// NO.23-044 | 11/2023

DISCUSSION PAPER

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Early Patent Disclosure and R&D Investment in Family Firms

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Early Patent Disclosure and R&D Investment in Family Firms

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This paper is forthcoming in the British Journal of Management

October 2023

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Abstract

This paper shows that the American Inventor's Protection Act, which introduced the disclosure of patent applications after 18 months, i.e. before a grant decision is taken and, hence, before it is known whether the respective technology receives legal protection, is associated with a reduction of family firms' research and development (R&D) investment. This suggests that early disclosure of patent applications is perceived as a threat to family firms' innovation activity and discourages their R&D investment. This finding deserves our attention because family firms account for a large share of the U.S. economy and a reduction of their R&D investment can have long-term consequences.

Keywords: R&D investments, AIPA, Family firms, Socio-emotional wealth (SEW)

JEL: O32, M14, O34

INTRODUCTION

Undisclosed knowledge remains secret, diffuses slowly and tends to stay within corporate boundaries (Hall et al., 2014; Baruffaldi and Simeth, 2020). Limiting the spread of valuable knowledge appeals to family firms (FF) since it allows them to keep control over important knowledge assets which is in line with consideration of their socio-emotional wealth (SEW) defined as non-financial, family-related benefits (e.g. Gomez–Mejia et al., 2014; Al-Tabbaa et al., 2022; Gao et al., 2022; Wu and Yu, 2022). In order to receive legal protection against the expropriation of their knowledge by third parties through patents, however, the underlying knowledge needs to be codified and disclosed to society in exchange for temporary legal protection. The decision to patent is, hence, difficult for FF and they ponder the benefits of legal protection against the risks of knowledge disclosure and a loss of control (Chirico et al., 2020). Nevertheless, FF often decide to apply for patents (Duran et al., 2016), especially when patent protection is in line with their business model (Bannò, 2016), when FF have a focus on internationalization (Tsao and Lien, 2013) or when they thrive on an open innovation strategy (Kotlar et al., 2013).

The U.S. Patent and Trademark Office (USPTO) published a patent application only after the grant decision was taken. The American Inventor's Protection Act (AIPA) of 1999, one of the most far-reaching legal reforms of the U.S. patent system (Campbell Jr, 2001; Ergenzinger Jr, 2006), introduced the disclosure of patent applications 18 months after the filing date irrespective of whether the patent was granted or not (Johnson and Popp, 2003; Graham and Hegde, 2015). The idea behind the early disclosure was to harmonize the U.S. patent law with that of the rest of the world and to increase the visibility and timely diffusion of inventions to spur technological progress (Graham and Hegde, 2015; Baruffaldi and Simeth, 2020).

Prior studies document positive effects of the AIPA such as timely knowledge diffusion (Baruffaldi and Simeth, 2020), easier navigation through technology markets (Hegde and Luo, 2018), reductions of duplicated research (Lueck et al., 2020), easier switching of bank relationships resulting in lower cost of debt (Saidi and Žaldokas, 2021) and access to venture financing (Mohammadi and Khashabi, 2021). A recent study by Kim and Valentine (2021) suggests, however, that the AIPA was followed by a decline in corporate innovation because firms aimed at avoiding the risk of sharing unprotected knowledge.[1]

Prior research has not yet paid attention to firm ownership and family ownership, in particular. We address this research gap and analyze whether R&D is differently affected if the firm is controlled by a family. Early patent disclosure heightens threats to SEW since FF lose control over valuable, legally unprotected knowledge assets. This is why we investigate the question: *What is the effect of early patent disclosure on the R&D investments of FF?*

We focus on the impact of early disclosure of patent applications on FF' R&D investment because FF constitute a large share of the U.S. economy accounting for 87% of all business tax returns, 59% of private sector employment and 54% of the private sector gross domestic product (Pieper et al., 2021). Due to the importance of FF for the U.S. economy, a reduction of their R&D in response to the AIPA could significantly harm the innovativeness of the U.S. economy in the long term.

Our investigation focuses on the S&P 500 firms. Those large, successful firms which are heavily involved in R&D allow examining how early disclosure of patent applications impacts R&D investment in the absence of financial constraints that smaller firms face (Block, 2012; Garms and Engelen, 2019).

[1] For firms whose rivals disclose more than the focal firms themselves, an increase in R&D investment was observed (Kim and Valentine, 2021).

We employ a difference-in-difference approach which compares the R&D response of FF to non-FF. Our results show that, as compared to non-FF, FF reduced their R&D investment after the AIPA. We find that this effect is more pronounced for FF controlled by the founding generation which is in line with prior literature arguing that SEW considerations are more prominent for the founding generation (Berrone et al., 2012; Arrondo-García et al., 2016; Bozec and Di Vito, 2019; Tsao et al., 2019; Issah et al., 2023).

