FACULTY OF LAW, ECONOMICS AND FINANCE

Department of Economics and Management

Discussion Paper

2022-11

Management

Department of Economics and Management
University of Luxembourg

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available online : https://wwwfr.uni.lu/recherche/fdef/dem/publications/discussion_papers

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August 2022

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TRADE SECRET PROTECTION AND R&D INVESTMENT OF FAMILY FIRMS

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August 2022

This paper is forthcoming in *Family Business Review*

ABSTRACT

Family firms are known for their reluctance to invest in research and development. We show that strengthened trade secret protection is associated with higher R&D investment by family firms. More specifically, we show that the association between the strength of trade secret protection through the U.S. Uniform Trade Secrets Act and R&D investment is positively moderated by family control. Our results further show that the positive moderation of family control on the association between the strength of trade secret protection and R&D investment varies with the industry context, being stronger in high tech industries and weaker in discrete product industries.

Keywords: Family firms; intellectual property protection; trade secret protection; UTSA; R&D investments; socioemotional wealth

Introduction

Family firms have been shown to invest less in research and development (R&D) than non-family firms because of the risky and uncertain nature of R&D (Chrisman & Patel, 2012; Block, Miller, Jaskiewicz, & Spiegel, 2013; Patel & Chrisman, 2014). Another reason for the lower R&D investment level of family firms can be their reluctance towards patent protection for appropriating the returns of their R&D (Bannò, 2016; Chirico et al., 2020). Patents are costly and require the disclosure of the protected technologies, which conflicts with family firms' preference for keeping control over their business and valuable assets (Chirico et al., 2020). Our study, therefore, focuses on the association between trade secret protection, an alternative means for intellectual property (IP) protection which is less costly than patents and does not require the disclosure of the protected knowledge (e.g. Hall, Helmers, Rogers, & Sena, 2014), and family firms' R&D investment. We ask the specific research question: Is the association between the strength of trade secret protection and R&D investments positively moderated by family control?

To the best of our knowledge, we are the first to investigate the association between trade secret protection and family firms' engagement in R&D. Therewith, we address an important research gap because practitioners see trade secrets as the most effective means for appropriating returns to R&D (see practicioner survey evidence provided by Levin et al., 1987; Cohen, Nelson, & Walsh, 2000; Arundel, 2001) and economic theorists agree that the most valuable inventions should be protected by trade secrets rather than by patents (Horstmann, MacDonald, & Slivinski, 1985; Anton & Yao, 2004; Zaby, 2010). As compared to patents, trade secrets have several advantages including the fact that the protected knowledge does not need to be disclosed (e.g. Hall et al., 2014), the absence of administrative fees (De Rassenfosse & Jaffe, 2018) and potentially high infringement costs (Somaya, 2012).

Drawing from the concept of socio-emotional wealth (SEW), defined as the stock of affective endowments or noneconomic utilities that accrue to members of the owning family (see Chen & Hsu, 2009; Muñoz-Bullón & Sanchez-Bueno, 2011; Block, 2012; Chrisman & Patel, 2012; Gomez–Mejia et al., 2014; Duran, Kammerlander, Van Essen, & Zellweger, 2016), we argue that the attractiveness of trade secrets as an IP protection tool should be greater for family firms than for non-family firms. The fact that trade secrets do not require the disclosure of the protected technologies should appeal to family firms' need for maintaining control over their valuable assets (Chrisman & Patel, 2012; Kotlar & De Massis, 2013; Gomez–Mejia et al., 2014; Patel & Chrisman, 2014). In addition, the undiversified nature of family firms (Anderson, Mansi, & Reeb, 2003) and the greater loyalty of their employees (Eisenberger, Armeli, Rexwinkel, Lynch, & Rhoades, 2001; Bammens, Notelaers, & Van Gils, 2015) should help preventing the leakage of trade secrets.

In order to investigate the possible association between trade secret protection and R&D investment of family firms empirically, we exploit the enactment of the Uniform Trade Secrets Act (UTSA) as our research laboratory (Png, 2017a, 2017b; Contigiani, Hsu, & Barankay, 2018). Trade secret protection in the U.S. is governed by state law which leads to variation in the strength of trade secret protection in the different U.S. states before and after the enactment of the UTSA. The UTSA was enacted in the U.S. states in different years between 1980 and 1998 (Pooley, 1997)). We employ an index developed by Png (2017a) that depicts the strength of trade secret protection before and after the state by state enactment of the UTSA in order to investigate the behavioral consequences of strengthened trade secret protection (see also Contigiani et al., 2018).

Our empirical analysis is based on a U.S. firm panel of 224 S&P 500 manufacturing and service industries' firms among which 64 are founding family firms, i.e. family firms where at least one member of the founding family is still present in the firm as CEO, chairman, chairman emeritus or member of the board and management at the end of our sample period (Anderson et al., 2003; Anderson & Reeb, 2003a; King & Peng, 2013; Mazur & Wu, 2016; Dick, Wagner, & Pernsteiner, 2021). The presence of family members in a controlling position is essential for our SEW-inspired arguments because we can assume that SEW-related goals such as family members' identification with the firm and family succession (Gómez-Mejía et al., 2007) receive priority over financial goals when family members are in control (Cruz, Gómez-Mejia, & Becerra, 2010; Zellweger, Kellermanns, Chrisman, & Chua, 2012). SEW-related goals are expected to lead to a stronger association between strengthened trade secret protection and R&D investment for family firms than for non-family firms. We find empirical support for a positive moderation of family control on the association between the strength of trade secret protection and R&D investments. This is our main hypothesis.

We further focus on the impact of different industry contexts (De Massis, Kotlar, Wright, & Kellermanns, 2018). Our results reveal that, in line with our second and third hypothesis, the moderation of family control on the association between the strength of trade secret protection and R&D investment is stronger in high-tech industries and weaker in discrete product industries.

Our study makes several contributions. First, we contribute to the literature on family firms and innovation (Duran et al., 2016; Calabrò et al., 2019). We add to two streams of this literature. First, we extend the small, but increasing literature which investigates family firms' usage of IP protection means (Block et al., 2013; Jell, Block, Henkel, Spiegel, & Zischka, 2014; Bannò, 2016; Chirico et al., 2020). To the best of our knowledge, previous evidence in this domain focuses exclusively on patents as a means of IP protection, meaning that we present the first study to demonstrate the importance of a strong trade secrecy regime for family firms. Second, we contribute to the literature on family firms' innovation behavior by confirming that variation in family firms' behavior depends on contextual factors (Gedajlovic, Carney, Chrisman, & Kellermanns, 2012; Wright, Chrisman, Chua, & Steier, 2014; Soluk, Miroshnychenko, Kammerlander, & De Massis, 2021). Therewith, we respond to the specific call by Calabrò et al. (2019) and Feranita, Kotlar, and De Massis (2017) to scrutinize not only the importance of the legal system and of property rights protection, but also of sector heterogeneity for family firms' innovation behavior (see also Neubaum, Kammerlander, & Brigham, 2019; Soluk et al., 2021).

We further contribute to the literature on trade secrets (see Hall et al., 2014 for a survey), and on the impact of the UTSA in particular (Png, 2017a, 2017b; Contigiani et al., 2018), by showing that family ownership is associated with a distinctive response to the UTSA. Family firms are characterized by concentrated ownership structures and governance which facilitates oversight over the typically few R&D projects (Anderson et al., 2003). In light of this, our results suggest that measures to strengthen trade secret protection may be more effective for firms with a concentrated ownership structure.

