with the venture capitalist, the entrepreneur's effort is crucial for the success of the start-up. In the ongoing business activity, the venture capitalist and the entrepreneur have to undertake joint effort. This could cause a double moral hazard problem if interests are divergent. Concerning the informational structure of the game, it might be worthwile to investigate whether the entrepreneur could have incentives to partionally disclose his product information or even to disclose wrong information. Here, an advantage in order to preserve his idea might be the result but also a reputation loss in front of the investors for the entrepreneur and for the platform might occur as well. Moreover, the market participants act completely rational. Their decisions are based on all available information, which stands in contrast to some studies, like Busenitz and Barney (1997) or Cooper et al. (1995). They show that market participants are affected by bounded rationality and cognitive biases. Allover, our model creates a suitable base for further extensions in order to capture the mentioned points.

Appendix

Proof of Proposition 1

(1) Monopoly market: The monopoly profit is maximized in accordance with (7) and (8). The monopoly region exists for the net margin $\alpha \in (\alpha_{min}, \alpha']$:

(i) α_{min} defines the smallest profitability which have to be exceeded such that positive monopoly profits exist. The monopoly profit has to be higher than the up-front costs F:

$$V^C_{1,m} = \pi^C_{1,m} - F > 0 \Leftrightarrow \alpha_{min} > \sqrt{2F}.$$

(ii) α' defines the highest margin where no competitor enters the product market given the entrepreneur induces the optimal marketing effort θ_m. Rearranging the condition $V^C_{2,d} = \pi^C_{2,d} - F = 0$ yields:

$$\alpha' = \frac{\sqrt{F}}{\sqrt{\frac{(1-\gamma)(\gamma(\gamma+2)+2)^2}{(1+\gamma)\left(\gamma^2-4\right)^2}}}.$$

(2) Monopoly market with adjusted marketing effort: The entrepreneur strategically diminishes his marketing effort (θ^C_{ma}) such that the competitor generates a zero profit and does not enter. The marketing effort θ^C_{ma} can be obtained by solving $V^C_{2,d} = \pi^C_{2,d} - F = 0 \Leftrightarrow \frac{(1-\gamma)\left(\alpha(2+\gamma)+\gamma(1+\gamma)\theta^C_{ma}\right)^2}{(1+\gamma)\left(\gamma^2-4\right)^2} = F$. The relevant solution is given by:

$$\theta^C_{ma} = -\frac{(\gamma+2)}{\gamma(\gamma+1)}\alpha + \frac{\sqrt{(1-\gamma)(\gamma+1)^3\left(\gamma^3-4\gamma\right)^2 F}}{(1-\gamma)\gamma^2(\gamma+1)^2}.$$

Consequently, the entrepreneur receives the monopoly net profit:

$$V^C_{1,ma} = \frac{1}{4}\left(\alpha^2 + 2\alpha\theta^C_{ma} - (\theta^C_{ma})^2\right) - F.$$

This adjusted monopoly region is bounded by α''. The threshold α'' is determined by the minimum of two following conditions. The first holds for $\gamma < 0.5168$, otherwise the second:

(i) High heterogeneity $(\gamma < 0.5168)$: A further downward adjustment of θ^C_{ma} to deter the market entry is not in the entrepreneur's interest, because his net profit with adjusted advertising $(V^C_{1,ma})$ becomes smaller than in duopoly $(V^C_{1,d})$ with the optimal chosen marketing activity $\theta_d^C = \frac{4(1-\gamma)(2+\gamma)}{\gamma^4+8}\alpha$. Reformulating $V_{1,ma}^C \leq V_{1,d}^C$ yields:

$$\alpha'' \leq \frac{16\sqrt{(1-\gamma)(1+\gamma)^3\left(\gamma^3-4\gamma\right)^2+F}}{(1+\gamma)\gamma(\gamma-1)\left(\gamma(\gamma(\gamma(\gamma(\gamma(\gamma^3-2\gamma+8)+16)-16)-64)-64)-32\right)}$$

$$+\frac{\gamma\left(\gamma\left((\gamma(2+\gamma)+2)\gamma^2+8\right)+16\right)\sqrt{(1-\gamma)(1+\gamma)^3\left(\gamma^3-4\gamma\right)^2+F}}{(1+\gamma)\gamma(\gamma-1)\left(\gamma(\gamma(\gamma(\gamma(\gamma(\gamma^3-2\gamma+8)+16)-16)-64)-64)-32\right)}$$

$$+\frac{\sqrt{2}\sqrt{(1-\gamma)\gamma^5(1+\gamma)^4\left(\gamma^2-4\right)^2\left(\gamma^4+8\right)\left(\gamma(\gamma(\gamma^2+\gamma+2)+6)+8\right)+F}}{(1+\gamma)\gamma(\gamma-1)\left(\gamma(\gamma(\gamma(\gamma(\gamma(\gamma^3-2\gamma+8)+16)-16)-64)-64)-32\right)}.$$

(ii) Low heterogeneity ($\gamma > 0.5168$): To deter the market, the entrepreneur has already adjusted his marketing effort down to the minimum level of zero ($\theta_{ma}^C = 0$). The entrepreneur has to accommodate the market entry because a further adjustment is not possible. The threshold value α'' can be obtained by solving $V_{2,d}^C = \pi_{2,d}^C - F = 0 \Leftrightarrow \frac{(1-\gamma)\left(\alpha(2+\gamma)+\gamma(1+\gamma)\theta_{ma}^C\right)^2}{(1+\gamma)\left(\gamma^2-4\right)^2} = F$ with $\theta_{ma}^C = 0$. The relevant solution is given by:

$$\alpha'' = \frac{\sqrt{F}}{\sqrt{\frac{1-\gamma}{(\gamma-2)^2(\gamma+1)}}}.$$

(3) Duopoly market: The duopoly market exists for a net margin $\alpha > \alpha''$. The solutions are given by (2) – (6).

Proof of Proposition 2

(1) Monopoly market ($\alpha_{min} < \alpha \leq \alpha'$)**:** The entrepreneur prefers crowdinvesting for the monopoly region because

$$V_{1,m}^C > V_{1,m}^B \Leftrightarrow \frac{\alpha^2}{2} - F > \frac{\alpha^2}{4} - F \Leftrightarrow \frac{\alpha^2}{4} > 0,$$

which is fulfilled for all α.

(2) Monopoly market with adjusted marketing effort ($\alpha' < \alpha \leq \alpha''$)**:** Crowdinvesting is also preferred for the monopoly region with adjusted marketing effort because

$$V_{1,ma}^C > V_{1,m}^B \Leftrightarrow +\frac{1}{4}\left(\alpha^2 + 2\alpha\theta_{ma}^C - (\theta_{ma}^C)^2\right) - F > \frac{\alpha^2}{4} - F$$

$$\Leftrightarrow 2\alpha - \theta_{ma}^C > 0.$$

Since the adjusted marketing effort is $\theta_{ma}^C < \theta_m^C = \alpha$, this condition is fulfilled.

(3) Duopoly market $(\alpha > \alpha'')$**:** In the duopoly region crowdinvesting is preferred to the bank if the products are of high heterogeneity:

$$V^C_{1,d} - V^B_{1,m} \Leftrightarrow \frac{4\,(1-\gamma)\,(2+\gamma)^2\,\alpha^2 - (1+\gamma)\left(\gamma^4+8\right)\alpha^2}{4(1+\gamma)(\gamma^4+8)} > 0.$$

Since the denominator is positive and rearranging the nominator, this condition is true if:

$$\gamma(1+\gamma)\left(\gamma^3+4\gamma+8\right)-8<0.$$

For $\gamma < 0.5168$ the condition holds. Summarizing the result in a duopoly yields:

$$\begin{cases} V^C_{1,d} - V^B_{1,m} > 0 & \text{for } \gamma < 0.5168 \\ V^C_{1,d} - V^B_{1,m} = 0 & \text{for } \gamma = 0.5168 \\ V^C_{1,d} - V^B_{1,m} < 0 & \text{for } \gamma > 0.5168. \end{cases}$$

Contract solutions for the case of venture capital

(1) First-best solution of venture capital: If the type of the venture capitalist is known and a competitive market for venture capital exists, the entrepreneur can specify the optimal menu of contract by only considering the participation constraints which are binding in optimum.

We obtain the optimal share:

$$s^{FB}_j = \frac{1}{2}\,\frac{\left(2\,\alpha^2 - 8\,F\right)k_j{}^2 - 8\,\left(F + \frac{1}{8}\,\alpha^2\,(v-1)\right)(v-1)\,k_j - 2\,F\,(v-1)^2}{\alpha^2 k_j{}^2},$$

and by optimizing the reduced net profit of the entrepreneur the effort:

$$e^{FB}_j = \frac{(1-v)\,\alpha}{v+2\,k_j-1},$$

and net profit for the entrepreneur:

$$V^{FB}_{1,m} = \frac{\left(\alpha^2(1-v)-4F\right)k_j + 2F(1-v)}{2(v+2k_j-1)},$$

with $j = L, H$.

(2) Entrepreneur's optimal second-best profit shares: With unknown types the optimal shares are given by:

$$s^{VC}_L = \frac{\alpha^2 - \frac{2k_L(v\phi-v-\phi+1)^2\alpha^2}{(v\phi-v-2k_L+\phi+1)^2} - \frac{2\alpha^2(v\phi-v-\phi+1)}{v\phi-v-2k_L+\phi+1} + \frac{(v\phi-v-\phi+1)^2\alpha^2}{(v\phi-v-2k_L+\phi+1)^2} - 4F}{\left(\alpha - \frac{(v\phi-v-\phi+1)\alpha}{v\phi-v-2k_L+\phi+1}\right)^2}, \tag{A.1}$$

$$s_H^{VC} = \frac{\alpha^2 - \frac{2k_H(v-1)^2\alpha^2}{(v+2k_H-1)^2} - \frac{2k_L(\phi v-\phi-v+1)^2\alpha^2}{(\phi v-2k_L+\phi-v+1)^2}}{\left(\alpha - \frac{(v-1)\alpha}{v+2k_H-1}\right)^2} + \frac{-\frac{2\alpha^2(v-1)}{v+2k_H-1} + \frac{(v-1)^2\alpha^2}{(v+2k_H-1)^2} + \frac{2(\phi v-\phi-v+1)^2\alpha^2}{(\phi v-2k_L+\phi-v+1)^2} - 4F}{\left(\alpha - \frac{(v-1)\alpha}{v+2k_H-1}\right)^2}. \tag{A.2}$$

(3) Entrepreneur's profit after contract signing: By inserting the respective contract values into (2) we obtain the ex post profitabilty of the types:

$$V_{1,m}^{VC}(k_H) - V_{1,m}^{VC}(k_L) \Leftrightarrow \frac{\alpha^2 (k_H - k_L)^2 (v-1)^2}{(v + 2k_H - 1)((-1+\phi)v + 2k_H\phi - 2k_L - \phi + 1)^2} > 0.$$

Since $k_H > \frac{1-v}{2}$ this is always fulfilled. After the contract is signed, the entrepreneur would always prefer a high productive venture capitalist to a low productive venture capitalist even though this one is more expensive and generates a higher loss of control.

(4) Comparative statics:

The influence of the effort e_L on the share s_L of condition (11) is given by:

$$\frac{\delta s_L}{\delta e_L} = \frac{4(-\alpha k_L e_L + 2F)}{(\alpha + e_L)^3}.$$

For sufficiently small set-up costs ($F < \frac{1}{2}\alpha k_L e_L$) the derivative is negative, i.e., the entrepreneur's (venture capitalist's) share declines (increases) with increasing effort.

The influence of the effort e_H on the share s_H of condition (12) is given by:

$$\frac{\delta s_H}{\delta e_H} = \frac{-4\alpha k_H e_H + (4k_L - 4)e_L^2 + 8F}{(a + e_H)^3}.$$

For sufficiently small set-up costs ($F < \frac{1}{2}\,\alpha\, k_H\, e_H - \frac{1}{2}\, k_L\, {e_L}^2 + \frac{1}{2}\, {e_L}^2$) the derivative is negative, i.e., the entrepreneur's (venture capitalist's) share declines (increases) with increasing effort.

A higher productivity, i.e., smaller values of k_L always leads to an increase in e_L^{VC}:

$$\frac{\delta e_L^{VC}}{\delta k_L} = -\frac{2(v\phi - v - \phi + 1)\alpha}{(v\phi - v - 2k_L + \phi + 1)^2} < 0.$$

Since $v < 1$ this is always true.

A higher productivity, i.e., smaller values of k_H always leads to an increase in e_H^{VC}:

$$\frac{\delta e_H^{VC}}{\delta k_H} = \frac{2(v-1)\alpha}{(v + 2k_H - 1)^2} < 0.$$

Since $v < 1$ this is always true.

Loss of control (v) leads always to a reduction of contractual effort:

$$\frac{\delta e_L^{VC}}{\delta v} = \frac{2\alpha(\phi - k_L)}{(\phi v - 2k_L + \phi - v + 1)^2} < 0,$$

since $k_L > 1$, this is always fulfilled.

$$\frac{\delta e_H^{VC}}{\delta v} = \frac{-2\alpha k_H}{(v + 2k_H - 1)^2} < 0,$$

which is always true.

Proof of Proposition 3

In order to examine the profit differences between crowdinvesting and venture capital, the loss of control is set to zero ($v = 0$).

The expected utility for the entrepreneur with $v = 0$ is obtained by inserting (13), (14), (A.1) and (A.2) into E[V$_{1,m}$] :

$$E[V_{1,m}^{VC}] = \frac{1}{2}\,\frac{-\alpha^2 (k_H - 1)\phi^2 + \left((3k_H - k_L - 1)\alpha^2 - 4Fk_H + 2F\right)\phi}{(-2k_L + \phi + 1)(-1 + 2k_H)}$$

$$+ \frac{8\left(k_H - \frac{1}{2}\right)\left(-1/4\,k_L\,\alpha^2 + F\left(k_L - \frac{1}{2}\right)\right)}{(-2k_L + \phi + 1)(-1 + 2k_H)}.$$

(1) Monopoly market $(\alpha_{min} < \alpha \leq \alpha')$: Crowdinvesting is preferred to venture capital $(V_{1,m}^C > E[V_1^{VC}])$ if:

$$\alpha^2 (2k_H - 1)(2(\phi - 1)k_H + 2k_L - \phi)\left(2k_H (k_L - 2\phi + 1) + 2(\phi - 1)k_H^2 + (\phi - 2)k_L + \phi\right) > 0.$$

This condition holds if:

$$k_L > k_L^1 := \frac{2k_H\left((1-\phi)k_H + 2\phi - 1\right) - \phi}{2k_H + \phi - 2}, \text{ and } \phi > \phi^1 := 2 - 2k_H.$$

(2) Monopoly with adjusted marketing effort $(\alpha' < \alpha \leq \alpha'')$: Crowdinvesting is preferred to venture capital$(V_{1,ma}^C] > E[V_{1,m}^{VC}])$ if:

$$\frac{1}{4}\left(\alpha^2\left(\frac{\phi^2}{2(\phi - 1)k_H + 2k_L - \phi} + \frac{\phi - 2k_H}{1 - 2k_H}\right) - \alpha^2 - 2\alpha\theta_{ma}^C + (\theta_{ma}^C)^2\right) < 0.$$

This condition holds if

$$k_L > k_L^2 := \frac{1}{2}\left(2(1-\phi)k_H + \phi + \frac{\alpha^2\phi^2\,(2k_H-1)}{\theta_{ma}^C\,(2\alpha-\theta_{ma}^C)\,(2k_H-1)-\alpha^2(1-\phi)}\right),$$
$$\text{and } \phi > \phi^2 := 1-\frac{\theta_{ma}^C\left(2\alpha-\theta_{ma}^C\right)(2k_H-1)}{\alpha^2}.$$

(3) Duopoly market ($\alpha > \alpha''$): Crowdinvesting is preferred to venture capital ($V_{1,d}^C > E[V_{1,m}^{VC}]$) if:

$$\frac{1}{4}\alpha^2\left(\frac{4(\gamma-1)(\gamma+2)^2}{(\gamma+1)\,(\gamma^4+8)}+\frac{\phi^2}{2(\phi-1)k_H+2k_L-\phi}+\frac{\phi-2k_H}{1-2k_H}\right)<0.$$

This condition holds if

$$\begin{aligned}
k_L > k_L^3 := &\frac{2((\gamma(\gamma+1)(\gamma^3+4\gamma+8)-8)(\phi-1)k_H^2}{4(\gamma-1)(\gamma+2)^2-2(\gamma(\gamma+1)(\gamma^3+4\gamma+8)-8)k_H+(\gamma+1)(\gamma^4+8)\phi}\\
&-\frac{2(\gamma-1)(\gamma+2)^2(2\phi-1)k_H+(\gamma-1)(\gamma+2)^2\phi)}{4(\gamma-1)(\gamma+2)^2-2(\gamma(\gamma+1)(\gamma^3+4\gamma+8)-8)k_H+(\gamma+1)(\gamma^4+8)\phi},\\
\text{and } \phi > \phi^3 := &\frac{2\left(\gamma(\gamma+1)\left(\gamma^3+4\gamma+8\right)-8\right)k_H-4(\gamma-1)(\gamma+2)^2}{(\gamma+1)\,(\gamma^4+8)},\\
\text{and } \gamma < 0.5168.&
\end{aligned}$$

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Essay II

Title

Earnings management, disclosure of R&D expenses and long-term innovation incentives: A game-theoretic analysis of real earnings management and classification shifting

Co-author

Tim Hensel

Earnings management, disclosure of R&D expenses and long-term innovation incentives: A game-theoretic analysis of real earnings management and classification shifting

ABSTRACT

This paper examines how a separately disclosed signal for R&D expenses affects earnings management. We investigate a single-period model in which the manager can engage in real earnings management and classification shifting. Here, the capital market holds rational expectations about the firm value and uses two reported signals, accounting income and R&D expenses, to update its beliefs. In order to increase managerial compensation, incentives arise to misclassify operating as R&D expenses and to reduce investment in R&D. Real earnings management leads to a deviation from the optimal economic investment level. We show that if innovation investment returns can be realized in the short run, a clear overinvestment occurs. In contrast, if the innovation risk is significantly high, classification shifting leads to a lower disclosed R&D investment signal and an underinvestment strategy is always implemented by the manager. We also study the effect of the precision of the accounting system. Our results show that more precise signals can avoid classification shifting and lead to less biased accounting signals. In contrast, stronger real earnings management incentives are provided. Thus, if the precision of the accounting system is improved, both manipulation tools act as substitutes in equilibrium.