BACKGROUND

The Patent Disclosure Function of the AIPA

Prior to the AIPA of 1999, patent applications at the USPTO were not disclosed to the public until they were granted (Johnson and Popp, 2003). The underlying technological content and the details of a patent application such as the details and scope of the specific patent claims were only disclosed after the grant date (Johnson and Popp, 2003; Okada and Nagaoka, 2020). Proprietary information about the new invention and the patent specification could, hence, be kept secret until there was clarity about whether patent protection was granted (Berger and Hann, 2007; Glaeser, 2018).

After the AIPA, disclosure of pending patent applications within 18 months after the filing date was mandated (Graham and Hegde, 2015; Baruffaldi and Simeth, 2020). The AIPA was partly motivated by the need for uniformity with other patent systems such as the European patent system which already had an early disclosure rule in place (Graham and Hegde, 2015). In addition, early patent disclosure was expected to facilitate the diffusion of inventions and the emergence of new ideas (Williams, 2017; Baruffaldi and Simeth, 2020).

Despite the positive intentions, there were concerns about potential negative effects of the AIPA, especially for small firms and individual inventors (Modigliani, 1999). Opponents reasoned

that financially constrained firms and individual inventors conduct most breakthrough inventions, which take considerable time in the patenting process, so that they suffer most from early disclosure (Johnson and Popp, 2003). They argued that the AIPA could undermine the value of the patent system for IP protection and disincentivize breakthrough inventors (Johnson and Popp, 2003), hampering the creation of knowledge (Gallini, 2002).

The Effect of the AIPA on R&D Investment

R&D investment is key to innovation, firm productivity and financial performance. At the same time, R&D is risky with high initial investments and uncertain long-term returns (Arrow, 1962).

Although proponents of the AIPA underscored its possible positive effects for the creation of new ideas, there is very little empirical evidence showing whether and how the AIPA's disclosure function stimulated R&D investment (Williams, 2017). Yet, there are reasons suggesting that the pre-grant disclosure of patent information reduces R&D investment as early disclosure imposes proprietary costs on patent holders and exposes them to the risk of imitation (Kim and Valentine, 2021). A recent survey shows that 38% of the contacted scientists who were skilled in the relevant domain believe that it is possible to recreate inventions based on the information contained in the published patents document after having been asked to read those patent documents (Ouellette, 2011). Undoubtedly, patents remain a source of technical information that can help people with state-of-the-art knowledge to reengineer and invent around prior inventions and, thus, reduce inventors' profits from their R&D.

Furthermore, lead time advantages and pivoting fast along the learning curve enhances the competitive advantage of R&D-oriented firms (Levin et al., 1987). Keeping an invention secret for a specific time period provides firms with the lead time to further develop the invention or a related

product without the threat of competition (Hurmelinna-Laukkanen and Puumalainen, 2007). This advantage is lost or significantly reduced with the AIPA (Kim and Valentine, 2021).

The arguments above suggest that mandatory patent disclosure imposes proprietary costs on firms, which can, in turn, disincentivize R&D investment (e.g. Aoki and Spiegel, 2009; Aghamolla and Thakor, 2019). Recent empirical work provides evidence in line (Kim and Valentine, 2021).

The Effect of Early Patent Disclosure on FF' R&D Investment

Firms invest in R&D in pursuit of inventions and innovations with the long-term aim of generating a competitive advantage and increasing profitability. However, R&D is risky, complex, and uncertain with high rates of failure (Arrow, 1962). The FF literature has documented how R&D investment can cause SEW losses (Gomez–Mejia et al., 2014; Choi et al., 2015; De Massis et al., 2018). First, R&D often requires substantial external financial capital which impedes family control and independence in decision making (Gomez–Mejia et al., 2014; Shaw et al., 2021), which are fundamental dimensions of SEW (Gómez-Mejía et al., 2007; Gao et al., 2022; Wu and Yu, 2022). Second, R&D demands external expertise which requires firms to reveal strategic information to external professionals (Miller and Cardinal, 1994). This can lead to the loss of family control over R&D decisions (Gomez-Mejia et al., 2010; Chrisman and Patel, 2012). Third, because of high rates of failure of R&D projects, extensive R&D expenses increase the bankruptcy risk (Miller and Bromiley, 1990) which can be interpreted as a total loss of SEW. The risk of bankruptcy is higher for FF than for non-FF because FF are undiversified and the personal wealth of the family is often invested in the firm (Anderson et al., 2012; De Massis et al., 2018). This implies that the failure of R&D projects in which the family has invested a substantial share of its wealth, may lead to the collapse of the family firm. Fourth, R&D investment reduces the resources available for alternative undertakings which restrains the independence or discretion of the family (De Massis et al., 2018).