Theoretical Background & Hypotheses

Socio-emotional wealth in family firms

Family firms are characterized by the influence exercised by the family on the management of the firm, as well as by the vision of how the business-family relationship should work across multiple generations (Chua, Chrisman, & Sharma, 1999; De Massis, Ding, Kotlar, & Wu, 2018). This vision leads to the adoption of particular family-centered goals which reflect family values and legacy and requires keeping control over business matters in the family (Gómez-Mejía et al., 2007; Chrisman & Patel, 2012; De Massis, Kotlar, Chua, & Chrisman, 2014). Family-centered goals and the tight relationship between family and firm generate what is called SEW (Gómez-Mejía et al., 2007; Berrone, Cruz, Gomez-Mejia, & Larraza-Kintana, 2010). SEW refers to the nonfinancial benefits that accrue to family members due to their ownership of the firm (Gomez-Mejia et al., 2007) such as building a family identity, the preservation of the family dynasty and family values and the opportunity to act altruistically vis-à-vis family members using business resources (Gómez-Mejía et al., 2007; Kellermanns, Eddleston, & Zellweger, 2012; Miller & Le Breton–Miller, 2014). Strategic decisions of family firms have been shown to be shaped by the quest to avoid SEW losses (Chrisman & Patel, 2012; Gomez Mejia et al., 2014).

In striving for SEW protection, family firms have been shown to be reluctant to engage in activities that could put family ownership and control at risk. These activities include firm acquisitions (Caprio, Croci, & Del Giudice, 2011; Hussinger & Issah, 2019; Issah, 2020), industry cooperatives (Gomez-Mejía et al., 2007) and R&D investment (Chrisman & Patel, 2012; Gomez–Mejia et al., 2014; De Massis, Ding, et al., 2018). Risky endeavors that have the potential to generate large future benefits, but threaten current SEW, present a dilemma for family firms who then often decide in favor of the status quo (Lumpkin & Brigham, 2011; Chirico et al., 2020).

The focus on SEW is especially strong among family firms when the founders are involved in decision making (Anderson et al., 2003; Anderson & Reeb, 2003b; Mazur & Wu, 2016; Dick et al., 2021). Founders of family firms often perceive themselves as custodians of the family legacy with an obligation to preserve the business for future generations (Brinkerink & Bammens, 2018). Fortified by discretionary powers derived from their controlling share holdings (Di Vito, Laurin, & Bozec, 2010) and their involvement in the management of the firms either in top management positions, as a member of the board of directors or as chairperson of the board of directors (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1999), founders of family firms maximize their tenure (Anderson, Duru, & Reeb, 2012) and influence business decisions to preserve the business for later generations (Bozec & Di Vito, 2019).

In addition, founders of family firms tend to have a large share of their personal wealth invested in their firms (Chen & Hsu, 2009). The undiversified nature of founders' wealth amplifies the risk of loss of personal wealth and SEW (Gomez-Mejia, Makri, & Larraza Kintana, 2011; Anderson et al., 2012; Miller & Le Breton–Miller, 2014). Therefore, SEW loss aversion is magnified in founder-controlled family firms and affects the investment preferences in founder-controlled family firms more strongly (Berrone, Cruz, & Gomez-Mejia, 2012; Kellermanns et al., 2012).

SEW and R&D investments of family firms

As a multifaceted construct, SEW impacts family firms' decision to invest in R&D through different channels which we detail in this section.

Costs, risk and uncertainty of R&D investments

Investment in R&D threatens short-term SEW because it involves substantial costs with uncertain returns which may only occur in the long-run (Chrisman & Patel, 2012; Gomez–Mejia et al., 2014). Part of the costs of R&D is sunk and subject to indivisibilities (Arrow, 1972). As it constitutes a large financial commitment, R&D threatens the short-term SEW of family firms (Berrone et al., 2010; Gomez-Mejia, Cruz, Berrone, & De Castro, 2011; De Massis, Di Minin, & Frattini, 2015).

Furthermore, family firms are directly impacted by R&D project failures, even more so if the family name is directly linked to the firm (Chirico et al., 2020). This implies a differential loss of current SEW owing to the reputational damage as a result of a failed R&D project (Gomez–Mejia et al., 2014).

Concentrated family firm investment and concentrated personal wealth

R&D additionally threatens short-term SEW because the family firm owner's personal wealth is often concentrated in a few projects with a large stake invested in the family firm (Chen & Hsu, 2009). In addition, family firms tend to be less diversified than non-family firms (Gomez-Mejia, Makri, et al., 2011; Anderson et al., 2012; Miller & Le Breton–Miller, 2014). The concentration of personal wealth and the lack of diversification of the firm induces a rational sensitivity of decision makers in family firms with regard to risky projects (Bianco, Bontempi, Golinelli, & Parigi, 2013).

Control and decision making and external financing for R&D

Control and decision-making are fundamental elements of family ownerships, and are closely linked to their need to preserve SEW (Miller & Le Bretton-Miller, 2014). The importance of control has implications for the financing of R&D (Chrisman & Patel, 2012; Gomez-Mejia et al., 2014; Patel & Chrisman, 2014) because external financing of R&D poses an additional SEW threat through the involvement or interference of external capital providers in company affairs (Gomez-Mejia, Makri, & Kintana, 2010). Due to the high level of asymmetric information between the innovating firm and the potential lenders, R&D is often financed largely by internal means (Arrow, 1972; Kamien & Schwartz, 1975; Himmelberg & Petersen, 1994). Family firms, with their emphasis on control over the business, avoid external financing even more strongly than non-family firms in order to not dilute family control by external parties who may in turn introduce reporting requirements and demand participation in decision-making processes (Chrisman & Patel, 2012).

Control and decision making and external expertise for R&D

Family firms' focus on control over business matters also plays a role in resource availability for R&D (Chrisman, Chua, De Massis, Frattini, & Wright, 2015; Sciascia, Nordqvist, Mazzola, & De Massis, 2015). Due to the technical nature of R&D projects, there are specialized human capital requirements that need to be met to conduct and manage the R&D process (Chrisman and Patel (2012). Often, the necessary skills and expertise cannot be provided by the family (De Massis, Audretsch, Uhlaner, & Kammerlander, 2018). Relying on external expertise to foster R&D and top management teams is, however, not desirable for family firms as this diminishes family control and grants non-family members access to decision-making processes, establishing yet another SEW threat (Gomez-Mejia et al., 2010; Gomez–Mejia et al., 2014).

Family firms' governance structure

Concentrated ownership is favored by family firms as it facilitates stricter financial and managerial control (Czarnitzki & Kraft, 2009; Block, 2012). For innovation, however, tight control is counterproductive. Innovation, and radical innovation projects in particular (Hussinger, Dick, & Czarnitzki, 2018), requires the freedom to experiment as well as a certain degree of slack, which is defined as resources currently not used (Levinthal & March, 1981). Slack facilitates the search for ideas (Levinthal & March, 1981) and, in addition, allows for a flexible adaption of free resources and managerial attention throughout the life cycle of innovation projects and across different innovation projects (Cyert & March, 1963). However, experimentation and slack to the search for new ideas and technical solutions cannot be justified in terms of expected short-term returns and is thus constrained by strict financial and managerial control exerted by family owners.

Success of family firms' R&D

The fact that family firms tend to invest less in R&D does not imply that their R&D efforts are less successful (De Massis et al., 2015; Duran et al., 2016). On the contrary, results from a meta-analysis of 108 studies show that family firms invest less in R&D but achieve greater results (Duran et al., 2016). The reason for the better conversion of R&D into innovations is the same reason that hampers R&D in the first place: tight control (Uhlaner, 2013). While control hampers the creative process at the beginning of an innovation project, it helps avoiding managerial inefficiencies when transforming R&D into an innovation (Uhlaner, 2013; Duran et al., 2016)

Hypotheses

After having established the multiple relationships between SEW and family firms' R&D investment, in this section we employ SEW as an explanatory framework when investigating family control as a moderator for trade secret protection and R&D investment.