1 Introduction

Motivating innovation is the new stigma of the twenty-first century. Long interdisciplinary debates have been held to find answers how to make innovations happen. Main findings and main problems have been seen in the fact that innovation activities are chiefly unobservable and contain a high degree of uncertainty: On the one hand, firms face the risk of spending enormous amounts even though the idea does not lead to the desired result, or has already been brought out on the market by competitors. On the other hand, there is the internal risk that responsible managers do not spend the money in the best interests of the shareholders.

Competitive pressure has always been seen to be a catalyst for innovation activities,[1] therefore it is especially the second problem that companies have to solve to remain competitive in the future. Within the company, conflicts of interest might occur because investment decisions are often made out of short-term considerations. Managers are intended to make myopic decisions because investment decisions cut off today's accounting income in favor of uncertain future growth. One way to handle this problem is to link the managers' compensation to the market price. By tying their compensation to the long-term firm performance, an alignment between the interests of shareholders and the manager shall be achieved.[2]

However, whether a stock-based compensation explicitly strengthens the innovation behavior of a firm, largely depends on the capital market's absorption of the signals about the firm's innovativeness. According to Kleinknecht et al. (2002), there are mainly four relevant signals: R&D expenditures, current patent applications, expenditures of innovation as a whole[3], and the share on sales by incremental and drastic products. A long list of empirical studies confirms that the capital market prices the statement about R&D expenditures into the firm valuation as a positive signal for future growth (Junge et al., 2003).[4]

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[1] See, for instance, Baily et al. (1995) and Blundell et al. (1995) for early empirical evidence.

[2] Several empirical studies, e.g., Lerner and Wulf (2007) as well as Murphy (2003), see a shift towards stock-based compensation during the last decades for responsibles in R&D divisions.

[3] These include also non-R&D expenditures which are linked to innovation activities.

[4] See, e.g., Chauvin and Hirschey (1993) who find a positive impact of R&D investment on the firm value

Besides, due to the fact that they are stated in the financial statements, R&D expenditures are observable and verified by auditors which make them advantageous compared to other signals. However, the management anticipates the use of R&D expenditures for firm valuation and has the discretion over the signals, such that incentives to manage earnings arise. Here, we differentiate between real and accounting earnings management. Real earnings management affects the timing or structuring of the investment or financing decision, and describes the deviation of the economically optimal investment level. Hence, accounting income can be intentionally altered which often entails real costs to the firm in form of a decreased long-term firm value (e.g. Ewert and Wagenhofer, 2005; Hunton et al., 2008). Empirical studies show that particularly an underinvestment behavior occurs as it means to let reported income increase (Baber et al., 1991; Cohen and Zarowin, 2010; Gunny, 2010; Roychowdhury, 2006). However, these studies take data where a capital market is not considered to use R&D expenditures for formulating expectations about the firm value. And, more important, compensation schemes are solely based on short-term signals. Even in the presence of a long-term compensation, He et al. (2003) show that R&D investment can be cut by managers if the bonus is based on the stock price.

In contrast to real earnings management, accounting earnings management contains the interpretation of accounting standards and aims at affecting the recognition, measurement and disclosure of transactions which have already taken place. This manipulation is also called window dressing, because the activity changes the reported signals but has no real effect on underlying economic earnings as in the case of real manipulation. There are many studies about accounting earnings management in the presence of stock-based compensation where the findings are ambiguous.[5] However, most of these studies have in common that they only consider accounting earnings management in the form of accrual

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of COMPUSTAT firms for U.S. firms of the industrial sector in the late 80's. Hall et al. (1993) find great evidence for the 80's and even before, Griliches (1981) for the early 70's. Patents, e.g., are the result of past innovation activity and are only a weak signal for future innovation activity. Coherently, Cooper et al. (2015) figured out that the number of filed patents is a stringy biased signal because round about 50% of ideas are not patented and, therefore, they do not measure the right current innovation strength.

[5] See, e.g., Subramanyam (1996), Ke (2003), Johnson et al. (2009), Burns and Kedia (2006), Bergstresser and Philippon (2006), and Efendi et al. (2007) who provide evidence of a positive association between the use of stock-based compensation and fraudulent manipulation of the accounting statements while Erickson et al. (2006) see no consistent evidence of such a link. Only O'Connor et al. (2006) find a contrary effect, namely, that high stock-based portions in the salary lead to less earnings management.

management. In our paper, we focus on an another approach, namely classification shifting as a special case of accounting earnings management which describes the misclassification of expenses between items within the income statement. In contrast to accrual management, classification shifting does not change the level of the accounting income but only the separately disclosed items.[6] This part of earnings management is a relatively new research direction. Nevertheless, first empirical studies document that responsibles manage expenses and revenues more likely in this manner (McVay, 2006; Fan et al., 2010) Market participants are often more interested in *adjusted* operating income rather than in accounting income (Bradshaw and Sloan, 2002; Gu and Chen, 2004). The *adjusted* operating income, also called core operating income,[7] is excluded from extraordinary special items (e.g., reconstruction or acquisition), and is therefore more informative about the profitability and efficiency of a firm.[8] Returns of R&D investment are realized some time in the future and excluding these expenses can increase the informativeness about the current core operating income. However, the impact of classification shifting on the publication of R&D investment has only marginally been considered.[9]

To fill this gap, our paper examines the interplay between opportunistic earnings management and financial statements information in the presence of a capital market. More precisely, we investigate how real earnings management and misclassification of expenses are affected by specific economic conditions like innovation risk, accounting system precision and duration of R&D projects. We also analyze which consequences arise for the innovation activities of the firm.

To address these questions, we consider a single-period model where the firm's terminal value is affected by the manager's effort in the operating business and by the investment

[6] Contrary to this intra-period earnings manipulation activity, accrual management is characterized by an earnings shift across reporting periods.

[7] For instance, see McVay (2006).

[8] Further examples for items which do not belong to the core earnings are earnings from goodwill impairments, employee stock options or pension gains and losses. In addition, revenues from non-core activities are also excluded.

[9] There are few empirical investigations in this research field. Skaife et al. (2013) study factors which lead managers to classify operating as R&D expenses. Koh and Reeb (2015) investigate the strategic decision with regard to the corporate R&D investment disclosure and also consider classification shifting as a used manipulation tool.

choice in R&D. The publicly observable accounting signals, accounting income and R&D expenditures, have to be disclosed at the end of the period and they determine the market price of the firm. The (exogenously given) compensation contract is based on the stock price and, in order to manipulate it, the manager can engage in real and accounting earnings management. Therefore, the manager can classify operating expenses as R&D expenses (or vice versa) which increases (decreases) the signal regarding the R&D investment, whereby the accounting income remains unaffected. In our model, real earnings management occurs if the R&D expenses deviate from the optimal economic investment level.

Our results show that the capital market takes the short-term signal (accounting income) more heavily into account compared to the forward-looking signal as an indicator for future growth (R&D investment). Higher reported investment in innovation leads to a positive market reaction and has the following effect on the two manipulation tools: First, the manager uses the misclassification of operating as R&D expenses to mislead shareholders (e.g., the manager can affect the partition of product engineering, employee's working hours and overhead costs between operating and R&D expenses which, in fact, does not change the accounting income). Thus, classification shifting causes too high disclosed R&D expenses because the firm signals a higher level of innovation activity, which should lead to higher returns in the future. In addition, the manipulation lowers the operating expenses which in turn implicitly increases the core operating income. Second, the real earnings management behavior is ambiguous and depends on the kind of innovation where the manager is responsible for investment. A clear underinvestment behavior is undertaken if innovation generates returns with a time lag, which is mainly the case of drastic innovations. However, if there are projects which can be launched immediately, e.g., small incremental innovations, then an overinvestment occurs. These results are based on the assumption that investors evaluate R&D expenses as a positive signal, which in turn is the case when innovation risk is moderate.

If the innovation risk is sufficiently high, an increase in disclosed investment amounts lead to a lower market price. In this special case, we show that classification shifting evokes lower disclosed R&D expenses and the investment in R&D is always below the benchmark level.

To study the effect of the accounting precision, we consider a firm which generates returns with a lag of time (e.g., the pharmaceutical industry) in a moderate innovation risk regime. We show that a higher precision of the accounting system leads to a lower level of classification shifting and, thus, a lower bias in the reported signals. This arises by a lower informativeness of the R&D investment signal for shareholders if the precision increases. Thus, the misclassification of expenses is less attractive. Moreover, we find a positive relation between a higher precision of the accounting system and real manipulation activities. Therefore, more precise signals lead to a reinforced reduction of the long-term investment. Consequently, there is a substitution effect of real earnings management and classification shifting due to the change in precision of the accounting signals.

Our paper is related to recent work on earnings management in the presence of a stock-based compensation. Regarding real manipulation activities, the work of Dutta and Reichelstein (2005) is worth mentioning. They use a multi-period model to examine the role of stock-based compensation on the managerial investment behavior.[10] In their model, the accounting system bears measurement errors which can be exploited by the manager in order to pursue opportunistic interests. These measurement errors occur due to a misclassification between intangible investments and operating expenses.[11] The authors show that an optimal capitalization rate of soft investments is able to reduce the manager's leeway to misreport. In an accounting earnings management context, Fischer and Verrecchia (2000) study earnings management in the presence of an exogenously given incentive rate which is based on the market price. They identify how accounting manipulation affects the informativeness of disclosed accounting income for the capital market.[12] Their study is extended by Ewert and Wagenhofer (2005) to a setting where the manager has the additional possibility to undertake real earnings management and examine whether tighter

[10] In contrast to Dutta and Reichelstein (2005), in our model, the manager undertakes an investment decision which is at no cost to him.

[11] In their model, misclassification is not endogenously chosen by the manager but is exogenously given by the accounting system.

[12] Unlike our model, Fischer and Verrecchia (2000) assume that the capital market is not perfectly able to anticipate the agent's equilibrium actions.

accounting standards might lower the extent of managerial manipulation.[13] However, all these studies have in common that they only consider accounting earnings management as accrual management. In contrast, we focus on classification shifting.

Our model is closely related to the work of Kanodia et al. (2004). They study how the capital market's perceptions can be influenced by different accounting signals, i.e., the current accounting income and the investment in intangibles.[14] Their work considers predominantly the accounting practice and investigates whether intangibles should be capitalized. The focus is set on the change in the market price due to a separating practice and does not depend on the behavior of the manager being responsible for the investment in R&D. Thus, the involved manager acts in the best interest of the owner. We consider instead a setting with an opportunistic manager who uses the possibilities of earnings management to improve his compensation.

After presenting the model setup in Section 2, we examine the capital market's reaction on the accounting information and the manager's equilibrium action levels in Section 3. Section 4 shows the manager's earnings management behavior in two different innovation risk scenarios. In Section 5, we examine the influence of the accounting system's precision on the relation between classification shifting and real earnings management. Section 6 concludes.

[13] Moreover, accounting earnings management resulting from a stock-based compensation is often examined in the recent literature, e.g., Feltham and Xie (1994) and Goldman and Slezak (2006).

[14] For the importance of the separation of investments from operating income for accounting issues, see Kanodia and Mukherji (1996).

2 Model setup

We consider a single-period LEN model with a risk-neutral principal and her risk-averse manager. The manager stays for one period in the firm and can affect the firm's terminal value by his effort e and the investment in R&D d.[15] The terminal value (i.e., economic earnings) is unobservable to all and given by:

$$X = \underbrace{\Omega - \Psi + \alpha\,\Pi}_{\text{Current period}} + \underbrace{(1-\alpha)\,\Pi}_{\text{Realized in future}} \,,$$

where

$$\Omega = e + \tilde{\theta},$$
$$\Psi = d + \tilde{\varepsilon},$$
$$\Pi = 2\sqrt{d}.$$

Due to his effort e, the manager enhances the current operating income Ω. The investment in innovation leads to current expenditures Ψ and total returns of Π. We assume that the manager has the possibility to invest in several innovation projects which differ in their profitability[16] and that he would always invest in those having the highest expected net present value: each additional unit of invested capital reduces the total profitability of the investment. Therefore, the returns which can be generated by the investment are positive but to decreasing rates. However, only a part of the returns of the investment belongs to the current period, where the rest leads to future gains.

To which extent total returns are divided in current and future returns is determined by $\alpha \in (0,1)$. If α is significantly high (low), the investment is front-loaded (back-loaded). Thus, the terminal value consists of $\Omega - \Psi + \alpha\,\Pi$, indicating the income of the current period, and $(1-\alpha)\Pi$ which stands for future returns of the investment. Note that the manager does not stay until the firm earns the whole returns of the investment.

[15] In the following, investment in R&D and investment in innovation are used as synonyms. In addition, since we do not assume any temporal disparity, we also use expenses and expenditures as synonyms.

[16] It is assumed that the firm does not have any budget restriction and can borrow needed financial resources.

Furthermore, the investment in R&D is subject to risk. Expenses might be unproductive and/or wasted which means that only few projects lead to success. We capture this by a random variable $\tilde{\varepsilon}$ where a positive value determines unproductive expenditures.[17] Besides, the operating income is linked to risk $\tilde{\theta}$ which is beyond the control of the manager.[18] For instance, an unscheduled increase in wholesale price, which can not be compensated by higher sales prices leads to higher expenses and, hence, to a lower operating income. Both error terms are independently distributed random variables and the distributions are common knowledge:[19]

$$\tilde{\theta} \sim N(0, \sigma_\theta^2),$$
$$\tilde{\varepsilon} \sim N(0, \sigma_\varepsilon^2).$$

Accounting system and earnings management

At the end of the period, the manager has to disclose two accounting signals to the capital market. The first signal is the accounting income y and the second one contains the amount of R&D expenditures z. The accounting income contains operating income, total R&D expenditures and the current part $\alpha\Pi$ of the R&D investment returns. Signal z is only one item out of this sum. Thus, an increase in R&D investment by one unit leads to a simultaneous reduction in the accounting income and an increase of the reported signal of the R&D expenditures by this unit.

The accounting reports are given by:

$$\begin{aligned} y &= (\Omega + b + \tilde{\eta}) - \overbrace{(\Psi + b + \tilde{\tau})}^{z} + \alpha\,\Pi, \\ &= e + \tilde{\theta} + \tilde{\eta} - d - \tilde{\varepsilon} - \tilde{\tau} + \alpha\, 2\sqrt{d}, \\ z &= \Psi + b + \tilde{\tau}, \\ &= d + b + \tilde{\varepsilon} + \tilde{\tau}. \end{aligned}$$

[17] See for a similar approach Kanodia et al. (2004).
[18] See Bushman and Indjejikian (1993).
[19] In the following, we denote unrealized random variables with a *tilde*.

For simplification, we assume that the capitalization of R&D expenditures is not allowed.[20]

Accounting signals enclose estimation errors which occur due to problems regarding the record of business transactions in the firm's accounting system. The way how transactions and events are recorded is determined by accounting standards and because of restrictive specifications, the accounting system is not completely able to map the terminal value. Furthermore, another reason for the imprecision of the signals is the high number of business transactions and their complexity. In our model, these errors are represented by $\tilde{\eta}$ for the operating income and $\tilde{\tau}$ for the R&D expenses.[21] The noise terms are independently distributed normal random variables, following:

$$\tilde{\tau} \sim N(0, \sigma_\tau^2),$$
$$\tilde{\eta} \sim N(0, \sigma_\eta^2).$$

To influence the signals, the manager can engage in classification shifting and real earnings management. Since he is responsible for the publication of the accounting signals, he has the discretionary leeway b to undertake classification shifting. We consider a situation where the manager is able to manipulate the signals by switching operating and R&D expenditures. Therefore, the reported innovation investment z can be increased or reduced by this manipulation while the accounting income y remains unaffected.

The manager also has discretion over the investment in R&D d. When he deviates from the optimal economic investment level, we interpret this as real earnings management

[20] In current accounting standards, the capitalization of selected R&D outlays may take place. For instance, development costs in accordance with IAS 38.57 are mandatory to recognize as an asset if enumerated conditions are fulfilled. However, since the main expenditures are excluded by that special case, we consider a generalized approach in which non of the expenditures are allowed to be capitalized. If we considered the possibility of capitalization of R&D, it would reduce z and would improve the accounting income.

[21] In this context, another important error is the misclassification of operating expenses and investments in R&D which are considered by Kanodia et al. (2004). Since boundaries between these two kinds of expenditures are fuzzy to identify, misclassifications are quite common in practice and hardly to avoid. For instance, marketing outlays support the revenue of current products, but also have a positive effect on future sales of new products or the brand building. Our primary results are not affected by this kind of accounting errors and, thus, the noise term is not considered in this model.

because he attempts to increase his own benefit.[22] Thus, the manager engages in real earnings management if he over- or underinvests in R&D.

Manager's utility

The utility function of the manager is determined by $U^M = -exp[-r(w-c)]$. Effort as well as accounting earnings management is costly for the manager and the disutility function is convex: $c = \frac{e^2}{2} + \frac{b^2}{2}$. In contrast, the investment decision of the manager is not linked to disutility since it is assumed that he only has to define the total budget for the R&D department. The budget decision is based on the evaluation of the possible projects by the R&D department and the manager's task to select these innovation projects having positive returns. Due to the fact that the terminal value is unobservable, a stock-based compensation scheme for contracting is used:

$$w = f + sP.$$

The compensation comes at the end of the period and takes the form of a linear contract, consisting of a fixed and a variable part where f denotes the fixed salary and $s > 0$ the incentive rate based on the market price P. In our model, the market price is normally distributed, as we will show in the next section. According to the work of Goldman and Slezak (2006), we do not consider any accounting signals for the manager's compensation. They show that accounting signals are short-term oriented and, thus, used for compensation this would strengthen an underinvestment behavior. The level of the incentive rate is common knowledge, exogenously given and, therefore, not part of the principal's optimization problem.

The difference between wage and disutility is weighted by the risk aversion parameter $r > 0$. Given the assumption of linear wages and a normally distributed market price P

[22] For the optimal investment level, see Section 4.

(as shown in the next section), the manager's certainty equivalent can be represented by:

$$CE = E[w-c] - \frac{r}{2}Var(w),$$

whereby the manager's reservation utility equals zero.

3 Equilibrium analysis

To model the market price, we use a standard noisy rational expectation framework. Here, the capital market is information efficient and holds conjectures about the manager's actions in order to estimate the terminal value X. According to IFRS, the total amount of CEO compensation has to be disclosed and, therefore, it is commonly known that the manager's wage depends on the market price.[23] Using all available information, the market price takes the following form:

$$P = E[X \mid y, z, \widehat{e}, \widehat{d}, \widehat{b}].$$

The market price consists of the expectation about the terminal value which is conditional on the reported signals y and z, as well as on the rational conjectures about the unobservable effort $\widehat{e}$, investment decision $\widehat{d}$ and the biasing decision $\widehat{b}$. The terminal value X, and the accounting reports $\xi = \begin{bmatrix} y & z \end{bmatrix}^T$ are jointly normally distributed:

$$\begin{bmatrix} X \\ \xi \end{bmatrix} \sim N\left(\begin{bmatrix} \widehat{e} - \widehat{d} + 2\sqrt{\widehat{d}} \\ E[\xi] \end{bmatrix}, \begin{bmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix} \right).$$

[23] Our model is in contrast to the approach of Fischer and Verrecchia (2000) who assume that the wage is not known to the market and the equilibrium biasing activities of the manager cannot be anticipated exactly.

The market price at the contract termination date is obtained by using standard results for conditional normally distributed first moments:[24]

$$P = E[X(\widehat{e},\widehat{d})] + \Sigma_{12}{\Sigma_{22}}^{-1}(\xi - E[\xi]).$$

The variance of the terminal value is represented by $\Sigma_{11} = \left[\begin{array}{c} \sigma_\varepsilon^2 + \sigma_\theta^2 \end{array} \right]$. The covariances between the terminal value X and the signals ξ are mapped by the vector $\Sigma_{12} = {\Sigma_{21}}^T = \left[\begin{array}{cc} \sigma_\varepsilon^2 + \sigma_\theta^2 & -\sigma_\varepsilon^2 \end{array} \right]$ and the covariance matrix of the signals by:

$$\Sigma_{22} = \left[\begin{array}{cc} \sigma_\varepsilon^2 + \sigma_\theta^2 + \sigma_\tau^2 + \sigma_\eta^2 & -\sigma_\varepsilon^2 - \sigma_\tau^2 \\ -\sigma_\varepsilon^2 - \sigma_\tau^2 & \sigma_\varepsilon^2 + \sigma_\tau^2 \end{array} \right].$$

Inserting the expressions and rewriting the price equation lead to the following form:

$$P = \beta_0 + \beta_1 y + \beta_2 z.$$

As y and z are normally distributed, P is normally distributed, too. The equation illustrates that the market price is determined by three coefficients: The first one, β_0, collects the initial expectations of the market where β_1 and β_2 describe the adjustment due to the signals y and z:

$$\beta_0 = E[X(\widehat{e},\widehat{d})] - \beta_1 E[y(\widehat{e},\widehat{d})] - \beta_2 E[z(\widehat{d},\widehat{b})],$$

$$\beta_1 = \frac{\sigma_\theta^2}{\sigma_\eta^2 + \sigma_\theta^2}, \tag{1}$$

$$\beta_2 = \frac{\sigma_\tau^2\,\sigma_\theta^2 - \sigma_\varepsilon^2\,\sigma_\eta^2}{\left(\sigma_\varepsilon^2 + \sigma_\tau^2\right)\left(\sigma_\eta^2 + \sigma_\theta^2\right)}. \tag{2}$$

Obviously, β_1 is strictly positive because market participants perceive the current accounting income as a positive conjunction to the economic earnings. Thus, an increase of the

[24] For a detailed derivation of the expression, see DeGroot (1970), p. 55, formula (19).

accounting income always leads to a higher market price.

In contrast, the sign of β_2 is ambiguous and depends on the risk which is linked to the R&D investment. If the risk is moderate ($\sigma_\theta^2 > \frac{\sigma_\eta^2 \sigma_\varepsilon^2}{\sigma_\tau^2}$), β_2 is positive and investment increases the investors' assessment.[25] If β_2 is negative, the market price decreases in the R&D investment. This is the case when the innovation investment risk is significantly high ($\sigma_\theta^2 < \frac{\sigma_\eta^2 \sigma_\varepsilon^2}{\sigma_\tau^2}$).

Compared to an accounting regime where the capital market can only observe the accounting income, the disclosure of an additional signal z has two advantages for the investors: First, it contains information about the realized R&D expenses Ψ and, thus, the capital market can infer information about ε. Second, since the accounting income includes z, reported R&D expenditures can be used to provide a more accurate picture of the realization of θ.

Evaluation of the financial reports

In order to analyze earnings management behavior of the manager, we first consider the capital market and its evaluation of the disclosed reports.

As mentioned above, the capital market makes use of the available accounting signals y and z where y stands for short-term profitability and z, the expenses in R&D, reflect the ability to realize future gains and growth. By comparing the effect of these two signals on the market price, we obtain our first result.

Result 1 *In order to influence the market price positively, an increase of the accounting income has a stronger effect than a comparable increase of the R&D expenses:*

$$\beta_1 > \beta_2. \tag{3}$$

Proof. See the Appendix.

[25] Note, that the risk addition is expressed in terms of the variance of the operating business risk $\tilde{\theta}$.Thus a moderate risk describes the case where a combination of innovation risk and accounting noise is lower than the overall risk of the operating business.

As β_1 is strictly positive and always exceeds β_2, we see that the market mainly uses short-term numbers for firm valuation. This important fact comes from the correlation between the two signals and the firm's terminal value: If there is a high correlation between a signal and the unobservable terminal value, the informativeness of the signal about the firm value is also high. The result above shows that for the capital market's assessment the accounting income is more informative about the terminal value than R&D expenses if the innovation risk is moderate. Recall that in the case of high innovation risk β_2 is negative. Therefore, the R&D investments z could have a higher impact on the market price $|\beta_1| < |\beta_2|$. However, condition (3) holds regarding the positive effect of the signals on the market price since the influence of y is still stronger.

The manager's optimal choice of effort and investment

In contrast to Kanodia et al. (2004), we consider a setting where the manager does not act in the best interest of the shareholders. Therefore, he makes all decisions to improve his own utility and the managerial decisions are determined by the underlying incentive contract. The manager chooses his operating effort, investment level and earnings management by maximizing his certainty equivalent which depends on the capital market pricing rule:

$$\max_{b,e,d} E[f + sP - c] - \frac{r}{2} Var(f + sP).$$

Solving the maximization problem brings us to the first lemma.

Lemma 1 *In the presence of a stock-based compensation, managerial levels of effort, investment and earnings management are given by:*

$$\begin{aligned} e^* &= s\beta_1, \\ d^* &= \frac{\beta_1^2\,\alpha^2}{(\beta_1 - \beta_2)^2}, \qquad (4) \\ b^* &= s\beta_2. \qquad (5) \end{aligned}$$

Proof. See the Appendix.

The manager decides simultaneously on effort, investment and biasing activities for maximizing his payment. Since the compensation depends on the market price, he will use all available actions in order to influence the market price in his favor.

In the next sections, we study more detailed the earnings management activities under different investment risk environments.

4 Earnings management and innovation risk

In this section, we consider the manager's earnings management in the case of either moderate or high innovation risk. To increase his compensation, the manager can undertake classification shifting and real earnings management in order to affect the capital market's assessment. Here, we focus mainly on the case of moderate risk where R&D investment is seen as a positive signal. Afterwards, a short analysis about high innovation risk follows.

Classification shifting and moderate innovation risk

In the case of moderate innovation risk, i.e., $\sigma_\theta^2 > \frac{\sigma_\varepsilon^2 \sigma_\eta^2}{\sigma_\tau^2}$, which leads to $\beta_2 > 0$, the classification shifting activity b is given by equation (5). The following result defines whether expenses are classified as operating or investment items.

Result 2 *The manager has an incentive to increase the disclosed signal for R&D expenses by a modified classification of operating expenses:*

$$b^* > 0. \tag{6}$$

Proof. See the Appendix.

This finding is primarily driven by two effects: First, R&D expenses are used to give a tendency about future innovation potential and future growth. This is recognizable in accounting reports where many firms emphasize their investment amount in innovation.[26] Hence, the investors consider investment in R&D separately and interpret these expenses as a positive signal for future income. Since the capital market uses the disclosed financial statements to update its belief about the firm value, managers have incentives to exaggerate these costs. Notice, that this is solely a book-entry act and not a real shift of expenses so that the firm's terminal value is not affected. However, classification shifting leads to personal costs for the manager and, in equilibrium, the firm has to compensate for the disutility. This reduces the firm value net of compensation. Furthermore, in contrast to accrual management, classification shifting does not change the reported accounting income y.

Second, beside the role of the informativeness about the future innovation potential of the R&D expenses, investors use the core operating income as an important measure for the terminal value.[27] In our model, the accounting income y, without the R&D expenses z, can be interpreted as core operating income. The possibility to separately disclose the investment allows the investors to make a more precise assessment about the level of core operating income.[28] The manager can use this to increase the valuation by classification shifting from operative to R&D expenses. The accounting income remains unaffected by the expenses shift but a higher amount of R&D investment implies lower operating expenses and, hence, higher core operating income.[29]

Classification shifting as a manipulation tool has one additional advantage compared to accrual management. The personal costs of the manager being related to classification shifting might be relativity low. Accounting earnings management is limited by exoge-

[26] Many rankings make use of these numbers. For instance, the Fortune Magazine has published a ranking for the most innovative firms based on the R&D expenditures in 2014.

[27] The interpretation of Result 2 is similar to the considerations of McVay (2006). Self-interested managers shift core operating expenses to income-decreasing special items in order to meet the earning targets of investors, since special items are often ignored by them. Thus, the manager can improve the capital market's assessment without a change in the disclosed accounting income.

[28] The accounting income is the sum of several items and is therefore influenced by several noise terms. Due to the separate publication of z, a more accurate calculation of $\Omega + \tilde{\eta} + \alpha\,\Pi$ is possible.

[29] An example of a classification shift is the case of the Borden, Inc. They classify marketing expenses in an amount of USD 194 million as part of the extraordinary special item *reconstruction*. The regular classification would have reduced the core operating income. Another example is IBM which has classified gains on asset sales as a part of the core income. For both examples, see McVay (2006).

nous factors like legal regulatory environment, corporate governance structures and external audits. In the case of classification shifting, McVay (2006) describes the advantage for the management in a lower audit incentive to verify the item classification if the amount of the reported income remains unchanged. Hence, the manager's disutility which results from the manager's time, the reputation costs and the litigation risk, is lower compared to accrual management. In addition, empirical studies find that the managerial use of a misclassification of expenditures in order to affect the investors' assessment increases if the possibility of accrual management is limited.[30]

Real earnings management and moderate innovation risk

In contrast to classification shifting, real earnings management directly changes the true underlying earnings and, thus, affects the firm's terminal value. To evaluate and quantify real earnings management, it is necessary to derive a benchmark investment level for a comparison. Recall that we consider a self-interested manager who chooses the R&D investment level to increase his compensation. To derive the benchmark, we assume that the manager makes all decisions in the interests of the shareholders, and solves the following decision problem:

$$\max_d E[X - c] - \frac{r}{2} Var(w).$$

The manager maximizes the netto surplus of the agency relationship and, thus, the optimal level of R&D expenses is given by:[31]

$$d^{FB} = 1. \tag{7}$$

The risk-neutral shareholders are not interested in the short-term market price development. Therefore, this first-best investment level is not affected by exogenous influences (e.g., the risk environment).

[30] See the empirical study of Fan et al. (2010). They examine classification shifting in the fourth quarter financial reports.

[31] Note that the participation constraint of the manager is already substituted into the optimization problem.

In the case of unobservable actions, the optimal investment level is defined by (4). Even if the investment decision is independent of the absolute level of the incentive rate, it depends on the capital market's reactions via β_1 and β_2.[32]

To analyze the extent of real earnings management, we compare the benchmark level with the equilibrium investment level of the manager by taking the difference:

$$\Delta = d^{FB} - d^{*}. \tag{8}$$

An underinvestment (overinvestment) occurs if Δ is positive (negative). The following result shows how the duration determines the real earnings management behavior.

Result 3 *Real earnings management of the manager leads to:*

1. *underinvestment in innovation (*$\Delta > 0$*) if* $\alpha < \alpha^c$,
2. *overinvestment in innovation (*$\Delta < 0$*) if* $\alpha > \alpha^c$,

where $\alpha^c = \dfrac{\sigma_\varepsilon^2(\sigma_\eta^2 + \sigma_\theta^2)}{\sigma_\theta^2(\sigma_\varepsilon^2 + \sigma_\tau^2)}$.

Proof. See the Appendix.

Result 3 shows that real earnings management critically depends on $\alpha \in (0,1)$. This parameter, describing the portion of the returns of the R&D investment affecting the current accounting income, can also be interpreted as development time: a high level indicates a quick development time. The degree of α is primarily driven by the business model and the industry in which the firm operates. For instance, it may take several years for pharmaceutical companies to offer medical solutions (low α) whereas food producers often have products with short life cycles. Here, the innovativeness shows up in product improvements which do not require a long research phase and are quickly launched onto

[32] Recall that investment does not lead to disutility. Since the incentive rate is positive, the manager is always better off to improve the capital market's assessment.

the market (high α). Only in case where α equals α^c, the manager chooses the first-best investment level. A significantly low α leads to an investment below the first-best level.

An interesting implication is that there is an opposite scenario under which a stock-based compensation leads to an overinvestment. If α is relatively high ($\alpha > \alpha^c$), the management invests in projects even if their net present value is negative. The immediate realization of project outcomes incentivizes the manager to undertake too many projects. As mentioned above, this can be seen in industries where mainly product improvements are launched. Figure 2 illustrates the influence of α on real earnings management.

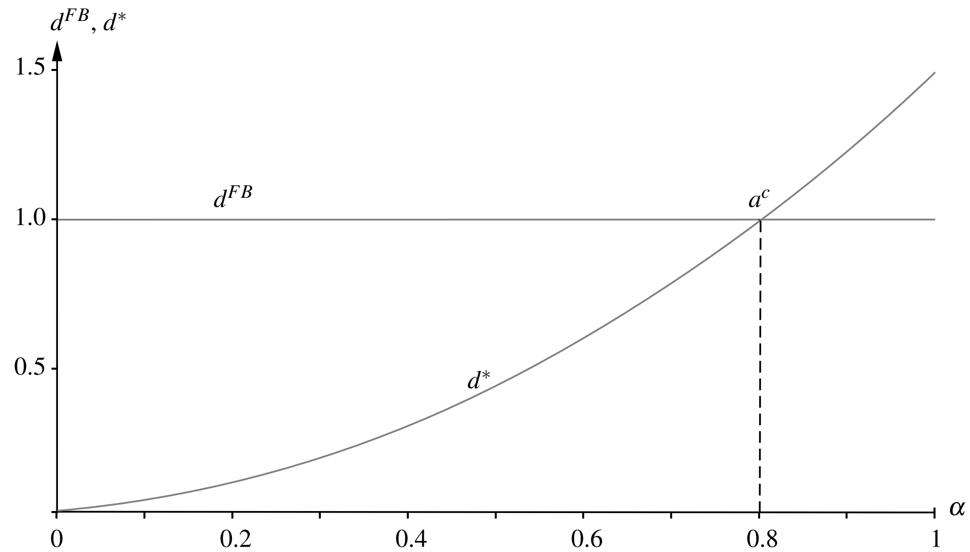

Figure 1: Comparison of first- and second-best investment levels (parameters: $\sigma_\theta^2 = 1$, $\sigma_\varepsilon^2 = 0.8$, $\sigma_\eta^2 = 0.2$, $\sigma_\tau^2 = 0.4$)

Comparative statics show explicitly which market components influence the investment decision in which manner. The next result summarizes the real manipulation behavior when returns of innovation investment can only be generated in the long run ($\alpha < \alpha^c$) and, thus, the manager always underinvests (Δ is strictly positive).

Result 4 *Assume a significantly low α. The level of underinvestment:*

(i) *decreases in a closer income realization:* $\dfrac{\partial \Delta}{\partial \alpha} < 0$,

(ii) *increases in the innovation uncertainty:* $\dfrac{\partial \Delta}{\partial \sigma_\varepsilon^2} > 0$,

(iii) *decreases in the operating uncertainty:* $\dfrac{\partial \Delta}{\partial \sigma_\theta^2} < 0$.

Proof. See the Appendix.

The first comparative statics result demonstrates how the effect of the return on innovation investment on the current income influences the level of R&D expenses. Projects that lead to an early realization of profits, increase the manager's willingness to invest. In the case of research projects which take many years to reach the launch stage, the investment is far below the benchmark level. In fact, this result gives a simple and intuitive explanation for the phenomenon that drastic innovations are rarely undertaken by firms.

The intuitive explanation for part (ii) of Result 4 is as follows: higher uncertainty concerning the productivity of the investment leads to a lower investment level. As we have discussed earlier, R&D expenses do not always generate innovation and can therefore be unproductive. The higher the risk σ_ε^2, the lower the positive influence of signal z on the capital market's assessment. Consequently, the importance of the R&D expenses for the capital market decreases and higher real activity manipulation occurs.

An interesting finding is that the investment approaches the first-best level in a higher operating risk. Under the assumption of $\sigma_\theta^2 > \frac{\sigma_\varepsilon^2 \sigma_\eta^2}{\sigma_\tau^2}$, the capital market is strongly interested in the realized level of operating income because it explains more of the terminal value. Thus, if the uncertainty in the operating environment increases, the accounting income is more informative about the economic earnings of the firm X which leads to an increase in β_1. Since d^* is driven by β_1, higher operating uncertainty leads to an increase in long-term investment.[33] As a consequence, real activity manipulations are reduced which is illustrated by part (iii) of Result 4.