Family firms' R&D investment under strengthened trade secret protection

The main aim of any IP protection strategy is to safeguard the returns from R&D investments (Reitzig & Puranam, 2009). Previous literature informs us about family firms' reluctance to employ patents, the most prominent IP protection means, to safeguard their R&D investment (Chirico et al., 2020). Patents are associated with substantial risks and costs, including the need to disclose the protected invention which can invite competitors to benefit from the invention through re-engineering (Arundel, 2001; Hussinger, 2006; Hall et al., 2014), administrative costs including the application costs and patent renewal fees (De Rassenfosse & Jaffe, 2018), potential infringement costs (Somaya, 2012), and costs associated with reallocating efforts and resources towards patenting (Foss & Foss, 2005). These risks and costs of patenting threaten short-term SEW by demanding financial resources that were intended for other purposes, by diverting financial and non-financial resources from other business lines, and by exposing the family firm to the risk of expropriation (Chirico et al., 2020). After weighing potential short-term SEW losses associated with patents against prospective long-term financial and SEW gains, family firms often decide against patent protection (Block et al., 2013; Bannò, 2016).

We argue that trade secrets offer a more attractive IP protection choice for family firms. The fact that trade secrets do not require disclosure of the protected technology should appeal more to family firms than to non-family firms because of family firms' need to maintain control over their business and valuable assets (Chrisman & Patel, 2012; Kotlar, De Massis, Frattini, Bianchi, & Fang, 2013; Gomez–Mejia et al., 2014; Patel & Chrisman, 2014). After a patented invention is disclosed, the owner of the patent has no control over the spread and the usage of the information being published in patent documents. There is a risk that third parties could re-engineer and improve upon the protected technology (Arundel, 2001; Hussinger, 2006). In addition, a competitor can sue the patent holder for infringement (Somaya, 2012). These possible consequences of patenting cannot be controlled by the patent owners and threaten family firms' short- and long-term SEW (Chirico et al., 2020).

We argue further that the absence of administrative and organizational costs for trade secret protection does not impose a threat to short-term SEW like patent protection does (Chirico et al., 2020). These costs require patenting firms to reallocate financial resources towards the patenting process, which can raise conflicts in family firms where the resource allocation is in line with SEW considerations. We conclude that trade secrets should appeal more to family firms that prioritize SEW goals over financial goals than to non-family firms (Cruz et al., 2010; Kellermanns et al., 2012)

Another aspect to be considered is the extent to which firms are able to protect trade secrets. We argue that family firms should be better able to prevent trade secret leaks because family firms have a concentrated ownership structure (Czarnitzki & Kraft, 2009; Block, 2012) and tend to be undiversified (Gomez-Mejia, Cruz, et al., 2011; Anderson et al., 2012; Miller & Le Breton–Miller, 2014). A firm with only a few projects can focus managerial attention which allows better oversight and control (Gomez-Mejia, Cruz, et al., 2011; Anderson et al., 2012; Miller & Le Breton–Miller, 2014). We argue that better managerial control and a higher involvement of the management with the ongoing projects helps to avoids undesired knowledge outflows.

Adding to this, family firms enjoy greater loyalty from their employees than non-family firms (Eisenberger et al., 2001; Bammens et al., 2015). With family firms showing a high level of concern for their employees (Miller, Le Breton-Miller, & Scholnick, 2008; Bammens et al., 2015), including the offer of greater job security (Stavrou, Kassinis, & Filotheou, 2007; Block, 2010), employees of family firms develop a feeling of obligation to reciprocate the employer's commitment by adopting behaviors that support organizational goals (Eisenberger et al., 2001; Bammens et al., 2015). The loyalty of family firm employees helps to prevent the deliberate leakage of trade secrets (Hannah, 2006).

After having established that trade secrets are an appealing means of IP protection for family firms, the question that remains is whether long-term profits of the invention and thus long-term SEW are protected well enough against misappropriation when trade secret protection is chosen. The UTSA strengthened trade secret protection tremendously by declaring the mere acquisition of a trade secret as misappropriation (Pooley, 1997). This means that third parties do not need to use or disclose the acquired trade secret to act in an unlawful manner. The UTSA further specifies that the owner of a trade secret has a three-year period to commence legal action (Png, 2017a). In addition, an injunction can be long enough to eliminate any advantages from misappropriating the trade secret (Png, 2017a). In case of willful and malicious misappropriation, the punitive damages can reach a value of up to twice the actual damage of misappropriation (Png, 2017b, 2017a). This illustrates that trade secrets, while already been seen as effective in earlier years (Levin et al., 1987; Cohen et al., 2000), received a substantial increase of legal protection power through the UTSA.

The last point that deserves attention is that the R&D investment made by family firms tends to be lower than the R&D investment from non-family firms (Berrone et al., 2010; Gomez-Mejia, Cruz, et al., 2011; De Massis et al., 2015; De Massis, Ding, et al., 2018). One can derive that there is greater potential for family firms to increase their R&D investment if the conditions change, because family firms will value incremental increases in trade secret protection more favorably than non-family firms.

From the discussion above, we conclude that strengthened trade secret protection through the UTSA should incentivize family firms to increase their R&D investment by providing better protection by means of IP, which meets family firms' desire to keep control of their technology. In other words, with strong trade secret protection, family firms do not need to employ costly SEW-threatening patents or completely abstain from IP protection, but can rely on trade secret protection to safeguard long-term profits from R&D and therewith long-term SEW without diminishing current SEW (Woodfield & Husted, 2017; Gimenez-Fernandez et al., 2020).

Hypothesis 1: Family control positively moderates the association between the strength of trade secret protection and R&D investment.

Family firms' R&D investment under stronger trade secret protection in different industry contexts

Recent studies have drawn our attention to heterogeneity of family firms' innovation behavior (Chua, Chrisman, Steier, & Rau, 2012; Calabrò et al., 2019; De Massis, Wang, & Chua, 2019) with a specific focus on contextual factors (De Massis, Frattini, & Lichtenthaler, 2013; Calabrò et al., 2019). Prior literature in the innovation domain has shown that the effectiveness of IP means varies with different industry contexts with IP protection being most important in high tech sectors (Levin et al., 1987; Cohen et al., 2000; Arundel, 2001). These prior studies also show significant differences in the usage and effectiveness of IP protection means in discrete and complex product industries (Levin et al., 1987; Cohen et al., 2000; Arundel, 2001). In the following, we derive hypotheses concerning the moderating effect of family control on the association between strengthened trade secret protection and R&D investment in these different industry contexts.

High tech sectors

R&D investment is essential for both family firms and non-family firms in high tech industries for survival and competitiveness (Griliches & Mairesse, 1984; Ortega-Argilés et al., 2010). The dependence on innovation in high tech industries implies that not investing in R&D bears a significant downside risk for non-family firms and also for family firms (Block, 2012; Gomez–Mejia et al., 2014). This is reflected in the fact that the R&D investment of family firms in high tech industries is higher as compared to family controlled firms that operate in a different industry environment (Gomez–Mejia et al., 2014; Tsao, Chang, & Koh, 2019).

Family firms' decision making on innovation-related matters is often characterized as a cost benefit analysis where family firms frame the costs and benefits differently than non-family firms because of their SEW considerations (e.g. Chrisman and Patel, 2012, Chirico et al., 2020). For family firms in high tech sectors, R&D investment is closely linked to SEW because innovation is essential for success and survival, and can grant competitive advantage (Block, 2012; Gomez-Mejia et al., 2014). In the previous section, we established that trade secrets are an appealing IP protection tool for family firms which incentivize R&D investment. Building on these arguments, we argue that strengthened trade secret protection leads to greater expected benefits from R&D investment for family firms in high tech sectors than in other industries because family firms in high tech sectors have more to gain from additional R&D investment in terms of financial performance and SEW.