[33] A similar relationship is documented by Atanassov et al. (2018). In an empirical study they find that R&D investment increases in higher political uncertainty.

Bringing both earnings management practices together, we show that classification shifting reinforces the disclosed expenditures in R&D, whereas real earnings management leads to a real under- or overinvestment behavior. Therefore, we have two effects which distort the results independently of one another. Moreover, it is obvious that the disclosed R&D expenditures must be handled with care: they do not reflect the entire growth potential of a firm since they contain a portion of distortion.

The effects of high innovation risk on earnings management

In this section, we consider the case where the firm operates in an industry with a high uncertainty of the R&D investment's productivity. Since $\sigma_\theta^2 < \frac{\sigma_\varepsilon^2 \sigma_\eta^2}{\sigma_\tau^2}$ is fulfilled, an increase in reported R&D expenditures leads to a lower valuation by the capital market, $\beta_2 < 0$. This influences the earnings management behavior which is summarized in the following result:

Result 5 *There is always an underinvestment in innovation, and incentives to reduce disclosed R&D expenses by a modified classification of operating expenses occur.*

Proof. See the Appendix.

Intuitively, if the capital market negatively weights the signal z, the manager attempts to reduce the disclosed R&D expenditures by the misclassification as operating expenses and by a lower real investment level. Due to the direct effect of real earnings management on the sent signal z, the manager would keep the investment level as low as possible. However, since the investment might lead to an immediate return in the current period ($\alpha \in (0,1)$), the R&D expenditures are still higher than zero in order to improve signal y. Nevertheless, the investment level is clearly lower compared to the benchmark investment as well as to the investment in a moderate innovation risk environment, $\sigma_\theta^2 > \frac{\sigma_\varepsilon^2 \sigma_\eta^2}{\sigma_\tau^2}$.

Result 5 illustrates that if the risk regarding innovation projects is sufficiently high, the shareholders of the firm cannot provide the right incentives to obtain neither the benchmark nor the investment level of the moderate risk environment. Consequently, in a high innovative industry, a stock-based compensation leads to competitive disadvantages since little future investments are made. Nevertheless, it is worth mentioning that firms in the growth phase (start-ups), where the innovation risk is high, are mainly of a small size where it is doubtful if incentives via a stock-based compensation are needed because managers are often the owners themselves.

5 Earnings management and the precision of the accounting system

We now examine how a higher precision of both reported signals affects the relation between real earnings management and classification shifting. Our analysis is focused on the behavior of listed companies which generate investment returns in the long run (e.g., pharmaceutical companies). Therefore, we consider the case of a moderate innovation uncertainty $\left(\sigma_\theta^2 > \frac{\sigma_\varepsilon^2 \sigma_\eta^2}{\sigma_\tau^2}\right)$ and long-term returns of R&D investment ($\alpha < \alpha^c$). As we know from the previous section under these conditions incentives for an underinvestment in innovation and a too high classification of R&D expenses are provided by a stock-based compensation. Note that both sources of manipulation incentives are determined by the capital market's reaction on the accounting signals. By changing the precision of the accounting system, the capital market's valuation of the firm is affected and, hence, the earnings management behaviour.

We assume that the informativeness of y and z regarding X can be refined by $k \geq 1$. This reduces the variances of $\tilde{\tau}$ and $\tilde{\eta}$, such that $Var(\tilde{\tau}) = \frac{\sigma_\tau^2}{k}$ and $Var(\tilde{\eta}) = \frac{\sigma_\eta^2}{k}$.[34] The parameter k is ad hoc exogenously given and observable to all parties. It can be thought of as a stronger corporate governance, e.g., tighter external controls or internal specifications by the owners for a more accurate publication. In which manner k affects the market's assessment is stated in the next lemma:

[34] In the literature, the precision is usually defined by the inverse of the variance of a signal (e.g., see Fishman and Hagerty, 1989; Christensen et al., 2013; Ewert and Wagenhofer, 2016). For a closer overview to referenced attributes of accounting precision, see Downen (2014).

Lemma 2 *Considering the precision of the accounting system, the regression parameters are given by:*

$$\beta_1 = \frac{k\sigma_\theta^2}{\sigma_\eta^2 + k\sigma_\theta^2}, \tag{9}$$

$$\beta_2 = \frac{k\left(\sigma_\tau^2\sigma_\theta^2 - \sigma_\varepsilon^2\sigma_\eta^2\right)}{\left(k\sigma_\varepsilon^2 + \sigma_\tau^2\right)\left(\sigma_\eta^2 + k\sigma_\theta^2\right)}. \tag{10}$$

Proof. See the Appendix.

Obviously, β_1 is strictly increasing in the precision of the accounting system $\left(\frac{\partial\beta_1}{\partial k} > 0\right)$ such that the reported accounting income y has a higher impact on the market price. In contrast, the influence on β_2 is not immediately apparent.

Recall that the disclosure of signal z has two advantages for the investors. First, the capital market can infer the information about ε (innovation risk) and, second, can implicitly use it to provide a more accurate picture of θ (operating risk) by the elimination of z from the accounting income. Here, the second effect is more important for the interplay of precision and valuation. The market can observe two signals which are correlated to each other and this correlation leads to a deviant impact of z on the capital market's assessment: a higher precision of the accounting system reduces β_2 $\left(\frac{\partial\beta_2}{\partial k} < 0\right)$. A higher level of k increases the informativeness of y about the operating income Ω and, thus, z is less important to give an accurate picture of Ω.

Since the manager is compensated proportional on the market price, the change in the market valuation also affects the managerial earnings management which is stated in the following result.

Result 6 *An increase in the precision of the accounting system k leads to:*

(i) *less classification shifting,*

(ii) *more underinvestment.*

Proof. See the Appendix

The first part of Result 6 describes the influence of the extent of accounting system precision on classification shifting. The optimal bias b^* critically depends on β_2, which is shown by equation (5). If the signals are more precise, z is less important for the investor's valuation and misclassification is less attractive for the manager ($\frac{\partial b^*}{\partial k} < 0$). Therefore, more precision mitigates the misclassification of expenses.

To understand part (ii) of the result, we need to consider the investment level in the second-best case which is shown in equation (4). Here, the investment is affected by a change in the precision of the accounting system in two ways. First, an increase of k leads to a higher β_1 which has a positive impact on the investment level. Second, a higher k extends the spread $(\beta_1 - \beta_2)$ which lowers d^*.[35] Since the second effect exceeds the first one, a lower investment results if the accounting system is more precise. Note that in the here considered risk environment scenario in equilibrium underinvestment occurs. Consequently, the manager engages in more real earnings management ($\frac{\partial \Delta}{\partial k} < 0$).[36]

The relationship between both kinds of earnings management can be described by a substitution effect which is described in the next result:

Result 7 *There is a substitution effect of real earnings management and classification shifting due to the change of precision in the accounting system.*

Under the condition of more precise accounting signals, on the one hand, there are less incentives to misclassify operating expenses. On the other hand, higher underinvestment incentives arise. Note, there is no direct effect between these two managerial manipulation activities from the beginning of the game. Therefore, an endogenous substitution effect arises due to the market's assessment.[37]

[35] See the Appendix (proof of Lemma 2).

[36] Recall that if returns of innovation investment can only be generated in the long run ($\alpha < \alpha^c$) and the innovation risk is moderate, the manager always underinvests (Δ is strictly positive).

[37] A similar effect is observed by Ewert and Wagenhofer (2005). They find, regarding tighter accounting standards, a substitution of accrual management by real earnings management.

Empirical studies state that the use of classification shifting is more likely if real earnings management is constrained.[38] Our model demonstrates that a change in the relation of the use of these both manipulation tools can also result from the informativeness of the disclosed accounting information and, thus, an adjusted market reaction. Consequently, standard setters can increase the informativeness of accounting information by a higher precision which also lowers the biasing of the reports by managerial misclassification of expenses. However, there arise additional "costs" from implicit real activity incentives: as a side effect, lower long-term investment should occur by this adjustment. In fact, a higher precision of the accounting system does not necessarily have to be beneficial to the firm's shareholders.[39] From an innovation incentives perspective, a more precise accounting system has a negative impact on the realization of innovative projects.

6 Conclusion

In order to assess the innovative strength of a firm, R&D expenses as a source of information cannot be ignored from an investor's perspective. We study how financial information affect the capital market's assessment and the resulting earnings management incentives which in turn determines the innovation activity. We consider a single-period model where a manager publishes two accounting signals, accounting income and R&D expenses, which he can manipulate to increase the market price and his stock-based compensation.

The signals are in conflict to each other, as higher investment in innovation reduces the current accounting income. Comparing both signals with regard to their impact on the valuation, we find that accounting income has a stronger positive effect on the market

[38] Abernathy et al. (2014) find that if real manipulation is limited by difficult financial conditions and high levels of institutional ownership, managers are more likely to misclassify expenses. More general, Zang (2011) shows the substitution effect between these two manipulation tools in an empirical study. She finds that the adjustment of the level of accrual management according to the level of real activities manipulation depends on the their relative costs.

[39] This counter-intuitive finding is similar to Kanodia et al. (2005) who consider the investment choice under private information where the size of the investment return is not observable to the capital market. They show that a less precise accounting system can be value enhancing.

price. Due to this, incentives to undertake real earnings management occur: depending on the risk being connected with the innovation project as well as on the time the innovation needs to generate returns, there is only one case in which the manager undertakes an over-investment strategy. Only if the innovation risk is not too high and returns are realized immediately, the manager invests more than optimal in these projects. In all other cases, he is incentivized to cut expenditures. Thus, we show that incremental innovations are favored in comparison to drastic ones which need more time.

Beside these real earnings management considerations, there are also incentives to misclassify expenses. Managers can enhance the market price by a classification shift from operating to R&D expenses. This only affects the disclosed amount of R&D expenditures and has neither an effect on the accounting income nor on the firm's terminal value. The market puts a positive weight on the R&D signal and, thus, the manager classifies operating expenses as coming from innovation activities. In the extreme case of significantly high innovation risk, the market values R&D expenditures negatively. This induces the manager to lower disclosed R&D expenses.

We also examine the effect of a higher precision of the accounting system on earnings management in an industry where investment returns are realized in the long-run. More precise accounting signals lead to a lower level of misclassification of expenses and, in contrast, to higher real activity manipulation. Therefore, a higher precision of the accounting system leads to a lower bias in the reported signals and to a lower investment in innovation may occur.

Appendix

Variances and covariances

$$\begin{aligned}
Var(X) &= \sigma_\varepsilon^2 + \sigma_\theta^2, \\
Var(y) &= \sigma_\varepsilon^2 + \sigma_\theta^2 + \sigma_\tau^2 + \sigma_\eta^2, \\
Var(z) &= \sigma_\varepsilon^2 + \sigma_\tau^2, \\
Cov(X,y) &= \sigma_\varepsilon^2 + \sigma_\theta^2, \\
Cov(X,z) &= -\sigma_\varepsilon^2, \\
Cov(y,z) &= -\sigma_\varepsilon^2 - \sigma_\tau^2.
\end{aligned}$$

$$\begin{aligned}
&\Sigma_{11} = Var(X), \\
&\Sigma_{12} = \Sigma_{21}{}^T \begin{bmatrix} Cov(X,y) & Cov(X,z) \end{bmatrix}, \\
&\Sigma_{22} = \begin{bmatrix} Var(y) & Cov(y,z) \\ Cov(z,y) & Var(z) \end{bmatrix}.
\end{aligned}$$

Proof of Lemma 1

The managerial expected utility is given by:

$$CE = \left(\left(e - d + 2\,\alpha\,\sqrt{d}\right)\beta_1 + (d+b)\,\beta_2 + \beta_0\right) s + f - \frac{1}{2}e^2 - \frac{1}{2}b^2 - \frac{r}{2}s^2 Var\,(P)\,,$$

where $\beta_0 = (\widehat{e} - \widehat{d} + 2\sqrt{\widehat{d}}) - \beta_1(\widehat{e} - \widehat{d} + 2\alpha\sqrt{\widehat{d}}) - \beta_2(\widehat{d} + \widehat{b})$. Differentiating managerial expected utility with respect to e, d and b and solving the first-order conditions for these variables yield:

$$\frac{\partial CE}{\partial e} = 0 \Longleftrightarrow e^* = s\beta_1,$$
$$\frac{\partial CE}{\partial d} = 0 \Longleftrightarrow d^* = \frac{\beta_1^2\,\alpha^2}{(\beta_1-\beta_2)^2},$$
$$\frac{\partial CE}{\partial b} = 0 \Longleftrightarrow b^* = s\beta_2.$$

Proof of Result 1

Comparing the difference between the regression coefficients β_1 and β_2, and simplifying yield:

$$\beta_1 - \beta_2 = \frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2 + \sigma_\tau^2} > 0.$$

It therefore follows that the difference is strictly positive.

Proof of Result 2

Since $s > 0$ and $\beta_2 > 0$, the sign of the optimal bias, which is given by equation (5), is strictly positive.

Proof of Result 3

To obtain the difference between the first-best and the second-best investment level, we consider the difference between (7) and (4):

$$\Delta = 1 - \frac{\beta_1^2\,\alpha^2}{(\beta_1-\beta_2)^2}.$$

Substituting (1) and (2) in the expression above and setting to zero, we obtain two solutions for α:

$$\alpha^C = \left[\frac{\sigma_\varepsilon^2\,\left(\sigma_\eta^2+\sigma_\theta^2\right)}{\sigma_\theta^2\,\left(\sigma_\varepsilon^2+\sigma_\tau^2\right)}, -\frac{\sigma_\varepsilon^2\,\left(\sigma_\eta^2+\sigma_\theta^2\right)}{\sigma_\theta^2\,\left(\sigma_\varepsilon^2+\sigma_\tau^2\right)}\right].$$

Variances have to be positive and additionally, $\alpha \in (0,1)$. Therefore, the second solution for α^C can be neglected. It follows that for $\alpha = \alpha^C$, Δ equals zero and, thus, the R&D expenses level corresponds to the benchmark investment level of the first-best solution. Since we assume $\sigma_\theta^2 > \frac{\sigma_\varepsilon^2 \sigma_\eta^2}{\sigma_\tau^2}$, the expression $\frac{\sigma_\varepsilon^2 \left(\sigma_\eta^2 + \sigma_\theta^2\right)}{\sigma_\theta^2 \left(\sigma_\varepsilon^2 + \sigma_\tau^2\right)}$ is less than one. Hence, if α is lower (higher) than α^C, the $sgn(\Delta)$ is positive (negative) and the investment is lower (higher) than the benchmark level. This completes the proof.

Proof of Result 4

(i) Differentiating (8) with respect to α and simplifying yield:

$$\frac{\partial \Delta}{\partial \alpha} = -\frac{2\,\sigma_\theta^4 \alpha \left(\sigma_\varepsilon^2 + \sigma_\tau^2\right)^2}{\left(\sigma_\eta^2 + \sigma_\theta^2\right)^2 \sigma_\varepsilon^4} < 0.$$

Because $\alpha \in (0,1)$, the expression above is strictly negative.

(ii) Differentiating (8) with respect to σ_ε^2 and simplifying yield:

$$\frac{\partial \Delta}{\partial \sigma_\varepsilon^2} = \frac{2\,\sigma_\theta^4 \alpha^2 \left(\sigma_\varepsilon^2 + \sigma_\tau^2\right) \sigma_\tau^2}{\left(\sigma_\eta^2 + \sigma_\theta^2\right)^2 \sigma_\varepsilon^6} > 0.$$

This provides that the investment level increases in σ_ε^2.

(iii) Differentiating (8) with respect to σ_θ^2 and simplifying yield:

$$\frac{\partial \Delta}{\partial \sigma_\theta^2} = -\frac{2\,\sigma_\theta^2\, \alpha^2 \left(\sigma_\varepsilon^2 + \sigma_\tau^2\right)^2 \sigma_\eta^2}{\left(\sigma_\eta^2 + \sigma_\theta^2\right)^3 \sigma_\varepsilon^4} < 0.$$

This provides that the investment level decreases in σ_θ^2.

Proof of Result 5

To obtain the difference between the first-best and the second-best investment level, we consider the difference between (7) and (4), and simplify:

$$\Delta = \frac{\left(1-\alpha^2\right)\beta_1{}^2 - 2\beta_1\beta_2 + \beta_2{}^2}{(\beta_1-\beta_2)^2}.$$

We assume in this setting $\sigma_\theta^2 < \frac{\sigma_\varepsilon^2\sigma_\eta^2}{\sigma_\tau^2}$ which leads to $\beta_2 < 0$. Hence, $\Delta > 0$ and it always occurs an underinvestment.

Proof of Lemma 2

In section 5, we expand our analysis by the precision of y and z. This affects the variance of these signals and the covariance between the signals which are now given by:

$$\begin{aligned} Var(z) &= \sigma_\varepsilon^2 + \frac{\sigma_\tau^2}{k}, \\ Var(y) &= \sigma_\varepsilon^2 + \sigma_\theta^2 + \frac{\sigma_\tau^2 + \sigma_\eta^2}{k}, \\ Cov(y,z) &= -\sigma_\varepsilon^2 - \frac{\sigma_\tau^2}{k}. \end{aligned}$$

Consequently, the regression parameters (β_1, β_2) have to be adjusted in accordance to the modified signals. From the derivation of the regression parameters, which is described in section 3.1, we obtain $(\beta_1, \beta_2) = \Sigma_{12}\Sigma_{22}{}^{-1} = \begin{bmatrix} \frac{k\sigma_\theta^2}{\sigma_\eta^2 + k\sigma_\theta^2} & \frac{k(\sigma_\tau^2\sigma_\theta^2 - \sigma_\varepsilon^2\sigma_\eta^2)}{\left(k\sigma_\varepsilon^2+\sigma_\tau^2\right)\left(\sigma_\eta^2+k\sigma_\theta^2\right)} \end{bmatrix}.$

Differentiating (9) and (10) with respect to k and simplifying yield:

$$\begin{aligned} \frac{\partial\beta_1}{\partial k} &= \frac{\sigma_\eta^2\sigma_\theta^2}{(\sigma_\eta^2 + k\sigma_\theta^2)^2} > 0, \\ \frac{\partial\beta_2}{\partial k} &= \frac{\left(-\sigma_\tau^2\sigma_\theta^2 + \sigma_\varepsilon^2\sigma_\eta^2\right)\left(k^2\sigma_\varepsilon^2\sigma_\theta^2 - \sigma_\tau^2\sigma_\eta^2\right)}{\left(k\sigma_\varepsilon^2 + \sigma_\tau^2\right)^2\left(\sigma_\eta^2 + k\sigma_\theta^2\right)^2} < 0. \end{aligned} \tag{A.1}$$

Therefore, β_1 increases in k and, since we assume $k \geq 1$ and $\sigma_\theta^2 > \frac{\sigma_\varepsilon^2 \sigma_\eta^2}{\sigma_\tau^2}$, β_2 declines in k.

We now consider the effect of k on the difference between the regression parameters. Differentiating $(\beta_1 - \beta_2)$ with respect to k leads to:

$$\frac{\partial\left(\beta_1 - \beta_2\right))}{\partial k} = \frac{\sigma_\varepsilon^2 \sigma_\tau^2}{(k\,\sigma_\varepsilon^2 + \sigma_\tau^2)^2} > 0.$$

The difference between the regression parameters increases in k.

Proof of Result 6

We now consider the effect of k on earnings management. First, we examine the influence of k on classification shifting. Inserting (10) in (5), differentiating with respect to k and simplifying yield:

$$\frac{\partial b^*(k)}{\partial k} = \frac{s\left(-\sigma_\tau^2\,\sigma_\theta^2 + \sigma_\varepsilon^2\,\sigma_\eta^2\right)\left(k^2\,\sigma_\varepsilon^2\,\sigma_\theta^2 - \sigma_\tau^2\,\sigma_\eta^2\right)}{\left(k\,\sigma_\varepsilon^2 + \sigma_\tau^2\right)^2\left(\sigma_\eta^2 + k\,\sigma_\theta^2\right)^2} < 0.$$

Note that $\frac{\partial b^*(k)}{\partial k} = s\,\frac{\partial \beta_2}{\partial k}$ with $s > 0$. We know from (A.1) that the amount of misclassified expenses decrease in the accounting precision.

Second, we consider the effect of k on real earnings management. As in the proof of Result 3, to investigate the difference between the first-best and the second-best investment level. Inserting (1) and (2) in (4) and simplifying yield:

$$\Delta(k) = -\,\frac{\left(\sigma_\varepsilon^2\left(k\,\sigma_\theta^2\,(\alpha-1) - \sigma_\eta^2\right) + \alpha\,\sigma_\tau^2\,\sigma_\theta^2\right)\left(\sigma_\varepsilon^2\left(k\,\sigma_\theta^2\,(\alpha+1) + \sigma_\eta^2\right) + \alpha\,\sigma_\tau^2\,\sigma_\theta^2\right)}{\left(k\,\sigma_\theta^2 + \sigma_\eta^2\right)^2\sigma_\varepsilon^4}.$$

Setting the expression above to zero, we obtain two solutions for α:

$$\alpha^K = \left[\frac{\sigma_\varepsilon^2\,\left(\sigma_\eta^2 + k\,\sigma_\theta^2\right)}{\sigma_\theta^2\,\left(k\,\sigma_\varepsilon^2 + \sigma_\tau^2\right)}, -\frac{\sigma_\varepsilon^2\,\left(\sigma_\eta^2 + k\,\sigma_\theta^2\right)}{\sigma_\theta^2\,\left(k\,\sigma_\varepsilon^2 + \sigma_\tau^2\right)}\right].$$

Variances have to be positive and additionally, $\alpha \in (0,1)$. Therefore, the second solution for α^K can be neglected. In this setting, it is assumed that $\alpha < \alpha^C$. Since $k \geq 1$, α^K always exceeds α^C. Therefore, in this setting, $\alpha < \alpha^C < \alpha^K$ and an underinvestment always occurs, $\Delta > 0$. To identify whether the additional precision k weakens or strengthens the underinvestment, we insert (9) and (10) in (4) and (8), differentiate both with respect to k, and simplifying yield:

$$\frac{\partial d^*(k)}{\partial k} = \frac{2\,\sigma_\theta^4\,\alpha^2\left(k\,\sigma_\varepsilon^2+\sigma_\tau^2\right)\left(-\sigma_\tau^2\,\sigma_\theta^2+\sigma_\varepsilon^2\,\sigma_\eta^2\right)}{\left(\sigma_\eta^2+k\,\sigma_\theta^2\right)^3\,\sigma_\varepsilon^4} < 0,$$
$$\frac{\partial \Delta(k)}{\partial k} = -\frac{2\,\sigma_\theta^4\,\alpha^2\left(k\,\sigma_\varepsilon^2+\sigma_\tau^2\right)\left(-\sigma_\tau^2\,\sigma_\theta^2+\sigma_\varepsilon^2\,\sigma_\eta^2\right)}{\left(\sigma_\eta^2+k\,\sigma_\theta^2\right)^3\,\sigma_\varepsilon^4} > 0.$$

Since, in this seeting, we assume $\sigma_\theta^2 > \frac{\sigma_\varepsilon^2\sigma_\eta^2}{\sigma_\tau^2}$, d^* strictly decreases in k. The optimal Δ is always negative ($\alpha < \alpha^C$) and, therefore, the amount of real earnings management increases in k, $\left(\frac{\partial\Delta(k)}{\partial k} > 0\right)$.

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Essay III

Title

Earnings management during family firm succession:

An analytical perspective on the influence of socioemotional wealth

Co-authors

Tim Hensel and Max Neubert

Earnings management during family firm succession: An analytical perspective on the influence of socioemotional wealth

ABSTRACT

In order to provide an analytical explanation for earnings management in family firms prior to a succession, we study a two-period agency setting in which a founder can invest in the future capital stock and may engage in earnings management. We examine two succession scenarios which differ in terms of who lead the firm in the second period. To capture dynastic and altruistic motives of the founder, we incorporate the behavioral concept of socioemotional wealth (SEW). Our model shows that SEW creates manipulation incentives. We find that the founder engages in both accrual-based and real earnings management in order to reduce inheritance tax payments for the offspring. We show how the successor's productivity, inheritance taxation, and internal monitoring influence the founder's choice between a family-member and an external manager as the future CEO.

1 Introduction

There is considerable evidence that family firms make up a significant proportion of the total number of companies, the employed workforce, and the total value added (e.g., GDP). For example, La Porta et al. (1999) build a global sample out of 27 of the richest countries (in terms of market capitalization) and find that 50 percent of the firms within the sample are family-controlled. Similarly, in Western Europe about 44 percent of all firms are family-owned (Faccio and Lang, 2002) and in the US S&P 500 founding families are present in one-third of all firms, controlling over 18 percent of the shares on average (Anderson and Reeb, 2003). Given these proportions and the corresponding economic influence, it is worth to examine if decision making in family organizations differs in comparison to publicly held firms. One particularly interesting field for analyses are turnover procedures. As these processes are often accompanied by policy revisions and restructurings, it is one of the greatest challenges for corporations to manage changes in ownership and control. This is especially true for family firms, where the implementation of such a process is also associated with additional family-related motivations. For this reason the inter-generational turnover in family-owned companies is one of the most often addressed issues in family business research. Several studies provide insights on how a family firm's inter-generational turnover is influenced by, e.g., inheritance taxation (Tsoutsoura, 2015), abilities of family members (Lee et al., 2003), or non-financial goals (Minichilli et al., 2014). The effects of these family-related aspects is widespread: examples are succession-related performance differences (Cucculelli and Micucci, 2008) or investment decisions and R&D activities (e.g., Block, 2012; Chrisman and Patel, 2012).[1] Following Gómez-Mejía et al. (2007), these family-related and non-monetary motivations can be aggregated to the concept *socioemotional wealth* (SEW). This concept argues that family members evaluate economic aspects with regard to their influence on the own socioemotional endowment, i.e., additional utility might come from belonging to the firm, from continuing a dynasty, or from altruistic behaviors within the family.[2]

[1] More detailed views on the idiosyncrasy of family firms can be found in Handler (1994).
[2] See (Kepner, 1983), (Kets de Vries, 1993) and (Schulze et al., 2003) for examples and (see, e.g., Westhead et al., 2001; Habbershon and Pistrui, 2002) for other factors influencing SEW.

Another argument for addressing succession in family firms is, that managerial turnover and the transition of ownership pose a high risk of misconduct. During a succession period opportunities to alter the own utility are expanded for the person in charge. Common practices are the manipulation of reports or diverging preceding/subsequent investment decisions, which can be summarized under the term *earnings management*. The field of earnings management is extensively analyzed in the accounting literature, but earnings management during a turnover in family firms has been less examined.[3] For example, there is no analytical research on earnings management in family firms, as far as we are aware. Moreover, empirical work studying manipulation activities concentrate either on whether reporting practices of family firms are of lower or higher quality compared to non-family firms (Jaggi et al., 2009), or on the question whether founding families use their power at the expense of minority interests (Yang, 2010). There are only few empirical studies analyzing how earnings management behavior is affected by SEW (e.g., Stockmans et al., 2010) and there is apparently no literature addressing earnings management in family firms with respect to successions. Finally, the majority of the empirical literature on earnings management in family firms focuses predominately on accrual-based earnings management,[4] which is mainly driven by short-term considerations.[5] However, given the dynastic thoughts of long-term sustainability in family firms,[6] it appears reasonable to examine long-term investment decisions of family companies and to investigate if there are practices affecting the firm value, that deviate from the economically optimal level, namely real earnings management activities.

[3] Reviews to the state of research concerning earnings management in family firms can be found in Gómez-Mejía et al. (2014), Paiva et al. (2016), and Carrera (2017).

[4] *Accrual-based earnings management* describes practices, where reporting methods are chosen in a way that they do not adequately reflect the firm's underlying economics. These activities have no direct cash flow consequences, instead they only change how transactions are recorded. *Real earnings management* in turn describes practices, which actually influence the firm's value, i.e., it changes the timing or structuring of real transactions (see Ewert and Wagenhofer, 2012).

[5] To our knowledge, Achleitner et al. (2014), Razzaque et al. (2016), Tian et al. (2018), and Avabruth and Saravanan (2018) are the only exceptions differentiating between real and accrual-based earnings management.

[6] There is a consensus view that family firms attempt to ensure inter-generational sustainability, see Berrone et al. (2012).

Thus, the objective of this paper is to examine patterns of earnings management in family firms during the transition of ownership and control. By considering two different succession scenarios, we aim at providing theoretical evidence on how family-related socioemotional wealth, inheritance taxation and internal monitoring influence manipulation activities. The main questions to be answered by this paper are the following:

1. How do incentives for earnings management, right before a succession takes place, change in two different succession scenarios, namely family-internal succession and recruitment of an external manager?
2. How is earnings management affected by SEW?
3. How is the decision whether to hire an external manager to run the firm related to SEW, inheritance taxation, and the productivity of potential successors?

We develop a two-period agency model to compare two succession scenarios.[7] The setting considers an owner-lead family firm where a SEW-sensitive principal/predecessor interacts with different agents/successors.[8] For reasons of simplicity, we assume that all players are risk neutral and that they provide effort in the periods where they are in charge (the principal in the first period, the respective agent/successor in the second period). Additionally, it is the senior's task in the first period to make a decision about the succession scenario, i.e., she has to choose whether the junior or an external manager should run the firm. In terms of real earnings management, our focus is set on activities before the succession takes place. Thus, only the senior can invest in the capital stock which determines the long-term value of the firm. Accrual-based earnings management shifts earnings between periods and can be undertaken by all players.

We find that earnings management incentives are induced by SEW and inheritance taxation. In the internal succession scenario where the junior obtains the senior's firm shares and assumes the management of the company, our analysis shows that the senior reduces

[7] Insights on bequest games with an infinite horizon and inter-generational altruism can be found in, e.g., Leininger (1986), Bernheim and Ray (1987), Balbus et al. (2015).

[8] We denote the predecessor (she) "senior". The successor (he) is either the "junior" or an "external manager".

the first-period accounting income by means of an earnings shift. This accrual manipulation is driven by the utility the senior gains from SEW. Since the junior has to pay inheritance taxes based on the first-period accounting income, it becomes important for the senior to lower the taxation basis in favor of the junior. Because it is costly and has no further benefit, the junior does not engage in accrual-based earnings management in period two. Regarding real earnings management, we find that, dependent on tax rate and SEW, the senior's activities either exceed (overinvestment) or are below the economically optimal level (underinvestment). Our results also show that the senior's investment in the firm increases whenever the junior possesses a high productivity and decreases if the junior is less productive. In the external scenario, the senior decides to hire an external manager to run the operational business after the company is inherited to the junior. While the junior aims to improve the economic earnings, the external manager chooses actions in order to increase his compensation, which leads to agency costs. Similar to the internal succession scenario, we find that accrual manipulation shifts earnings from the first into the second period. In terms of real earnings management, the senior's activities depend on inheritance taxation and SEW but also on the monitoring costs of the external manager. Compared to an internal succession, an overinvestment by the senior is less likely.

With our paper we contribute to the analytical earnings management literature. As indicated earlier, this literature is quite extensive and provides various evidence on causes and effects.[9] However, most of these studies investigate either accrual manipulation or real earnings management.[10] We, in turn, consider both types of activities and are thus able to formulate a suggestion on how the two types might be related. Moreover, a large part of the accounting literature considers contractual/agency settings where opportunistic earnings management arises due to managerial hidden action (moral hazard). This kind of motivation is also partly considered in our model. However, our main focus is set on earnings management incentives driven by socioemotional concerns. Therefore, we add a behavioral explanation to the question of how family firms might engage in earnings

[9] Common examples for earnings management relate to, e.g., incentive contract design (Dutta and Fan, 2014), capital market reactions (Fischer and Verrecchia, 2000), or career concerns (Nieken and Sliwka, 2015).
[10] A notable exception is Ewert and Wagenhofer (2005).

management during changes of ownership and control.

The rest of the paper is structured as follows: Section 2 introduces the analytical model, Section 3 analyzes two scenarios of succession, Section 4 compares the internal succession with the external scenario, and Section 5 concludes.

2 Model setup

We consider a game-theoretical setting consisting of two periods and three risk-neutral players: the senior (s), her junior (j), and an available external manager (m).[11] In the first period, the senior exclusively holds all firm shares and manages the firm. At the end of period one, she transfers her shares to the junior. Whether the junior runs the firm as the CEO or controls the management as a member of the board, is determined by the senior's succession plan. This succession decision about the future management is chosen by the senior at the beginning of the game. Figure 1 displays the two different succession scenarios:

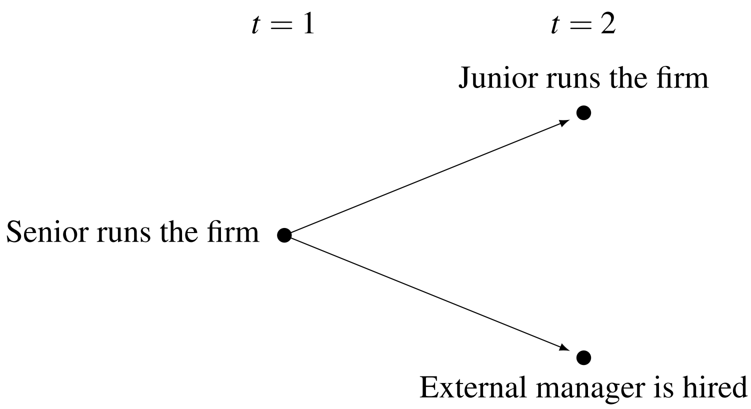

Figure 1: Succession scenarios

We assume that, following the firm succession, the ownership remains in the family. Here, a distinction is made between cases in which the junior takes over full responsibility for the company and cases where the operating business is delegated to an external manager.[12]

[11] In the following, time is indicated by the subscript $t = (1,2)$. Whenever one of the three players comes into play he/she is identified by a second subscript $i = (s, j, m)$.

[12] We also consider the possibility that the senior runs the company in both periods. However, this scenario

Economic earnings

True economic earnings at the end of the periods are given by:

$$x_1 = -\,d_{1,s}\; + K(d_0)\;(\delta_s\; e_{1,s} + \tilde{\theta}_1),$$
$$x_2 = K(d_{1,s})\;(\delta_i\; e_{2,i} + \tilde{\theta}_2),$$

with $X = x_1 + x_2$ being the terminal value of the firm. First-period earnings contain the capital stock $K(d_0) = k_0$, which is a positive constant that specifies the initial firm size. Similar to Bhattacharya and Ravikumar (2001), the capital stock is fully consumed after one period. Since the first period describes the situation before the succession takes place, the senior is the only possible decision maker. With her effort $e_{1,s}$ and her productivity δ_s, she manages the initial capital stock. Productivity and effort are substitutes, i.e., a low productivity can be balanced by a higher effort such that it is still possible to reach the same result. In the following, we assume that the productivity of the senior and the external manager is the same, i.e., $\delta_s = \delta_m = 1$. In turn, the junior's productivity is equal or below their productivity such that $\delta_j \in \{\frac{1}{2}, 1\}$. We make this assumption in order to capture differences in experience and to analyze how these differences interact with socioemotional concerns and the succession decision.[13]

Investment $d_{1,s}$ lowers current earnings but defines the size of the future capital stock. Correspondingly, the capital stock of period two is modeled as an increasing (concave) function of the previous investment $K(d_{1,s}) = \sqrt{d_{1,s}}$.[14] Together with effort $e_{2,i}$ and productivity δ_i of the respective decision maker, it determines economic earnings of the second period. The economic earnings x_t are also affected by economic risk. The periodical economic risk $\tilde{\theta}_t$ is an independent and identically distributed random variable with $\tilde{\theta}_t \sim N(1, \sigma_\theta^2)$. The strength of the risk's impact on the economic earnings depends on the

only serves as our benchmark solution (see Section 3.1), which is not depicted in Figure 1.