We observe that family-controlled firms in high tech sectors have, in general, greater incentives to invest in R&D (Gomez–Mejia et al., 2014; Tsao et al., 2019). The importance of R&D investment in high tech sectors also leads to an increased need for family firms to protect the resulting inventions, which implies that strengthened trade secret protection alters the cost benefit calculation for R&D investment of family firms in high tech industries differently. Trade secrets allow family firms to protect their IP better according to family firm preferences so that they expect to be able to generate greater value from their R&D investment. The value generated from R&D investments in high tech sectors is greater than in other industries given that R&D investment can lead directly to a competitive advantage or an increase in profits (Gomez–Mejia et al., 2014). In other words, stronger IP protection by trade secrets can help family firms in high tech sectors, where competition is based on innovation, to increase their financial performance and also SEW more strongly than in other industries which in turn incentivizes additional R&D investment.

Due to the importance of R&D in high tech sectors and the resulting strong link between SEW and R&D for family firms, we argue that the association between R&D investments and strengthened trade secret protection is stronger for family firms in high-tech sectors.

Hypothesis 2: The positive moderation of family control on the association between the strength of trade secret protection and R&D investment is stronger in high-tech industries than in low-tech industries.

Discrete product industries

Discrete product industries such as the chemical or pharmaceutical industry produce inventions that consist of a few patentable elements (Cohen et al., 2000). By contrast, complex product industries such as electronics and information technology are those where a single product consists of a large number of patentable elements (Cohen et al., 2000). While trade secrets are generally preferred over patents for appropriating the returns from R&D (see survey evidence provided by Levin et al., 1987; Cohen et al., 2000), patents are nevertheless found to be effective for appropriating the returns from inventions in discrete product industries (Cohen et al., 2000). The higher effectiveness of patents for appropriating the returns from R&D makes it less desirable to substitute trade secrets for patents in discrete product industries. We argue that this has implications for the association between strengthened trade secret protection and family firms' R&D investment, leading to a weaker relationship between both.

Apart from their function of protecting knowledge and safeguarding returns from R&D, patents are used as strategic tools across all industries (Arundel & Kabla, 1998; Cohen et al., 2000; Blind, Edler, Frietsch, & Schmoch, 2006; Giuri et al., 2007; Graham, Merges, Samuelson, & Sichelman, 2009). More specifically, patents are used for blocking rival firms' innovation (Blind et al., 2006; Giuri et al., 2007; Motohashi, 2008; Czarnitzki et al., 2020). In discrete product industries, we observe so-called offensive patent blocking strategies (Cohen et al., 2000; Blind et al., 2006; Czarnitzki et al., 2020). Offensive patent blocking is a practice whereby firms patent alternatives for a focal invention as a way of pre-empting technology substitutes by rival firms. This can be imagined as the erection of "patent fences" for related inventions around a firm's core technologies (Cohen et al., 2000; Schneider, 2008). Patent fences hinder competitors from commercializing substitute inventions for the firm's core technologies, thereby helping the firm to safeguard the expected returns (Gilbert & Newbery, 1982; Schneider, 2008). Trade secrets cannot be used for building such fences due to their non-disclosure feature which, as we argue, makes them less attractive for firms in discrete product industries.

We argue that the moderating role of family control on the association between strengthened trade secret protection and R&D investment is weaker in discrete product industries. Given that the risks of foregoing the chance to patent are higher in discrete product industries than in other industries where patents are less effective, we expect that family firms, aiming to preserve their SEW, are more reluctant to replace a functional IP strategy based on patents by a new IP strategy based on trade secrets. Family firms have been shown to tend to chose strategies or actions that maintain the status quo (Chirico, Sirmon, Sciascia, & Mazzola, 2011) which means in our context that they stick to their existing IP protection strategy. In addition, family firms have been shown to prefer inaction over action to not put SEW at risk (Chrisman & Patel, 2012). Aiming at maintaining the status quo implies in our context that family firms in discrete product industries do not change their IP protection strategy strongly in response to a stronger trade secret protection regime, so that we also do not expect a major change of their R&D investment under a stronger trade secret regime.

Hypothesis 3: The positive moderation of family control on the association between the strength of trade secret protection and R&D investment is weaker in discrete product industries than in complex product industries.

Data, Variables and Descriptive Statistics

Data

Our sample is based on the Standard & Poor's (S&P) 500 firms as of July 2003 (See also Anderson & Reeb, 2003b; Miller, Le Breton-Miller, Lester, & Cannella Jr, 2007; Chrisman & Patel, 2012;

Hussinger & Issah, 2019). Focusing on the S&P 500 firms has several advantages. First, the S&P 500 firms present a clearly defined sample of (top performing) U.S. firms. To the best of our knowledge, a dataset that follows the population of U.S. (family) firms or a representative sample of U.S. (family) firms over time does not exist. Second, large public firms face greater visibility than small family firm, which implies that they adhere more closely to industry practices while smaller family firms are known for their non-conforming behavior (Miller, Breton-Miller, & Lester, 2013). Testing our hypotheses for large publicly traded family firms thus implies that our empirical findings are less likely to be impacted by idiosyncratic behaviors of individual small family firms. The fact that we find our hypotheses supported for our sample of large, publicly traded firms, in fact, can suggest that we should find stronger reactions for the average smaller and privately held family firm. Lastly, there is a lot of prior evidence available for large publicly traded U.S. family firms which helps us to understand and compare our results (see Miller et al., 2013).

Financial information is retrieved from Compustat, which leads to an unbalanced firm panel for the time period 1980-2003. The choice of the time period has a dual motivation: First, we have information about changes in secrecy law up until the year 1998 retrieved from Png (2017a). We keep five years after the last observed law change to trace the association with firms' R&D investment. Second, we access qualitative details for the S&P 500 firms, which allows us to distinguish family firms from non-family firms from the July issue of the BusinessWeek 2003.

The Business Week definition of family firms follows Anderson & Reeb (2003b) who classify any firm where the founding family controls more than 5% or where a member of the founding family is present on the board as a family firm.[1] In addition, BusinessWeek provides information on what we refer to in the following founder family firms. These are family firms

[1] The list of family firms was validated by Block (2009) and used to investigate the behavior of family firms by Block (2009, 2010, 2012) and Hussinger & Issah (2019).

where at least one member of the founding family is still present in the firm as CEO, chairman, chairman emeritus or member of the board and management in 2003.[2] For our main analysis, we only focus on the founding family firms and drop family firms that cannot be classified as either founding family firms or non-family firms. The focus on founding family firms is chosen because SEW preferences are supposed to be stronger the more the family is involved in the business. We present a robustness check for our empirical findings for the broader family firm definition.

We focus on manufacturing and service industries, which leads to a final sample of 4400 observations for the time period 1980-2003. These observations correspond to 224 S&P 500 firms among which 64 are founding family firms.[3]

The firm-level dataset is supplemented with information about changes in the state-level strength of trade secret protection through the UTSA (Png, 2017a, 2017b). Png (2017a) constructs a sophisticated index for state-level trade secret protection based on substantive law, civil procedure and remedies.[4] The index ranges from zero to one and is shown in Table 1 in Png (2017a, p. 169). It covers 40 trade secret law changes in 40 different U.S. states for the period 1980-1998.