[13] This assumption corresponds to some empirical findings. For example, Cucculelli and Micucci (2008) show that the firm performance following a succession increases if an external manager becomes CEO. Bertoni et al. (2016) analyze internal successions and find a lower performance after the transition of control.

[14] To simplify the model, we exclude investment decisions in the second period.

size of the capital stock.[15]

Accounting signals and inheritance taxation

At the end of each period, the current CEO has to disclose an accounting report which is based on the underlying economic earnings. The reported accounting signals are defined as follows:[16]

$$y_1 = x_1 + b_{1,s} + \tilde{\varepsilon}_1,$$
$$y_2 = x_2 - b_{1,s} + b_{2,i} + \tilde{\varepsilon}_2,$$

where $\tilde{\varepsilon}_t \sim N(0, \sigma_\varepsilon^2)$ is again an independent and identically distributed random variable that represents accounting noise, which is uncorrelated to the economic risk $\tilde{\theta}_t$. Since the person in charge has discretion over the reported numbers, he/she is able to bias the accounting earnings, e.g., by using judgments in a principle-based accounting system. We assume that a bias in the current period reverses its effect in the following period. Consequently, $b_{1,s}$ is added (subtracted) in period one and subtracted (added) in period two. The same holds for the second-period bias $b_{2,i}$, however, due to the time horizon of our model, we do not illustrate its reversal in a third period. As underlying economic earnings are not affected by these shifting activities, this can be interpreted as accrual-based or accounting earnings management.

In our model, the accounting signals are used for two different purposes: for contracting with non-family managers and as a base for inheritance taxation. Economic earnings are not observable and, thus, not a reliable performance measure for contracting purposes. Therefore, an incentive contract must be based on publicly available accounting numbers.[17] Furthermore, because of the transfer of firm shares between generations, inheritance taxation must be considered. In the context of a family firm succession, inheritance

[15] Keep in mind that capital stock $K(d_t)$ is multiplicatively linked to economic risk θ_t.

[16] Note, that the clean surplus principle does not hold in our model because we only consider two periods, i.e., the period right before and right after the succession. To make the clean surplus principle hold further future/past periods would have to be taken into account in order to balance accounting earnings.

[17] The use of accounting reports for the purpose of compensation is only relevant in the external scenario in Section 3.3.

taxation might have a strong influence on business decisions. Given by local law, inheritance tax has often to be paid by the person who is taking over the firm. For inheritance tax purposes, corresponding assets are valued at their open market value at the transfer date (see, e.g., Great Britain's Inheritance Tax Act, Part IV, Chapter I, Sections 160-170 or Germany's §11 and §12 ErbStG, as well as §§199-203 BewG). By these regulations, the accounting signals of the past 3 years serve as an indicator for the market value. For simplification, we consider a one-book accounting system (i.e., accounting signals are also used for taxation purposes) and assume that the first-period signal serves as the assessment base of the inheritance tax that results from the transfer of the firm shares. In our model, the total tax liability amounts to $h \cdot y_1$ where h denotes the inheritance tax rate. In order to exclude implausible solutions, the range of the tax rate is $h \in [0, \frac{1}{2})$.[18]

The players' utility functions

Independently of the respective succession scenario, the senior's utility function (where $i = s$) possesses the following structure:

$$U_s = x_1 - c_{1,s} + \underbrace{\Psi}_{SEW} U_j.$$

In both succession scenarios, the senior receives the economic earnings x_1. However, her utility does not only depend on value coming from the first period where she is actively involved in the ongoing business. In addition, she receives utility from the second period, or more precisely, from SEW. In our model we consider two socioemotional aspects: Firstly, there is an effect which results from the dynastic character of the family firm. Here, socioemotional wealth increases in exercising personal authority, preserving a family dynasty (Gómez-Mejía et al., 2007), or ensuring transgenerational control (Zellweger et al., 2012). We label this as *dynastic SEW* and assume that the senior's utility is positively affected if firm's owner- and leadership remains in the family. Secondly, family

[18] For simplicity, we only consider inheritance taxation. Effects coming from income taxes do not change our primary findings and, thus, are not subject of our work.

members are also concerned about the welfare of relatives and show altruistic behavior towards each other (Schulze et al., 2003; Zahra and Sharma, 2004). Therefore, the future utility of the junior also generates positive value for the senior, which we label *altruistic SEW*. In our model both aspects are captured by $\Psi \in (0,1]$.[19] Furthermore, the senior suffers disutility as a result of her effort and possible manipulation activities in period one: $c_{1,s} = \frac{1}{2}(e_{1,s}^2 + \frac{b_{1,s}^2}{K(d_0)^2})$. The disutility for accrual-based earnings management depends on the size of the firm, i.e., the capital stock. Since a larger firm leads to higher complexity, it offers more possibilities for earnings management and makes it also more difficult for an external auditor to identify these manipulations.

The utility function of the junior ($i = j$) depends on whether he manages and owns the firm or just owns the firm in the second period. This is depicted in the paths of Figure 1. Thus, we have:

$$U_j = x_2 - hy_1 - \begin{cases} c_{2,j} & \text{if the junior runs the firm,} \\ w & \text{if the junior hires a manager.} \end{cases}$$

In both scenarios, the junior obtains the economic value x_2 and must pay the inheritance tax. However, in the first case, the junior also bears disutility $c_{2,j} = \frac{1}{2}(e_{2,j}^2 + \frac{b_{2,j}^2}{K(d_{1,s})^2})$ from running the firm. As before for the senior, the disutility comes from exerted effort and from manipulation activities.

In the second case, managing tasks are delegated and the junior has to pay the wage to an external manager. The corresponding contract is based on the accounting income of the second period such that $w = f + v \cdot y_2$ where f denotes the fixed salary and v denotes the incentive rate.

Finally, the utility function of the external manager ($i = m$) is given by:

$$U_m = w - c_{2,m}. \tag{1}$$

[19] Note that we do not cover a scenario where the firm is sold. In this case there would be no utility from SEW ($\Psi = 0$).

Recall that the manager's productivity is the same as for the senior, $\delta_m = 1$. However, in contrast to junior and senior, an additional parameter λ enters U_m such that $c_{2,m} = \frac{1}{2}(e_{2,m}^2 + \lambda \frac{b_{2,m}^2}{K(d_{1,s})^2})$. With the exogenous parameter λ, we take into account that manipulations of an owner-manager are only limited by external controls (e.g., external audit or accounting standards), whereas biasing activities of a non-family CEO might also be subject to internal controls (e.g., board monitoring), which makes manipulation activities for an external more costly.[20] This is expressed by $\lambda > 1$. The manager's reservation wage is set to zero without loss of generality.

Timeline

The following timeline summarizes the sequence of the player's actions:

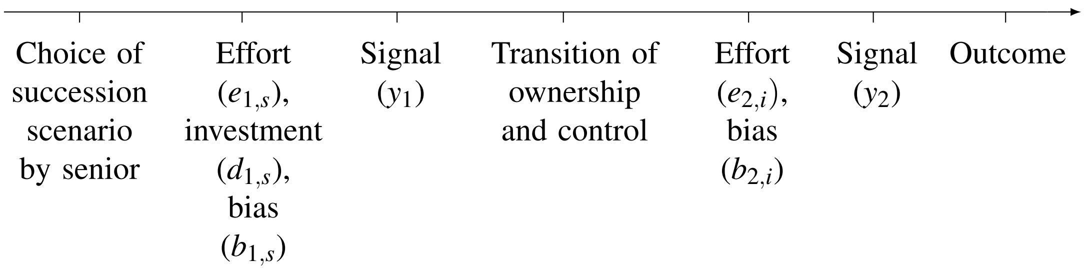

Figure 2: Timeline of events

[20] We assume that manipulation costs of an external manager are strictly higher than costs of an owner-manager who is not affected by internal controls.

3 Earnings management during firm succession

3.1 Benchmark solution

We start with the development of a benchmark solution where no transfer of firm shares takes place. Here, the senior stays for both periods in the firm where neither her actions nor her utility are affected by a succession. Thus, we are subsequently able to identify deviations from economically optimal behavior as a result of the different succession scenarios. While staying for two periods, the senior's objective is to optimize the total firm value. She simultaneously chooses optimal levels of effort and accrual-based earnings management for both periods and determines the optimal investment size in period one. We obtain the following optimization problem:

$$\begin{aligned}
\max_{e_{1,s},\, e_{2,s},\, b_{1,s},\, b_{2,s},\, d_{1,s}} \quad E[U_s] &= E[X - (c_{1,s} + c_{2,s})] \\
&= E\big[-d_{1,s} + k_0(e_{1,s} + \tilde{\theta}_1) + \sqrt{d_{1,s}}(e_{2,s} + \tilde{\theta}_2) \\
&\quad - \frac{1}{2}(e_{1,s}^2 + \frac{b_{1,s}^2}{k_0^2} + e_{2,s}^2 + \frac{b_{2,s}^2}{d_{1,s}})\big].
\end{aligned}$$

The solution of the problem is presented in Lemma 1.

Lemma 1 *The benchmark levels of effort, investment and accrual-based earnings management are given by:*

$$e_{1,s}^B = k_0, \tag{2}$$

$$e_{2,s}^B = \sqrt{d_{1,s}^B}, \tag{3}$$

$$b_{1,s}^B = 0, \tag{4}$$

$$b_{2,s}^B = 0, \tag{5}$$

$$d_{1,s}^B = 1. \tag{6}$$

Proof: See the Appendix.

The results show positive efforts in both periods, whereas accrual-based earnings management does not take place. The reason for the latter is that the bias has no effect on underlying earnings but generates personnel costs. The investment level $d_{1,s}^{B}$ equals one and, in the following, we interpret deviations from this level, that are not driven by differences in the productivity, as real earnings management.[21] Thus, whenever an investment level is above (under) the benchmark case (e.g., due to SEW considerations), the manager undertakes positive (negative) real earnings management.

3.2 Internal family succession

We now assume that the firm is owned and controlled by family members across generations. Thus, the senior allocates property rights and management tasks of the second period to the junior. In comparison to the benchmark solution, it is now the junior who runs the company in the second period. He benefits from the capital stock, which results from the senior's investment in the first period, but also has to bear disutility for the exerted effort and biasing activity in period two as well as for inheritance taxes coming from the inter-generational transfer of ownership.

To determine the optimal actions of the sub-game perfect equilibrium, we use backward induction. Thus, we first solve for the optimal levels of effort and accrual-based earnings management of the junior in the second period. Afterwards, we analyze the first period where the senior anticipates the actions of her junior, when deciding about the size of the investment, the level of effort, and the extent of earnings management. Given the junior's decisions in period two, the senior's optimization problem can be expressed by:[22]

$$\max_{e_{1,s},\, d_{1,s},\, b_{1,s}} E\left[U_s(e_{2,j}^{F}, b_{2,j}^{F})\right] = E\left[x_1 - c_{1,s} + \Psi\, U_j(e_{2,j}^{F}, b_{2,j}^{F})\right].$$

The corresponding solution to the problem is presented in Lemma 2.

[21] All *benchmark* levels are denoted with the superscript B.

[22] Note that optimal levels of effort and earnings management in the *family* succession scenario are marked with the superscript F.

Lemma 2 *Assume that the junior obtains the firm shares and manages the firm, then the optimal actions of junior and senior are given by:*

$$e^F_{2,j} = \delta_j \sqrt{d^F_{1,s}},$$

$$b^F_{2,j} = 0, \tag{7}$$

$$e^F_{1,s} = k_0 \ (1 - \Psi h), \tag{8}$$

$$d^F_{1,s} = \frac{\Psi^2}{(2 - \Psi \ (2h + \delta_j^2))^2}, \tag{9}$$

$$b^F_{1,s} = -h \, \Psi k_0^2. \tag{10}$$

Proof: See the Appendix.

Apparently, the junior's effort of period two depends on the senior's investment in the previous period, as well as on his productivity $\delta_j = \{\frac{1}{2}, 1\}$. Another result is, that the senior's effort level is below the benchmark ($e^F_{1,s} < e^B_{1,s}$). This is caused by SEW Ψ, which tempts the senior to lower the effort the more she is interested in the junior's utility. The seemingly counter-intuitive result can be explained by the inheritance tax, which has to be paid by the junior. He pays inheritance taxes according to the company's accounting earnings of the first period. Therefore, by lowering her effort, the senior reduces the junior's tax base, which in turn increases both the junior's utility and (via Ψ) the senior's utility. This indirect effect of altruistic SEW on the senior's effort is accompanied by a negative direct effect of the tax rate, which is why tax rate h and SEW Ψ are substitutes. Regarding the level of investment, we find that it is also determined by SEW. However, the influence of Ψ on $d^F_{1,s}$ is ambiguous: Firstly, there is a *growth effect* coming from the capital stock. As returns are realized in the next period, a higher investment of the senior increases the capital stock of the junior. A higher capital stock in period two leads also to a higher effort of the junior and, consequently, an additional increase in the equilibrium surplus of the junior.[23] To which extent the junior is able to generate earnings from the

[23] Remember that $\tilde{\theta}_2$ has an expected value of one. Thus, the junior's expected returns without any effort are given by $\sqrt{d^F_{1,s}}$.

capital stock through his effort, strongly depends on his productivity. Consequently, it is also the junior's productivity that influences the senior's investment decision via Ψ: the more productive the junior, the higher the investment level.[24] The second effect is again the *tax effect*. Following the argumentation from above, the senior can relieve the junior from the tax liability by lowering the tax base y_1 with her investment $d_{1,s}$. Bringing these results together, the core insight of the investment and effort choice is, that the senior renounces a part of her financial outcome x_1 in order to improve the junior's wealth.

The effects of different parameters on the senior's investment behavior is summarized in the following result.

Result 1 *Assume that $h \in [0, \frac{1}{2})$ and that the junior obtains the firm shares and manages the firm in the second period. Then the senior's first-period investment increases in*

1. *the senior's level of SEW Ψ,*
2. *the junior's level of productivity δ_j,*
3. *the inheritance tax rate h.*

Proof: See the Appendix.

Summarizing the earnings management behavior in the internal succession scenario, we can state that the junior does not engage in manipulation activities (see equation (7)). The senior, in turn, undertakes earnings management as described in Result 2.

[24] In our model, the future capital stock is implicitly determined by the productivity of the junior. A similar relation is found by Lucas (1978). He shows that the optimal firm size depends on exogenous talent or expertise of the manager (see also Aron, 1988).

Result 2 *Assume that the junior manages the firm in period two. Then*

1. *the senior shifts earnings from the first into the second period,*

2. *the senior's investment behavior, in the context of real earnings management, critically depends on the senior's SEW and on the inheritance tax rate. Whenever the senior's altruism is sufficiently high (low), $\Psi > \widehat{\Psi} = \frac{1}{h+1}$ ($\Psi < \widehat{\Psi}$), the investment $d^F_{1,s}$ exceeds (is below) the benchmark $d^B_{1,s}$.*

Proof: See the Appendix.

Our first part of the result shows that the senior undertakes accrual-based earnings management (see equation (10)). She shifts earnings from period one into period two where the true underlying earnings remain unaffected. Thus, y_1 and thereupon, the inheritance tax base is lowered.

Even though this biasing activity leads to personnel costs, and we know from the benchmark that the senior is not interested in accounting signals but only in economic earnings, she does so in favor for the junior. Thus, accrual-based earnings management is considerably influenced by SEW. More precisely, the senior attempts to increase her utility via the junior's utility, i.e., besides lowering her effort ($e^F_{1,s} < e^B_{1,s}$) as stated in Lemma 2, she uses accrual-based earnings management to increase the junior's utility and ultimately, the own utility. Intuitively, the bias increases in the inheritance tax rate, $\frac{\partial b^F_{1,s}}{\partial h} > 0$, to offset a higher tax payment.

From a real manipulation perspective, the question whether an over- or underinvestment occurs again critically depends on the senior's level of SEW, which is shown in the second part of Result 2. If she is strongly interested in the utility of the junior, an investment above the benchmark occurs. Since investment creates an immediate loss in period one, the senior is only willing to overinvest if her interest for the junior is high enough ($\Psi > \widehat{\Psi}$). Here, the high investment has again two utility increasing effects: the growth and the tax effect.

A similar finding is documented by Achleitner et al. (2014), who suggest that, driven by SEW, family businesses are less likely to engage in value-decreasing underinvestment practices. However, we also find that there is a reversed case, where the senior invests less than optimal in order to cut costs in the first period, as current utility has a higher impact on her total utility ($\Psi < \widehat{\Psi}$). Note, that the critical value for an over- or underinvestment itself depends on the inheritance tax rate $\left(\frac{1}{h+1}\right)$. Therefore, it is more likely to observe underinvestment when the tax rate decreases. Thus, we predict that an overinvestment is less likely in countries with a low inheritance tax rate or where selling firm shares is not relevant for inheritance taxation.

3.3 Succession with an external manager

An essential advantage of family firms comes from low agency costs because of the consolidation of ownership and management. However, it is not always the case that a junior takes over the ownership and the operating business, e.g., when children are not interested in managing the firm. Operational tasks are then often delegated to external managers, which changes the situation into a classical principal-agent setting, where agency costs arise because of the possibility of opportunistic behavior (moral hazard). In this chapter, we take a closer look at the separation of ownership and control in family firms following a succession. Thus, we assume that an external manager is hired in period two and analyze how actions in both periods are affected.

Second-period compensation contract

Applying backward induction, we start again by analyzing the actions of the second period. In our model, agency costs occur for two reasons. Firstly, a lower than optimal effort level of the manager decreases the residual outcome of the junior, x_2. Secondly, the manager might engage in accrual-based earnings management in order to increase his compensation w. Both, effort and manipulation activities, are not observable for the junior. For this reason, the linear contract w also contains the incentive rate v besides the fixed payment f. Since earnings after the succession x_2 are not observable and, therefore, not available for contracting purposes, the junior has to use the accounting signal y_2 as performance measure for the contract: $w = f + v \cdot y_2$.[25] The manager in turn privately observes earnings x_2 and has discretion over the reported numbers, which is a leeway to manipulate the accounting earnings in his favor. However, recall that the manipulation cost is higher for the external manager than for the internal manager ($\lambda > 1$). The optimal contract solves the following problem of the junior:

$$\max_{f,v} E[x_2 - h\, y_1 - w] \tag{11}$$

subject to

$$E[U_m] \geq 0, \tag{12}$$

$$(e_{2,m}, b_{2,m}) \in \underset{e'_{2,m}, b'_{2,m}}{argmax}\, E[U_m(e'_{2,m}, b'_{2,m})]. \tag{13}$$

The junior maximizes the expected firm value net of managerial compensation, subject to two constraints. The first constraint ensures the participation of the manager and the second is the incentive constraint for the manager's second-period actions. The solution to the problem is presented in Lemma 3.[26]

Lemma 3 *The optimal incentive rate and the corresponding actions of the manager in the second period are given by:*

$$e^E_{2,m} = \frac{\lambda\sqrt{d^E_{1,s}}}{\lambda+1},$$

$$b^E_{2,m} = \frac{d^E_{1,s}}{\lambda+1},$$

$$v^E = \frac{\lambda}{\lambda+1}.$$

Proof: See the Appendix.

[25] From an agency viewpoint, it would be optimal for the junior to lease the firm to the agent in a risk-neutral setting. Then the manager would gain the second-period economic earnings and would give a fixed payment to the junior. However, since true economic earnings cannot be used for contractual purposes and the performance measure y_2 is not congruent to the true economic earnings, agency costs arise even when players are risk neutral.

[26] Results in the *external* succession scenario are symbolized by the superscript E.

Since we consider a risk-neutral setting, the incentive rate is not affected by risk sharing considerations and the size of the firm. Even though v^E motivates the manager to work, it also creates incentives to manipulate earnings. The extent to which the manipulation occurs depends on the monitoring intensity λ, as comparative statics show: $\frac{\partial v^E}{\partial \lambda} > 0$. The first-best effort level can only be reached if $\lim_{\lambda \to \infty} v^E = 1$. In this case, monitoring eliminates agency costs. However, in any other case, the contract cannot duplicate the benchmark solution.

First-period reporting

Anticipating the reaction of the external manager, the senior chooses her optimal actions in period one. These are stated in the next lemma.

Lemma 4 *If an external manager is hired in the second period, optimal actions of the senior in the first period are given by:*

$$d^E_{1,s} = \frac{(\lambda+1)^2 \Psi^2}{(\Psi(\lambda+2h(\lambda+1)) - 2\lambda - 2)^2}, \tag{14}$$

$$e^E_{1,s} = k_0 (1 - \Psi h),$$

$$b^E_{1,s} = -h\,\Psi\,k_0^2. \tag{15}$$

Proof: See the Appendix.

Even though agency costs arise, the senior still invests in future growth. By working on the capital stock and providing effort, which positively depends on the investment, the manager increases firm value. The internal monitoring technology makes it less attractive for the manager to manipulate earnings and, thus, limits the agency costs. In equilibrium, a stronger monitoring technology λ in period two leads to a higher first-period investment of the senior.[27] The question whether the investment exceeds the extent in the benchmark solution is answered in the next result.

[27] See the Appendix: proof of Lemma 4.

Result 3 *Assume that the senior's succession plan requires that the junior has the chairmanship of the supervisory board and an external CEO must be hired. Then the following observations can be documented:*

1. *The senior's accrual-based earnings management equals the level of the internal scenario.*
2. *The senior's investment level is positively affected by monitoring technology λ.*
3. *Real earnings management: senior's investment level is always lower compared to the internal scenario. If $\Psi > \breve{\Psi} = \frac{\lambda+1}{\lambda(h+1)+h+\frac{1}{2}}$ ($\Psi < \breve{\Psi}$), the investment d_1^E exceeds (is below) the benchmark.*

Proof: See the Appendix.

Similar to the internal succession setting, the senior's actions are SEW-driven. She uses accrual-based earnings management to shift earnings into the second period in order to avoid a high taxation for her junior. Thus, manipulation incentives do not depend on whether an internal or external management runs the firm. The question remains if the senior's accrual-based earnings management, which increases the manager's contractual base y_2, has an effect on the manager's payoff. The answer can be found by taking a look at the fixed payment. As the participation constraint is binding, it holds that $\frac{\partial f^E}{\partial b_{1,s}^E} < 0$. Thus, the junior takes the accrual management of the senior into account and lowers the fixed payment in order to balance out the higher variable payment.

Regarding the investment volume, the extent of deviation from the benchmark solution depends on the SEW of the senior and on the agency costs. Note that, as opposed to the internal succession scenario, there is accrual earnings management in the second period of the external succession scenario ($b_{2,m}^E > 0$), since the manager attempts to increase his incentive payment. Therefore, second-period accrual management is strictly higher if a non-family member is CEO, which is in line with empirical studies. For example, Yang (2010) shows that non-family CEOs exhibit a stronger tendency to manipulate accruals than family CEOs do. Similar to our findings, it is argued that it is more necessary for firms with external CEOs to monitor them and to motivate them using incentive compensation based on accounting earnings than it is for firms employing family CEOs, who reject costly manipulation practices.[28]

The last part of Result 3 shows that real earnings management of the senior again depends on her SEW: There is a critical value $\breve{\Psi}$, which determines whether first-period over- or underinvestment occurs. Moreover, in comparison to the internal scenario, a higher degree of altruism of the senior is needed for an overinvestment in the first period. Since an external manager leads to agency costs, which in turn provide lower investment incentives to the senior, $\breve{\Psi}$ exceeds $\widehat{\Psi}$.[29]

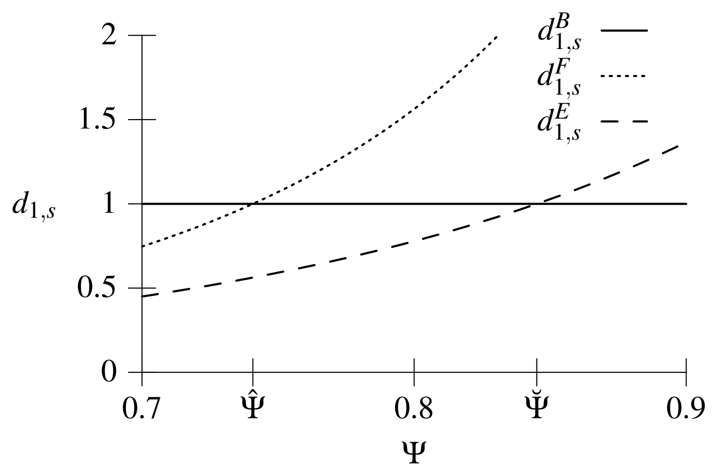

Figure 3: Investment levels of different scenarios (parameters: $h = 0.35$, $\lambda = 2$)

Figure 3 illustrates the investment levels of the different succession scenarios as functions of SEW Ψ. It demonstrates the effect of the critical values of SEW on the real earnings management behavior. If $\Psi < \widehat{\Psi}$, the senior's investment is below the benchmark level in both scenarios. In contrast, independent of the succession scenario, the senior always overinvests if $\Psi > \breve{\Psi}$. Although real activity manipulations differ from each other with respect to their absolute levels, the manipulation strategy is identical. Only in the area

[28] In addition, Ferramosca and Allegrini (2018) show that the extent of accrual-based earnings management activities depends on the involvement of family members in executive positions.

[29] Note that we define real earnings management activities as decisions, which are driven by SEW-considerations. Decisions, that are solely based on differences in the productivities of the second-period players (without any consideration of *behavioral* aspects), are investment decisions. Therefore, in order to determine real earning management practices of the senior, the productivities of all other players are set equal one. The influence of a lower productivity of the junior ($\delta_j < \delta_m$) on investment is investigated in Section 4.

between $\widehat{\Psi}$ and $\breve{\Psi}$ the real earnings management strategies are different. While the senior will overinvest if her offspring leads the firm, the investment is strictly below the benchmark in the case of an external manager. Consequently, if the firm's leadership remains within the family, an overinvestment is more likely.

4 Senior's succession decision: internal vs. external

In this section, we identify conditions under which the senior prefers a succession scenario, where an external manager is hired in period two even though an interested internal successor is available. The previous chapters show that the senior adjusts her actions dependent on the succession scenario. However, recall that the senior has authority over the succession, i.e., she can implement whatever succession scenario she prefers. As an example, she could establish in the firm's articles of association that only external managers can have the executive rights, whereas next-generation family members are solely permitted to assume duties/responsibilities in the firm's advisory board.

To study whether the senior prefers a family-member or an external agent as CEO of the second period, we compare the senior's equilibrium expected utility in both scenarios: $\Delta = E[U_s^F] - E[U_s^E]$.[30] We find that effects of most parameters are clear and intuitive. For example, improving monitoring (λ increases) makes it more complicated for external managers to engage in manipulation activities and, thus, reduces agency costs.[31] Correspondingly, hiring an external manager becomes more advantageous, i.e., the senior's utility $E[U_s^E]$ increases. In contrast, a higher productivity of the junior makes an internal succession more beneficial.[32] For $\delta_j = 1$, the senior chooses the internal succession since the junior does not cause any moral hazard problem and provides the same productivity. However, in case of a less productive junior (i.e., $\delta_j = \frac{1}{2}$), the question whether the junior becomes CEO depends on the agency costs caused by an external manager. If these costs

[30] Note that the difference is expressed in absolute values. Thus, it can take positive and negative values.
[31] See Section 3.3 for a closer analysis of the agency costs.
[32] Recall that there are always capable managers available on the market. These external agents provide a productivity of $\delta_m = 1$, whereas the junior's productivity equals $\delta_j \in \{\frac{1}{2}, 1\}$.

are sufficiently high, it can be advantageous for the senior to choose a less productive junior to run the firm. Similarly, a low-productivity junior could also take over the job as CEO if the additional utility of keeping the management within the family (via dynastic utility from Ψ) is significantly high. It is straightforward that an increase of both (δ_j, Ψ) reduces the advantage of hiring an external professional.

Regarding the inheritance tax rate h, we find that its impact on the senior's succession decision is less intuitive. Result 4 summarizes the effects.[33]

Result 4 *Assume a sufficiently high degree of SEW of the senior ($\Psi = 1$) and a low productive junior ($\delta_j = \frac{1}{2}$), a higher inheritance tax rate influences the senior's succession decision in favor of the external manager, i.e., $\frac{\partial \Delta}{\partial h} < 0$.*

Proof: See the Appendix.

We are able to identify three effects coming from an increase in the taxation rate h. The first effect evokes a decrease of Δ, which results from the taxes' influence on the investment level: Initially, a higher tax rate leads to a higher investment of the senior in order to lower the junior's inheritance taxation base. This is driven by SEW, which means $d_{1,s}$ increases particularly strong for high values of Ψ. The increased capital stock then provides higher expected second-period earnings $K(d_{1,s})(\delta_i\ e_{2,i} + 1)$. Since the effort positively depends on the investment, the optimal second-period effort level increases, which additionally leads to higher earnings. This reaction takes place in both scenarios (internal and external). However, due to the lower productivity of the junior ($\delta_j = \frac{1}{2} < \delta_m$), the effort level in the external scenario is strictly higher. Consequently, an earnings difference between the scenarios increases in the investment $d_{1,s}$ and makes hiring an external agent more beneficial. For reasons of tractability, we call this process "earnings effect". Secondly, a higher tax rate h directly increases the future tax burden. Because of the high $d_{1,s}^E$ and the corresponding lower tax base y_1^E, Δ decreases in h, which we denote as the "tax burden effect". The third effect is that a higher tax rate leads to higher agency

[33] Note that the condition $0 \leq h < \frac{1}{2}$ must be fulfilled. However, the condition $\Psi = 1$ is not necessary. The effect of Result 4, i.e., the influence of the tax rate on the senior's succession decision, holds also for lower values of Ψ (see the Appendix).

costs. This is again caused by the increased capital stock, which makes accrual-based manipulation by an external more attractive $\left(\frac{\partial b^E_{2,m}}{\partial d_{1,s}} > 0\right)$ and, due to the larger size of the company, more difficult to prevent. As agency costs arise, the senior's expected utility $E[U^E_s]$ decreases, and an increase of Δ follows. This may be called "agency effect".

It becomes clear that the decision whether to implement an internal or an external succession depends on the interplay between the tax rate with various other factors. For the assumptions named in Result 4, we find that, in equilibrium, the "earnings effect" and the "tax burden effect" dominate the "agency effect", i.e., a higher tax rate makes hiring a non-family CEO more beneficial.

As a consequence, we would predict that internal successions are more preferred in countries where inheritance taxation is low and agency costs (e.g., because of low corporate governance standards) are high. A similar result is documented by Tsoutsoura (2015). She considers family firm sales and family-internal successions, and shows that a higher inheritance taxation makes the latter scenario less likely. Although, we do not consider the possibility of a liquidation of the firm in this model, her findings still do correspond to our result: if we assumed a sufficiently high level of h, the expected surplus of both succession scenarios $\left(E[U^F_s] \text{ and } E[U^E_s]\right)$ would become negative, making the firm's liquidation a more beneficial option.

5 Conclusion

We develop a two-period agency model to examine earnings management practices of a family firm at the time of change in ownership and control. By considering two succession scenarios, we are able to suggest explanations for differences in investment and earnings management behaviors of family firms.

We show that earnings management strongly depends on the succession scenario which is implemented by the person who is in charge prior to the succession. If the firm shares are transferred within the family, accrual-based earnings management of the preceding owner leads to an earnings shift from the first into the second period. This is driven by SEW considerations which aim to reduce the inheritance taxation of a successor from the family. Regarding real earnings management, incentives for manipulations arise again through SEW. We find that activities critically depend on the degree of altruism. A significantly high (low) SEW leads to a first-period investment in the capital stock which is above (below) the economic optimal level. If a successor from the family does not run the operational business of the firm and instead hires an external manager, earnings management activities are also affected by agency costs. A further insight from our model is that the inheritance tax rate can affect the founder's decision regarding the succession scenario. We show that an increase in the inheritance tax rate makes hiring an external manager in the second period more beneficial compared to the situation where the firm is led by a family member. Our results show that SEW facilitates inter-generational thinking and, thus, extends the time horizon of decision-makers. Consequently, we find a positive influence of SEW on long-term investments.

Our model is able to provide detailed explanations for some empirical patterns regarding earnings management in family firms during a succession. We suggest that succession decisions, earnings management activities, investment behaviors and performance differences of family firms are largely explained by simple contractual and socioemotional considerations of the families involved in the businesses. In particular, we identify inheritance taxation, agency costs, as well as altruistic and dynastic SEW as the main drivers of the results. Nevertheless, we believe that future analytical research can generate more precise results that allow predictions beyond the ones we propose. Moreover, as the emphasis of previous studies is mainly set on empirical methods, we are convinced that accounting behaviors and succession decisions of family firms should be examined in more controlled environments.

Appendix

Proof of Lemma 1

In the benchmark solution, the senior does not leave or assigns the firm and is only interested in the firm value. Since she stays for two periods, she chooses her actions in order to maximize the sum over both periods. The senior's ex ante utility is given by:

$$E[U_s] = -d_{1,s} + k_0(\delta_s e_{1,s} + 1) + K(d_{1,s})(\delta_s e_{2,s} + 1) - \frac{1}{2}\left(e_{1,s}^2 + \frac{b_{1,s}^2}{k_0^2} + e_{2,s}^2 + \frac{b_{2,s}^2}{K(d_{1,s})^2}\right).$$

Differentiating above with respect to $e_{1,s}$, $e_{2,s}$, $d_{1,s}$, $b_{1,s}$ and $b_{2,s}$ leads to the following first-order conditions:

$$\begin{aligned}
\frac{\partial E[U_s]}{\partial e_{1,s}} =& 0 \Longleftrightarrow -e_{1,s} + k_0\delta_s = 0,\\
\frac{\partial E[U_s]}{\partial e_{2,s}} =& 0 \Longleftrightarrow -e_{2,s} + \sqrt{d_{1,s}}\delta_s = 0,\\
\frac{\partial E[U_s]}{\partial d_{1,s}} =& 0 \Longleftrightarrow -1 + \frac{\delta_s e_{2,s} + 1}{2\sqrt{d_{1,s}}} + \frac{b_{2,s}^2}{2d_{1,s}^2} = 0,\\
\frac{\partial E[U_s]}{\partial b_{1,s}} =& 0 \Longleftrightarrow -\frac{b_{1,s}}{k_0^2} = 0,\\
\frac{\partial E[U_s]}{\partial b_{2,s}} =& 0 \Longleftrightarrow -\frac{b_{2,s}}{d_{1,s}} = 0.
\end{aligned}$$

Solving the equation system for $e_{1,s}$, $e_{2,s}$, $d_{1,s}$, $b_{1,s}$ and $b_{2,s}$, under the assumption of $\delta_s = 1$, the solutions are represented by equations (2), (3), (4), (5) and (6). Inserting these values in the Hessian matrix of the objective function H gives

$$H^B(e_{1,s}^B, e_{2,s}^B, b_{1,s}^B, b_{2,s}^B, d_{1,s}^B) = \begin{bmatrix} -1 & 0 & 0 & 0 & 1/2 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & -k_0^{-2} & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 1/2 & 0 & 0 & 0 & -1/2 \end{bmatrix}.$$

Since $k_0 > 0$, $H^B(\cdot)$ is negative definite and, thus, the derived solution is a maximum.