Variables

Our dependent variable is the yearly R&D expenditure of the firm, which we normalize by firm assets (*R&D/ASSETS*) (Block, 2012; Hussinger & Issah, 2019).

[2] The classification of family firms and founder family firms is available from the authors upon request.

[3] Next to firms in other sectors than manufacturing and services, we dropped three firms and their corresponding observations since they turned out to be outliers concerning some of their characteristics. These were Amgen Inc, Medimmune and Danaher.

[4] Png's (2017a) index is the sum of the scores for the six items listed below, divided by six: Substantive law: (a) Whether a trade secret must be in continuous business use, (b) whether the owner must take reasonable efforts to protect the secret, and (c) whether mere acquisition of the secret is misappropriation; Civil procedure: (d) The limitation on the time for the owner to take legal action for misappropriation; Remedies: (e) Whether an injunction is limited to eliminating the advantage from misappropriation and (f) the multiple of actual damages available in punitive damages.

Our first independent variable of main interest is a dummy variable that indicates whether a firm is a founder family firm (*FAM*) or a non-family firm (Anderson & Reeb, 2003b; Andres, 2008; Hussinger & Issah, 2019; Dick et al., 2021). The second important independent variable is a moderator indicating the strength of trade secret protection (*UTSA*) according to Png (2017a). This variable interacted with the family firms' indicator (*FAM*) allows testing H1.

For testing H2, we distinguish between firms associated with high tech industries according to the definition of the OECD (2003) and others. We create a binary variable that indicates whether firms are associated with high tech sectors (*HIGH TECH*). We interact the variables *HIGH TECH*, *FAM* and *UTSA* for testing H2.

For testing H3, we distinguish between firms in discrete and complex product industries (*DISC*). Our definition follows Cohen et al. (2000, pp. 19, footnote 44). A formal test of H3 is conducted by interacting the variables *DISC*, *FAM* and *UTSA*.[5]

In addition to our main variables, we use a number of standard control variables. First, we control for firm size in terms of the logarithm of total assets (*LOG(ASSETS)*) (Scherer, 1965a, 1965b). We take the logarithm of this variable in order to account for the skewness of its distribution. We further control for return on assets (*ROA*) to measure firm performance (See e.g. Bonilla, Sepulveda, & Carvajal, 2010; Kowalewski, Talavera, & Stetsyuk, 2010; Michiels, Voordeckers, Lybaert, & Steijvers, 2011; Graves & Shan, 2014; Holt, Pearson, Carr, & Barnett, 2017). The next control variable is the debt to assets ratio (*DEBT/ASSETS*) which shows whether a firm is highly leveraged, and accounts for the risk associated with the firm's operations (Shim &

[5] Note that complex product industries are a different concept from technological complexity. "Technology is complex when there are many ways to combine inventions in a particular field to obtain novel applications of these inventions" (Hall et al., 2021, p. 914). Table C-5 in the Online Appendix of Hall et al. (2021) shows that there is quite some heterogeneity of technological complexity among the subgroups of complex and discrete product industries.

Okamuro, 2011). We also consider previous patent activity, which is measured as the firm's patent stock normalized by total assets because innovation has been shown to be highly persistent over time (Peters, 2009). Lastly, we include a set of year dummies, 16 industry dummies and 32 state dummies.

Descriptive Statistics

Table 1 shows the descriptive statistics. We distinguish between founding family firms and non-family firms. Firms in our sample are large in terms of assets, which is also reflected in a lower R&D intensity. Founding family firms and non-family firms show significant mean differences for *R&D/ASSETS*, *LOG(ASSETS)*, *PATSTOCK/ASSETS* and *DEBT/ASSETS*. Founding family firms among the S&P 500 firms have a higher R&D/ASSETS ratio than non-family firms and have more patents. Table 1 further shows that there is no significant difference for the variable *UTSA* between family firms and non-family firms indicating that they are equally distributed across the states and years. Table 2 shows that there are no high bivariate correlations between the variables.

Table 1 and 2 about here

Regression Results

Main results

Table 3 presents results of a random effect tobit model with the standard errors clustered at the firm level. A tobit model is used to account for the fact that not all firms have R&D expenses in every year so that we see a left-censored distribution of our dependent variable (*R&D/ASSETS*).

We show three different specifications for each hypothesis. The first specification employs control variables as well as a dummy for founding family firms (*FAM*). We see that, after accounting for several control variables, founding family firms among the S&P 500 do not differ from their peers in terms of *R&D/ASSETS*. This is not surprising because we look at a selective sample of very well-performing founding family firms. The second specification adds the variable *UTSA*. Like Png (2017a), we do not find a significant association between the average firm's R&D investment and the law change. The third specification adds the interaction term between *UTSA* and *FAM*. The estimated coefficient is positive and significant at the 1% level of statistical significance showing that founding family firms are associated with higher R&D investments after the enactment of the UTSA. This supports H1.

Model 4, 5 and 6 of Table 3 present the results of the empirical test for H2. We extend the previous specification by including an indicator for high tech firms (*HIGH TECH*) and interaction terms of this variable with *FAM* and *UTSA* as well as a triple interaction term of these variables.

Founding family firms in high tech sectors do not differ significantly from their non-family peers in the same industries as an insignificant estimated association for the interaction term shows (*FAM * HIGH TECH*). Again, this is likely explained by our focus on the S&P500 firms. Regarding the triple interaction term that tests H2 (*FAM * UTSA * HIGH TECH*), we find that *R&D/ASSETS* for founding family firms in high tech sectors is more strongly related to *UTSA*. The significance level of 1% level of statistical significance of our estimated coefficient supports H2.

Models 7-9 of Table 3 show the results for our test of H3 which predicts a weaker association between the UTSA and R&D investment of family firms in discrete product industries. We extend the specification of models 1-3 by including an indicator for firms operating in discrete product industries (*DISC*) and interaction terms of this variable with *FAM* and *UTSA* as well as a triple interaction of these variables. The triple interaction term (*FAM * DISC * UTSA*) is statistically significant at the 1% level of statistical significance in support of H3.

Table 3 about here

Robustness tests

We conduct various robustness checks. First, we use the broader family firm definition which includes all family firms identified by BusinessWeek rather than only those where founding family members are still actively involved in 2003. We now have a larger sample of 5367 observations for 273 firms, 113 of which are family firms. Table 4 shows the results which confirm the support for H1, H2 and H3 at the 1% level of statistical significance. These robust findings suggest that SEW preferences are also important for S&P 500 family firms in which the founders are not in a controlling position anymore.

Table 4 about here

Next, since triple interaction terms imply a rather complex model specification with many interaction terms, we show that our results hold if we use the respective subsamples for testing H2 and H3. Table 5 shows the results for the subsamples of high tech industries and discrete product industries. The results for the simplified specification show a positive significant association at the 1% level of statistical significance for the interaction term *FAM * UTSA* (model 3) indicating that founding family firms in high tech firms show a stronger association between *R&D/ASSETS* and *UTSA* than their non-family peers. This is in line with hypothesis 2. The results show a negative and significant association for the interaction term *FAM * UTSA* at the 1% level of statistical significance (model 6), indicating that there is a weaker association between *R&D/ASSETS* and *UTSA* for founding family firms in discrete product industries. We conclude that the results are in line with H3.

Table 5 about here

Another robustness check employs a specification in which we use an interaction variable of the patent stock with the founding family firm indicator as an additional control variable. This accounts for the fact that founding family firms are differently predisposed to use patents for the protection of their IP. The results indeed show that there is a significantly different association of the patent stock variable and R&D for founding family firms and non-family firms, wherein the association of the patent stock of founding family firms with the dependent variable is twice as strong. The results for our hypotheses do not change and the full regression results are available upon request.