Proof of Lemma 2

In contrast to the benchmark, in the internal scenario the senior is also interested in the junior's utility. We obtain the first-period actions by solving the junior's problem in the second period (backward induction): The junior's ex ante utility in period two is given by:

$$E[U_j] = \sqrt{d_{1,s}}(\delta_j e_{2,j} + 1) - h \cdot (-d_{1,s} + k_0(\delta_s e_{1,s} + 1) + b_{1,s}) - \frac{e_{2,j}^2}{2} - \frac{b_{2,j}^2}{2d_{1,s}}.$$

Differentiating the expected utility with respect to $e_{2,j}$ and $b_{2,j}$, and solving the first-order conditions yield:

$$\frac{\partial E[U_j]}{\partial e_{2,j}} = 0 \Longleftrightarrow e_{2,j}^F = \delta_j \sqrt{d_{1,s}},$$
$$\frac{\partial E[U_j]}{\partial b_{2,j}} = 0 \Longleftrightarrow b_{2,j}^F = 0.$$

The senior's expected utility is given by:

$$\begin{aligned} E[U_s^F] = & -d_{1,s} + k_0(\delta_s e_{1,s} + 1) - \frac{e_{1,s}^2}{2} - \frac{b_{1,s}^2}{2k_0^2} + \Psi\left(\sqrt{d_{1,s}}(\delta_j e_{2,j} + 1)\right) \\ & + \Psi\left(-h \cdot (-d_{1,s} + k_0(\delta_s e_{1,s} + \tilde{\theta}_1) + b_{1,s}) - \frac{e_{2,j}^2}{2} - \frac{b_{2,j}^2}{2d_{1,s}}\right). \end{aligned} \quad \text{(A.1)}$$

Inserting $e_{2,j}^F$ and $b_{2,j}^F$, and differentiating with respect to $e_{1,s}$, $d_{1,s}$ and $b_{1,s}$ lead to:

$$\frac{\partial E[U_s^F]}{\partial e_{1,s}} = 0 \Longleftrightarrow -\Psi k_0 \delta_s h + k_0 \delta_s - e_{1,s} = 0,$$
$$\frac{\partial E[U_s^F]}{\partial d_{1,s}} = 0 \Longleftrightarrow -1 + \Psi\left(\frac{\sqrt{d_{1,s}}\delta_j^2 + 1}{2\sqrt{d_{1,s}}} + h\right) = 0,$$
$$\frac{\partial E[U_s^F]}{\partial b_{1,s}} = 0 \Longleftrightarrow -\frac{b_{1,s}}{k_0^2} - \Psi h = 0.$$

Solving the linear equation system for $e_{1,s}$, $b_{1,s}$ and $d_{1,s}$, and given $\delta_s = 1$, the solutions are represented by equations (8), (10) and (9).

Since $\delta_j \in \{\frac{1}{2}, 1\}$, $\Psi \in [0,1]$, $h \in [0, \frac{1}{2})$ and $k_0 > 0$, the Hessian matrix $H^F(\cdot)$ of the objective function is negative definite and, thus, the derived solution is a maximum.

Proof of Result 1

To proof the influence of different parameters on the investment level, note that the conditions $\delta_j \in \{\frac{1}{2}, 1\}$, $\Psi \in [0,1]$ and $h \in [0, \frac{1}{2})$ hold:

(i) Differentiating (9) with respect to Ψ and simplifying yield:

$$\frac{\partial d_{1,s}^F}{\partial \Psi} = -\frac{4\Psi}{\left(\Psi \delta_j^2 + 2\Psi h - 2\right)^3} > 0.$$

The investment increases in Ψ.

(ii) Differentiating (9) with respect to h and simplifying yield:

$$\frac{\partial d_{1,s}^F}{\partial h} = -\frac{4\Psi^3}{\left(\Psi \delta_j^2 + 2\Psi h - 2\right)^3} > 0.$$

The investment increases in h.

(iii) Differentiating (9) with respect to δ_j and simplifying yield:

$$\frac{\partial d_{1,s}^F}{\partial \delta_j} = -\frac{4\Psi^3 \delta_j}{\left(\Psi \delta_j^2 + 2\Psi h - 2\right)^3} > 0.$$

In our model, we assume that $\delta_j \in \{\frac{1}{2}, 1\}$. Thus, the investment is strictly higher if $\delta_j = 1$.

Proof of Result 2

(i) To investigate accrual-based management behavior, we consider the sign of $b^F_{1,s}$. Since $\Psi \in [0,1]$ and $h \in [0, \frac{1}{2})$, equation (10) is always negative and, thus, the senior shifts earnings from the first to the second period in equilibrium.

(ii) To study real earnings management, we consider the difference between the investment levels in the benchmark and the internal succession scenario. Recall that, in order to determine real earnings management, the productivity of the player may not be considered (see footnote 30 on page 21). To eliminate productivity effects, we set δ_s and δ_j to one. Using (6) and (9), we obtain:

$$d^B_{1,s} - d^F_{1,s} = \frac{4(\Psi h - 1)(\Psi h + \Psi - 1)}{(2\Psi h + \Psi - 2)^2}.$$

Solving $d^B_{1,s} - d^F_{1,s} = 0$ for Ψ yields:

$$\widehat{\Psi} = \frac{1}{h+1}.$$

Since $h \in [0, \frac{1}{2})$, $\widehat{\Psi} \in (\frac{2}{3}, 1]$. Thus, an overinvestment takes place if $\Psi > \widehat{\Psi}$. Otherwise, if $\Psi < \widehat{\Psi}$, the senior's investment level is lower compared to the benchmark.

Proof of Lemma 3

To obtain the optimal incentive contract of period two, we must consider the optimal action levels of the external manager. Differentiating (1) with respect to $e_{2,m}$ and $b_{2,m}$, and solving the first-order conditions yield:

$$\frac{\partial E[U^E_m]}{\partial e_{2,m}} = 0 \iff e^E_{2,m} = v^E \delta_m \sqrt{d^E_{1,s}},$$
$$\frac{\partial E[U^E_m]}{\partial b_{2,m}} = 0 \iff b^E_{2,m} = \frac{v^E d^E_{1,s}}{\lambda}.$$

In program (11), the participation constraint is binding at the optimum: $E[U_m] = 0$. By substituting from that constraint into the objective function, the junior's utility can be written as:

$$E[U_j] = \sqrt{d_{1,s}}(\delta_m e_{2,m} + 1) - h \cdot (-d_{1,s} + k_0(\delta_s e_{1,s} + 1) + b_{1,s}) - \frac{e_{2,m}^2}{2} - \frac{\lambda\, b_{2,m}^2}{2\, d_{1,s}}. \quad \text{(A.2)}$$

Inserting the incentive constraint for $e_{2,m}$ and $b_{2,m}$ into the junior's objective function leads to:

$$\sqrt{d_{1,s}} + v\, \delta_m^2 d_{1,s} - h \cdot (-d_{1,s} + k_0(\delta_s e_{1,s} + 1) + b_{1,s}) - \frac{v^2\, \delta_m^2 d_{1,s}}{2} - \frac{v^2\, d_{1,s}}{2\lambda}.$$

From the first-order condition for the optimal v, we obtain the equilibrium incentive rate:

$$v^E = \frac{\lambda}{\lambda + 1}.$$

The corresponding manipulation activity of the external manager is then given by:

$$b_{2,m}^E = \frac{\lambda \sqrt{d_{1,s}^E}}{\lambda + 1}.$$

Inserting v^E, $b_{2,m}^E$, and $e_{2,m}^E$ in the expected mangers utility $E[U_m]$, which is given by equation (1), and simplifying yield:

$$f^E = \frac{1}{2} \frac{\lambda \left(2\sqrt{d_{1,s}^E} - 2\, b_{1,s}^E + d_{1,s}^E\right)}{\lambda + 1}.$$

In equilibrium, an increase of the senior's bias $b_{1,s}^E$ reduces the fixed payment of the external manager: $\frac{\partial f^E}{\partial b_{1,s}^E} < 0$.

Proof of Lemma 4

The solutions of the optimal actions of the senior in a succession setting with an external manager correspond to the procedure explained in detail above for Lemma 2. Therefore, the proof is omitted.

Next, we study the effect of a stronger internal monitoring on senior's investment. Differentiation (14) in respect to λ gives:

$$\frac{\partial d_{1,s}^{E}}{\partial \lambda} = -\frac{(\lambda+1)\,\Psi^3}{4\left(\left(-1+\left(h+\frac{1}{2}\right)\Psi\right)\lambda+\Psi h-1\right)^3} > 0.$$

Since $h \in [0, \frac{1}{2})$ and $\Psi \in [0, 1]$, $\frac{\partial d_{1,s}^{E}}{\partial \lambda}$ is strictly positive.

Proof of Result 3

(i) Accounting earnings management: See proof of Result 2.

(ii) To study real earnings management, we consider the difference between the investment levels of the benchmark and the external succession scenario. Again recall, that effects from the productivities of the players are not considered in order to determine earnings management. Using (6) and (14), we obtain:

$$d_{1,s}^{B} - d_{1,s}^{E} = 1 - \frac{(\lambda+1)^2\,\Psi^2}{(2\,(\Psi)\,\lambda\,h + (\Psi)\,\lambda + 2\,(\Psi)\,h - 2\,\lambda - 2)^2}.$$

Solving $d_{1,s}^{B} - d_{1,s}^{E} = 0$ for Ψ yields:

$$\breve{\Psi} = \frac{\lambda+1}{\lambda(h+1)+h+\frac{1}{2}},$$
$$\overline{\Psi} = \frac{\lambda+1}{\lambda\,h+h-\frac{1}{2}}.$$

The critical value $\breve{\Psi}$ is always between 0 and 1. Thus, an overinvestment takes place if $\Psi > \breve{\Psi}$. Otherwise, if $\Psi < \breve{\Psi}$, the senior's investment level is lower compared to the benchmark. In contrast, the second critical value $\overline{\Psi}$ takes no value which fulfills the condition $\Psi \in [0, 1]$.

Comparing the critical values of Ψ of the internal and external scenario gives:

$$\widehat{\Psi} - \breve{\Psi} = -\frac{0.5}{(1+h)\,(\lambda\,(h+1)+h+0.5)} < 0.$$

This shows that the critical value of altruism in the external setting is strictly higher. Therefore, an underinvestment is more likely if an external manager runs the firm in period two.

Proof of Result 4

(1) Senior's succession decision if the junior's ability is low

For the optimal decision of the senior between an internal and external scenario with a low ability of the junior, we distinguish two cases of monitoring. For simplification, a high degree of SEW ($\Psi = 1$) is assumed. Inserting $e^F_{1,s}$, $b^F_{1,s}$, $e^F_{2,j}$, $b^F_{2,j}$ and $d^F_{1,s}$ in the senior's utility $E[U_s]$ which is given by $(A.1)$, and we obtain the equilibrium surplus $E[U^F_s]$ of the internal succession scenario. To derive the equilibrium surplus of the external succession scenario, we must consider the modified objective function of the junior which is given by $(A.2)$. Inserting $e^E_{1,s}$, $b^E_{1,s}$, $e^E_{2,m}$, $b^E_{2,m}$, v^E, f^E and $d^E_{1,s}$ into the senior's utility $E[U_s]$, we obtain $E[U^E_s]$. The senior's utility between the internal and the external succession scenario is given by

$$E[U^F_s] - E[U^E_s] = \Delta. \tag{A.3}$$

(i) Assume a scenario with a low productive junior ($\delta_j = 0.5$) and low monitoring ($\lambda = 1$). Then, the difference between the senior's utility between the internal and the external succession scenario is characterized by:

$$\begin{aligned}\Delta = {} & \frac{8h\left(h-\frac{1}{2}\right)\left(h-\frac{7}{8}\right)^2 {k_0}^2 - 4h\left(h-\frac{7}{8}\right)}{(2h-1.75)^2} - \sqrt{(4h-3)^{-2}}\left(2\sqrt{(4h-3)^{-2}}+2\right) \\ & - \frac{32\left(\frac{1}{8}+\left(h-\frac{3}{4}\right)^2\left(h-\frac{1}{2}\right){k_0}^2 - \frac{1}{2}\left(h-\frac{3}{4}\right)^2 k_0\right)h-5}{(4h-3)^2} \\ & + \sqrt{(2h-1.75)^{-2}}.\end{aligned}$$

Differentiating the above with respect to h and simplifying yield:

$$\frac{\partial\Delta}{\partial h}=\frac{\frac{32}{\sqrt{(2h-1.75)^2}}\left(-\left(h-\frac{3}{4}\right)\left(-\frac{13}{16}+h\right)\left(h-\frac{7}{8}\right)\sqrt{(4h-3)^{-2}}+2\left(h-\frac{7}{8}\right)^3\right)}{\sqrt{(4h-3)^{-2}}\sqrt{(2h-1.75)^{-2}}\,(2h-1.75)^3\,(4h-3)^3}$$
$$+\frac{32\left(-4\left(h-\frac{3}{4}\right)^3\sqrt{(4h-3)^{-2}}\right)}{\sqrt{(4h-3)^{-2}}\sqrt{(2h-1.75)^{-2}}\,(2h-1.75)^3\,(4h-3)^3}.$$

Since $h\in(0,0.5]$, $\frac{\partial\Delta}{\partial h}$ is strictly negative. In this scenario, a higher inheritance tax rate makes hiring of an external manager more beneficial.

(ii) Assume a scenario with a low productive junior ($\delta_j=0.5$) and a high monitoring ($\lambda=2$). Then, the difference between the senior's utility in the internal and the external succession scenario is characterized by:

$$\Delta=\frac{\left(8h\left(h-\frac{1}{2}\right)\left(h-\frac{7}{8}\right)^2{k_0}^2-4h\left(h-\frac{7}{8}\right)^2k_0+h-\frac{7}{8}\right)}{(2h-1.75)^2}+\sqrt{(2h-1.75)^{-2}}$$
$$+3\,(3h-2)^{-2}-2\left(3\sqrt{(6h-4)^{-2}}+\frac{2}{3}\right)\sqrt{(6h-4)^{-2}}$$
$$\frac{-18h\left(\frac{1}{8}+\left(h-\frac{1}{2}\right)\left(h-\frac{2}{3}\right)^2{k_0}^2-\frac{1}{2}\left(h-\frac{2}{3}\right)^2k_0\right)}{(3h-2)^2}.$$

Differentiating above with respect to h and simplifying yield:

$$\frac{\partial\Delta}{\partial h}=-\frac{22.5\left(h-\frac{3277057}{4915586}\right)\left(h-\frac{102295}{132707}\right)\left(h-\frac{1225405}{1400463}\right)}{\left(2h-\frac{7}{4}\right)^3(3h-2)^3}$$
$$+\frac{18\left(h^2-\frac{97205h}{55576}+\frac{1577}{2062}\right)\left(h-\frac{24341}{27788}\right)}{\sqrt{(6h-4)^{-2}}\left(2h-\frac{7}{4}\right)^3(3h-2)^3}$$
$$+6\frac{-9h^3+18h^2-12h+8/3}{\sqrt{\left(2h-\frac{7}{4}\right)^{-2}}\left(2h-\frac{7}{4}\right)^3(3h-2)^3}.$$

Since $h\in(0,0.5]$, $\frac{\partial\Delta}{\partial h}$ is strictly negative. Therefore, a higher tax rate makes hiring an external manager more beneficial.

In Result 4, we study the influence of the inheritance tax rate on the senior's succession decision. Above, we consider the extreme case of $\Psi = 1$. However, the same influence of the tax rate can be obtained if we relax this condition. Therefore, we now assume $\Psi = \frac{1}{2}$:

(iii) Assume a scenario with a low productive junior ($\delta_j = 0.5$), low monitoring ($\lambda = 1$) and a lower value for SEW ($\Psi = 0.5$). Inserting these values in ($A.3$) and differentiating the expression with respect to h yield:

$$\begin{aligned}\frac{\partial \Delta}{\partial h} = & - \frac{(h-1.749987)(h-1.81256)(h-1.8749865)}{32\ (h-1.875)^3 (h-1.75)^3} \\ & + \frac{(h-1.8761)\left(h^2-3.7489h+3.5136\right)}{4\sqrt{(h-1.75)^{-2}(h-1.875)^3 (h-1.75)^3}} \\ & - \frac{1}{4\sqrt{(h-1.875)^{-2}(h-1.875)^3}}.\end{aligned}$$

As in (i), it holds that $\frac{\partial \Delta}{\partial h}$ is strictly negative since $h \in [0, \frac{1}{2})$.

(iv) Assume a low productive junior ($\delta_j = 0.5$), low SEW ($\Psi = 0.5$) and a stronger monitoring ($\lambda = 2$), substitution and differentiation yield:

$$\begin{aligned}\frac{\partial \Delta}{\partial h} = & - \frac{45\ (h-1.6666)(h-1.7708)(h-1.874999)}{256\ (h-1.875)^3 (1.5h-2.5)^3} \\ & - \frac{3(9h-14.9921)\left(h^2-3.3342h+2.7792\right)}{32\sqrt{(h-1.875)^{-2}(h-1.875)^3 (1.5h-2.5)^3}} \\ & + \frac{18(h-1.87708)\left(h^2-3.7479h+3.5117\right)}{32\sqrt{(1.5h-2.5)^{-2}(h-1.875)^3 (1.5h-2.5)^3}}.\end{aligned}$$

Similar to (ii), it also holds that $\frac{\partial \Delta}{\partial h}$ is strictly negative since $h \in [0, \frac{1}{2})$.

In all scenarios mentioned above and in presence of a low productive junior, comparative statics have the same effect. Therefore, a higher tax rate makes hiring an external manager more attractive. This finding also holds for lower values of Ψ (i.e., $\Psi = 1$).

(2) Senior's succession decision if the junior's ability is high

In case of a junior with a high ability, he is equally productive as an external manager. Since hiring an external is linked to agency costs, the senior will always decide that his junior should run the firm. To show this analytically we use (A.3) and assume $\delta_j = 1$ and $\lambda = 2$:

$$\Delta = -1296 \frac{\left(h - \frac{2}{3}\right)^3 (h - 0.5)^3 \left(\left(-h^2 + \frac{7}{6}h - \frac{1}{3}\right)\sqrt{(2h-1)^{-2}} + \frac{1}{24}\right)}{(3h-2)^4 (2h-1)^4}$$
$$- 1296 \frac{\left(h - \frac{2}{3}\right)^3 (h - 0.5)^3 \left(0.5\sqrt{(6h-4)^{-2}}\left(6h^2 - 7h + 2\right)\right)}{(3h-2)^4 (2h-1)^4}.$$

Since $h \in [0, \frac{1}{2})$, the equation above is strictly positive and, therefore, a family-member CEO is always preferred.

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