Graphical illustration of the effect size

Figures 1, 2 and 3 illustrate the estimated associations. We use the results of model 3 of Table 3 for the main association of the UTSA and founding family firms, the association of model 3 of Table 5 for founding family firms in high tech sectors and of model 6 of Table 5 for founding family firms in discrete product industries.

Figure 1 shows the positive association between *R&D/ASSETS* and the UTSA for founding family firms and non-family firms. In high tech sectors (Figure 2), we see the largest difference between founding family firms' R&D investment and that of non-family firms. For founding family firms in discrete product industries (Figure 3), the graph does not indicate a positive association between *R&D/ASSETS* and the UTSA.

Figure 1, 2 and 3 about here

Discussion

General discussion of the results

Here, we explore the relationship between the strength of the legal protection of inventions through trade secrets and R&D investment of family firms. We empirically show that the R&D investment of family firms is positively associated with strengthened legal protection through trade secrets. This effect appears to be family firm specific because, like previous studies (see Png, 2017a), we do not detect an association between the R&D investment of non-family firms and strengthened legal protection through trade secrets. Our findings suggest that trade secrets are especially attractive for family firms. Since trade secrets do not require disclosure of the protected invention (e.g. Hall et al., 2014), do not involve the administrative costs of patents (De Rassenfosse & Jaffe, 2018), or require resource reallocation within the firm (Foss & Foss, 2005), trade secrets do not threaten short-term SEW like alternative means of IP protection such as patents (Chirico et al., 2020). At the same time, trade secrets promise long-term SEW gains by safeguarding the protected inventions because well-protected trade secrets prevent the risks of expropriation and allow firms to recoup their R&D investment (Horstmann et al., 1985; Anton & Yao, 2004; Zaby, 2010; Hall et al., 2014) .

In response to the call to take into account contextual heterogeneity surrounding family firms' innovation behavior (Chua et al., 2012; Calabrò et al., 2019; De Massis et al., 2019), we further investigate two industry contexts which have shown to influence the effectiveness of IP protection (Levin et al., 1987; Cohen et al., 2000; Arundel, 2001). We show that the positive association between the strength of trade secret protection and family firms' R&D investment is stronger for family firms in high-tech industries. In these industries, where SEW related goals are strongly linked to R&D (Gomez-Mejia et al, 2014), the benefits of strong trade secret protection are amplified for family firms.

We further find a less strong association between the strength of trade secret protection and family firms' R&D investment in discrete product industries. This result was expected since patents are more effective for IP protection in discrete product industries (Cohen et al., 2000). In response, the risks of foregoing the chance to patent are higher. Our finding is in line with previous studies that show that family firms prefer inaction over action to not put SEW at risk (Chrisman & Patel, 2012) and that family firms chose strategies that maintain the status quo rather than taking a risk (Chirico et al., 2011).

Contribution to research

Our paper makes several contributions to the literature. First, we contribute to the literature on family firms and innovation (Block, 2012; Duran et al., 2016; Calabrò et al., 2019) where we add to two streams of this literature. We extend the small, but increasing literature on family firms and IP protection (Jell et al., 2014; Bannò, 2016; Chirico et al., 2020; Gimenez-Fernandez et al., 2020) which focuses exclusively on patents as a means of IP protection (Banno, 2016; Kotlar et al., 2013; Chirico et al, 2020) to trade secret protection. While patents appear to be important as a mechanism for protecting control over technologies when it comes to R&D contracts with external partners (Kotlar et al., 2013), patents are costly for family firms as they threaten short-term SEW (Chirico et al., 2020). In particular, the requirement to disclose the protected technology is threatening SEW because it implies that the family firm loses control over the spread and usage of the technology by competitors who may re-engineer the technology and find a way to "invent around" it (Arundel, 2001; Hussinger, 2006; Hall et al., 2014).

Trade secrets, by contrast, are more likely to guarantee control over the protected technology because they do not require disclosure of the protected technology (Hall et al., 2014). In light of this, trade secrets increase control over the protected technologies and the ability to appropriate value from R&D investment (Chirico et al., 2020; Gimenez-Fernandez et al., 2020). Family firms are also likely to have a better chance to control the outflow of knowledge because they tend to focus on only a few projects, which facilitates oversight (Anderson et al., 2003). In addition, employees in family firms have been shown to be more loyal by supporting organizational goals (Eisenberger et al., 2001; Bammens et al., 2015). To the best of our knowledge, previous evidence in this domain focuses exclusively on patents as a means of IP protection; we present the first study that demonstrates the importance of a strong trade secrets regime for family firms. The insights which can be drawn from our study imply that trade secrets are a means of IP protection that appealing to the SEW goals of family firms and, hence, are associated with larger R&D investment of family firms.

We further extend the literature on family firms' innovation behavior by showing that variations in family firms' behavior depend on contextual factors. In so doing, we respond to the call by Calabrò et al. (2019) and Feranita et al. (2017) to scrutinize not only the importance of the legal system and of property rights protection, but also of sector heterogeneity for family firms' innovation behavior. Here, our contribution includes an investigation of the importance of property rights protection through trade secrets in light of different industry sector contexts (Calabro et al, 2018; Feranita et al, 2017; Neubaum et al, 2019). Prior evidence shows that family involvement is associated with lower R&D investment (Block, 2012, Chrisman & Patel, 2012) arising from the concern that SEW may be compromised (Brinkerink & Bammens, 2018). Yet some recent studies explore contexts in which R&D at family firms might behave differently (see Block, 2012;

Chrisman & Patel, 2012; Gomez-Mejia et al., 2014). For example, De Massis, Ding, et al. (2018) focus on China with its weak property rights regime, and observe that, contrary to the view that family involvement leads to lower R&D investments, Chinese firms increase R&D spending when there is family involvement in the business. Since the empirical context of our study is inherently different as we focus on a mature legal and institutional environment, we add to the literature by showing that family firms' responses to strengthened legal IP protection through trade secrets differs depending on the industry context (Wright et al, 2014; Gedajlovic et al, 2012), as do other types of strategic behavior of family firms and their innovation behaviors in particular (Duran et al., 2016; Miroshnychenko & De Massis, 2020; Brinkerink & Rondi, 2021; Rondi, De Massis, & Kraus, 2021). By doing so, we extend the incipient line of inquiry on contextual factors in family firm innovation (Duran et al., 2016; De Massis, Ding, et al., 2018; Neubaum et al., 2019; Jaskiewicz, Neubaum, De Massis, & Holt, 2020; Neubaum & Micelotta, 2021; Soluk et al., 2021)..

Lastly, we extend the literature on trade secrets (See Hall et al., 2014 for a survey), and on the effects of the UTSA in particular (Png, 2017a, 2017b; Contigiani et al., 2018) by showing that family ownership is associated with a distinctive response to the UTSA. Png (2017a) shows that the UTSA had a positive effect on the R&D expenditure of large firms and firms affiliated with high-tech sectors. Castellaneta, Conti, and Kacperczyk (2017) add that trade secret protection has a positive effect in industries with high mobility of knowledge workers and a negative effect in industries with high resource-value uncertainty and high poor-investment risk. We contribute to this literature that shows that the UTSA affected different groups of firms differently by highlighting family firms as one of these firm groups. Family firms are characterized by concentrated ownership structures and governance which leads to a reluctance to invest in R&D (Czarnitzki & Kraft, 2009; Block, 2012) . We suggest that the different governance structure of family firms can lead to higher expected benefits from stronger trade secret protection as it facilitates keeping inventions secret. Hence, our study suggests that corporate governance is an important factor of firm heterogeneity (Aguilera & Crespi-Cladera, 2012; Villalonga, Amit, Trujillo, & Guzmán, 2015) which may moderate the association between trade secret protection and R&D investment beyond family ownership.

Practical implications

Our research also has practical implications. Trade secrets are the most commonly used form of intellectual property protection by managers (Levin et al., 1987; Cohen et al., 2000) so that a better understanding of who is using trade secrets should be of managerial interest and also of policy interest. Managers using trade secrets have to strike a balance between the advantages of non-disclosure and the risk of leakage. Knowledge about which firms, i.e. family firms in our context, see benefits in trade secret protection allows rivals to make a better estimate of the total volume of inventions of a firm by being able to make an informed guess that a large share of the inventions might be kept secret. Family firms themselves can learn from our results that in a regime where trade secrets are well protected they do not need to rely on costly patent protection with potentially negative implications for their short-term SEW, but instead can safeguard their R&D investments with trade secrets. Thus, while some previous studies encourage family firms to open up their innovation process to facilitate value creation (e.g., Chrisman & Patel, 2012; Kotlar et al., 2013), our study encourages family firms to preserve a strong controlling position and to extend it to the protection of their IP through trade secrets in order to capture value from innovations.

Regarding the policy implications, family firms are an important pillar in many economies (Fiss & Zajac, 2004; Soluk & Kammerlander, 2021). For instance, family firms are responsible for 59% of private sector employment and 54% of private sector Gross Domestic Product (GDP) in the U.S. (Pieper, Kellermanns, & Astrachan, 2021). At the same time, there is evidence that family firms make their strategic decisions differently than the average non-family firm, leading to lower levels of innovation in this important segment of the economy than other types of organizations (Duran et al., 2016). This suggests that policy makers who aim to foster innovation in family firms should take measures which appeal specifically to these firms and their SEW considerations. Our results suggest that strengthening legal protection for trade secrets can be one of these measures that stimulate the R&D investment of family firms.

Limitations and future research

Our study is not free of limitations. First, our analysis relies on the enactment of a stronger trade secrecy law to observe behavioral consequences for family firms. This is due to the fact that trade secrets cannot be observed by the researcher (Png, 2017a; 2017b; Contigiani et al., 2018). Future research can complement our study with interview and survey evidence following Levin et al. (1987), Cohen et al. (2000) and Arundel (2001), but with an explicit focus on family owned firms. Furthermore, it would be interesting to investigate firm level factors explaining heterogeneity in the use of trade secrets by family firms. For instance, family firms might rely more on trade secret protection the greater their employee loyalty (Bammens et al, 2015; Hannah, 2006). In relation to this, it would be interesting to investigate whether there is a nonlinear relationship between family involvement and the likelihood of using trade secrets as has been found for patents to protect new technological discoveries (Chirico et al., 2020). In addition, patents and trade secrets can be used for different inventions or for different elements of the same inventions. It would be interesting to investigate whether family firms differ in their IP strategy from comparable non-family firms. Here, survey evidence or interviews with R&D responsible managers in family firms would be informative.

Second, our study uses binary measures of family ownership. The practice of using a binary variable is common in family firm studies (Berrone et al., 2010; Gomez–Mejia et al., 2014; Hussinger & Issah, 2019; Issah, 2020), but in light of the discussion about family firm heterogeneity it would be desirable to distinguish further between different degrees of family involvement. Future studies may examine how varying levels of family ownership influence the R&D behavior of family firms in response to changes of trade secrecy laws. Therefore, a dataset which contains the shares held by families would be helpful.

Third, our study focuses on large publicly traded firms. This has implications for both our empirical results and our theoretical arguments. Regarding the theoretical arguments, we acknowledge that SEW-related motives such as a reluctance to hire external competence or to access external financing are more prevalent in smaller family firms (Berrone et al., 2012). Prior literature, however, also suggests that the family's attachment to the firm, and, thereby the importance of SEW, is highest when the firm is owned and managed by the founding family, which is the case for our main analysis, and that it weakens when the next generation takes over (Chua et al., 1999; Mishra & McConaughy, 1999). With a focus on the Fortune 1000 companies, Le Breton-Miller, Miller, and Lester (2011)additionally suggest that founding family firms place a higher value on SEW than on the business agenda, especially when later generations are involved. Miller et al. (2013) make a strong case for SEW preferences among large publicly traded firms and argue that SEW priorities of large publicly traded family firms can be compensated by strategic conformity. This makes us confident that our SEW arguments are applicable to the family firms in our sample.

Our data confirm this assumption because of at least two reasons. First, more than 57% of the family firms have at least one founding family member in a controlling management position.

This is in line with the argument that family firms aim to keep control in the hands of the family and are reluctant to hire externals for decision making positions. Second, the debt over assets ratio is significantly lower for founding family firms in our sample which is in line with the observation that family firms prefer internal financing due to SEW considerations. Hence, the data supports our SEW based arguments.

Nevertheless, our results might not be representative for the entire population of family firms. We would expect that smaller family firms react more strongly to strengthened trade secret protection. Future studies can focus on family owned and managed small and medium sized firms in order to understand how size variation of family firms influences their responses to the UTSA. Therefore, a dataset of firms including small and medium sized family and non-family firms would be required.

Fourth, the importance of trade secret protection for family firms is likely to differ depending on the firms' innovation strategy. Family firms that are engaged in collaborative innovation activities (Chrisman et al., 2015; Brinkerink, Van Gils, Bammens, & Carree, 2017; Rondi et al., 2021) might be less inclined to rely on trade secret protection for their inventions and technologies. This is because a certain level of disclosure of information about the technologies of a firm is often a prerequisite for accessing external knowledge or technologies (Nieto, Santamaria, & Fernandez, 2015). This presents an opportunity for future research to investigate family firms' IP protection strategy in an open and collaborative innovation setting.

Conclusion

Our study shows that the strengthening of the trade secret protection legislation through the Uniform Trade Secrets Act (UTSA) in the U.S. is associated with an increase in family firms' R&D investment. Our results further show that the industry context matters. The moderating role of family control on the association between R&D investment and a strengthened trade secrecy regime through the UTSA is stronger for family firms in high tech industries and weaker for family firms in discrete product industries.

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Tables

Table 1: Descriptive statistics

Variables	Non-family firms		Family firms		T-test
	Mean	SD	Mean	SD	
R&D/ASSETS	0.042	0.050	0.072	0.073	***
LOG(ASSETS)	7.908	1.584	6.935	1.813	***
ROA	0.069	0.085	0.072	0.110	
DEBT/ASSETS	0.169	0.135	0.114	0.124	***
PATSTOCK/ASSETS	0.063	0.080	0.081	0.106	***
UTSA	0.174	0.232	0.172	0.227	

*** Statistical significance at the 1% level.

Table 2: Bivariate correlations

	Variables	1	2	3	4	5	6
1	R&D/ASSETS	1					
2	LOG(ASSETS)	-0.281	1				
3	ROA	-0.068	-0.077	1			
4	DEBT/ASSETS	-0.353	0.192	-0.250	1		
5	PATSTOCK/ASSETS	0.350	-0.074	-0.075	-0.166	1	
6	UTSA	-0.091	0.102	0.044	0.030	-0.018	1

Table 3: Random effect tobit regression models for R&D investment

	H1: FAM and UTSA			H2: HIGH-TECH INDUSTRIES			H3: DISCRETE PRODUCT INDUSTRIES		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
LOG(ASSETS)	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ROA	-0.058***	-0.058***	-0.058***	-0.058***	-0.058***	-0.057***	-0.058***	-0.058***	-0.058***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
DEBT/ASSETS	-0.027***	-0.027***	-0.026***	-0.026***	-0.025***	-0.024***	-0.026***	-0.026***	-0.025***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
PATSTOCK/ASSETS	0.086***	0.086***	0.088***	0.086***	0.089***	0.089***	0.088***	0.087***	0.090***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
FAM (d)	-0.002	-0.002	-0.006	-0.007	-0.009	-0.006	-0.006	-0.004	-0.007
	(0.008)	(0.008)	(0.008)	(0.007)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)
UTSA		0.001	-0.006	-0.008	-0.018***	-0.013**	-0.006	-0.007	-0.014**
		(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)
FAM*UTSA			0.028***		0.033***	0.016	0.028***	0.028***	0.054***
			(0.009)		(0.009)	(0.010)	(0.009)	(0.009)	(0.011)
HIGH-TECH				0.032***	0.034***	0.036***			
				(0.009)	(0.011)	(0.011)			
HIGH-TECH*UTSA				0.027***	0.033***	0.018*			
				(0.008)	(0.008)	(0.009)			
FAM*HIGH-TECH					-0.006	-0.018			
					(0.017)	(0.017)			
FAM*HIGH-TECH*UTSA						0.080***			
						(0.022)			
DISC							0.027	0.028	0.025
							(0.031)	(0.031)	(0.031)
FAM*DISC								-0.008	0.002
								(0.017)	(0.017)
DISC*UTSA							0.003	0.003	0.023**
							(0.008)	(0.008)	(0.010)
FAM*DISC*UTSA									-0.079***
									(0.019)
constant	0.065	0.065	0.068	0.071	0.075	0.074	0.067	0.066	0.063
	(0.051)	(0.052)	(0.052)	(0.049)	(0.050)	(0.050)	(0.052)	(0.052)	(0.052)
N	4400	4400	4400	4400	4400	4400	4400	4400	4400
ll	6911.73	6911.75	6916.49	6925.24	6932.07	6938.87	6916.57	6916.67	6925.24

d) dummy variable; standard errors in parentheses.
The regressions include industry fixed effects, state fixed effects and year fixed effects.
*p < .10. **p < .05. ***p < .01.

Table 4: Random effect tobit regression models for R&D investment (broader family firms definition)

	H1: FAM and UTSA			H2: HIGH-TECH INDUSTRIES			H3: DISCRETE PRODUCT INDUSTRIES		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
LOG(ASSETS)	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ROA	-0.060***	-0.060***	-0.059***	-0.059***	-0.059***	-0.059***	-0.059***	-0.059***	-0.059***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
DEBT/ASSETS	-0.024***	-0.024***	-0.023***	-0.023***	-0.022***	-0.022***	-0.023***	-0.023***	-0.021***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
PATSTOCK/ASSETS	0.068***	0.069***	0.073***	0.070***	0.074***	0.075***	0.073***	0.074***	0.077***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
FAM (d)	-0.011	-0.011	-0.016**	-0.015**	-0.020**	-0.018**	-0.016**	-0.012	-0.016*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)	(0.009)	(0.009)
UTSA		0.006	-0.006	-0.004	-0.018***	-0.012**	-0.004	-0.004	-0.014**
		(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)
FAM*UTSA			0.033***		0.036***	0.022**	0.033***	0.033***	0.062***
			(0.007)		(0.007)	(0.009)	(0.007)	(0.007)	(0.009)
HIGH-TECH				0.030***	0.029**	0.032***			
				(0.010)	(0.012)	(0.012)			
HIGH-TECH*UTSA					-0.000	-0.008			
					(0.017)	(0.017)			
FAM*HIGH-TECH				0.029***	0.033***	0.018*			
				(0.008)	(0.008)	(0.009)			
FAM*HIGH-TECH*UTSA						0.046***			
						(0.016)			
DISC							0.053*	0.057**	0.053*
							(0.028)	(0.029)	(0.029)
FAM*DISC								-0.012	0.000
								(0.015)	(0.015)
DISC*UTSA							-0.006	-0.006	0.025***
							(0.008)	(0.008)	(0.010)
FAM*DISC*UTSA									-0.082***
									(0.016)
constant	0.037	0.034	0.040	0.040	0.047	0.045	0.041	0.036	0.032
	(0.055)	(0.055)	(0.055)	(0.053)	(0.053)	(0.053)	(0.055)	(0.055)	(0.055)
N	5367	5367	5367	5367	5367	5367	5367	5367	5367
ll	7692.50	7693.68	7703.38	7707.50	7718.99	7723.06	7703.66	7703.98	7717.89

d) dummy variable; standard errors in parentheses

The regressions include industry fixed effects, state fixed effects and year fixed effects.

*p < .10. **p < .05. ***p < .01.

Table 5: Random effect tobit regression models for R&D investment – split sample regressions

	H2: HIGH TECH INDUSTRIES			H3: DISCRETE PRODUCT INDUSTRIES		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
LOG(ASSETS)	-0.009***	-0.009***	-0.010***	-0.005***	-0.005***	-0.005***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
ROA	-0.057***	-0.057***	-0.056***	-0.026**	-0.026**	-0.025**
	(0.015)	(0.015)	(0.015)	(0.013)	(0.013)	(0.013)
DEBT/ASSETS	-0.038**	-0.038**	-0.028*	-0.011	-0.011	-0.010
	(0.015)	(0.015)	(0.016)	(0.008)	(0.008)	(0.008)
PATSTOCK/ASSETS	0.151***	0.151***	0.156***	0.272***	0.272***	0.276***
	(0.020)	(0.020)	(0.020)	(0.022)	(0.022)	(0.022)
UTSA		-0.004	-0.020*		-0.000	0.010
		(0.010)	(0.011)		(0.007)	(0.008)
FAM (d)	0.001	0.001	-0.014	0.010	0.010	0.015
	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.010)
FAM*UTSA			0.086***			-0.039***
			(0.023)			(0.014)
constant	0.089**	0.090**	0.114***	0.043	0.043	0.037
	(0.035)	(0.035)	(0.037)	(0.035)	(0.035)	(0.034)
N	959	959	959	1762	1762	1762
ll	1617.48	1617.57	1624.32	2761.05	2761.05	2764.96

d) dummy variable; standard errors in parentheses
The regressions include industry fixed effects, state fixed effects and year fixed effects.
*p < .10. **p < .05. ***p < .01.

Figures

Figure 1: Association between the UTSA and family firms' R&D/ASSETS

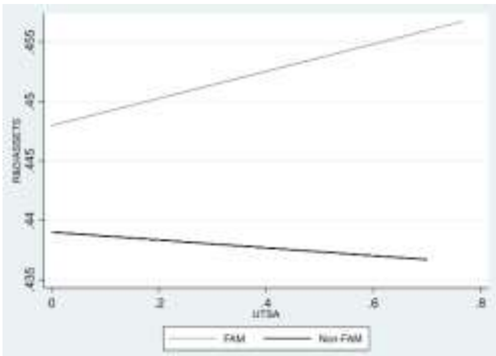

Figure 2: Association between the UTSA and family firms' R&D/ASSETS – High tech industries

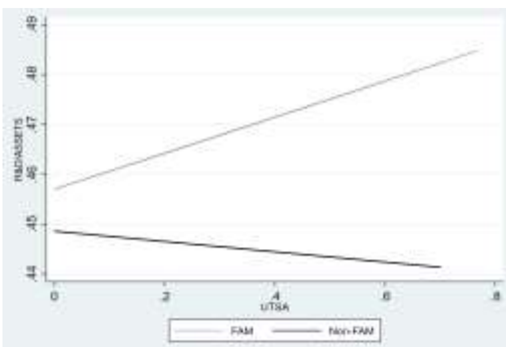

Figure 3: Association between the UTSA and family firms' R&D/ASSETS – Discrete product industries