While FF can expect SEW gains in the event of a successful R&D project (Gomez–Mejia et al., 2014), these gains are uncertain. Losses in SEW, such as weakened control and independence arising from the use of external financial capital and expertise, are certain. Facing this dilemma, FF are likely to be more strongly influenced by the certainty of SEW losses (Chrisman and Patel, 2012; Hughes et al., 2018). This typical behavior of FF is referred to as loss aversion which describes a situation where an individual or an organization is more focused on avoiding losses than deriving gains (Kahneman and Tversky, 1979; Chrisman and Patel, 2012). The focus on SEW losses alters FF' R&D decisions in support of lower R&D investment levels (Chrisman and Patel, 2012; Gomez–Mejia et al., 2014). However, in specific circumstances the gain perspective can lead FF' decision. Choi et al. (2015), for instance, find that, when expecting growth opportunities, FF increase their R&D investment. Zahra (2005) argues that it is not the family involvement but the tenure of the CEO that limits FF' risk-taking.

Protecting inventions through patents can be a way to safeguard returns from R&D. In fact, the chance of receiving temporary legal protection for an invention establishes a major incentive for R&D investment (Levin et al., 1987). In exchange for the legal protection, firms need to detail the technology (Guellec and de la Potterie, 2000), which fosters the risk of imitation and reverse engineering (Kim and Valentine, 2021). FF, therefore, carefully ponder the potential benefits and costs of patent protection and often decide against patenting (Chirico et al., 2020).

We acknowledge that the AIPA exposes all firms to the same negative risks (Kim and Valentine, 2021). We, however, further argue that FF are more affected by the early disclosure function introduced by the AIPA than non-FF because they face the threat of SEW losses in addition to financial losses. We, hence, investigate the research question:

What is the effect of early patent disclosure on the R&D investments of FF (as compared to non-FF)?

DATA, VARIABLES AND METHODOLOGY

Data

In constructing our data sample, we rely on the Standard & Poor's (S&P) 500 firms as of July 2003 (e.g. Block, 2012; Garms and Engelen, 2019). To distinguish between FF and non-FF, we follow the definition of the BusinessWeek (2003) and Anderson and Reeb (2003) who described FF as firms in which the family has more than 5% control or a member of the family serves on the board.

The S&P firms were supplemented with financial information retrieved from Compustat. Further, we link the firm data to their patent records at the USPTO using the NBER patent database.

We supplement the sample with information about changes in the strength of state level trade secret protection through the Unified Trade Secret Act (UTSA) (Png, 2017a; Png, 2017b). Png (2017a, 2017b) provides a trade secret protection index which ranges from zero to one (see Table 1 in Png, 2017a, p. 169).[2]

We focus on the time period 1993-2006 including six years before and after the AIPA. We exclude earlier and later years because a change of R&D investment in those earlier or later years would be unrelated to the AIPA. This leaves us with an unbalanced sample of 6509 observations, 36.40% of which correspond to 170 FF.[3,4]

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[2] 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.

[3] Three firms were dropped from the sample for being outliers regarding some of their characteristics namely Amgen, Medimmune and Danaher. Two firms could not be matched to Compustat. After deleting firms which are not affiliated with the manufacturing or service sector, we arrive at 468 firms.

[4] We do not take a survival bias of the S&P 500 firms into account. We do not believe that our results are driven by a survival bias because 80.51% of our observations belong to firms that we observe in each year.

To make sure that FF and non-FF are comparable, we also use a matched sample. We match based on ten different firm age classes defined along the firm age distribution, ten different firm size classes defined along the firm size distribution and a dummy indicating whether the firm reported R&D or not. Our matched sample consists of 6133 observations corresponding to 145 FF and 244 FF.

Variables

We use firms' yearly R&D investment as dependent variable which we normalize by total assets *(R&D/ASSETS)* to account for the skewness of the distribution of this variable (e.g. Block, 2012). For one of our approaches, we employ a dummy variable that takes the value one if R&D was not reported (*NON-REPORTED R&D*).

Our first independent variable *(FAM)* is a binary variable which takes the value one for FF and zero for non-FF (see Anderson and Reeb, 2003; Andres, 2008; Hussinger and Issah, 2019).

Our moderating variable, *AIPA,* is a binary variable that takes the value one from the year 1999 onwards and equals zero in earlier years.

We control for the strength of trade secret protection *(UTSA)* using the index developed by Png (2017a; 2017b). Firms may revert to trade secret protection after it became more attractive (Hussinger and Issah, 2022). Furthermore, we control for firm age (*AGE*) (Block et al., 2022), firm performance measured as return on assets *(ROA)* (Hussinger and Issah, 2022), *TOBIN'S Q* (Fang et al., 2018) and leverage *(DEBT/ASSETS)* capturing the operational risks (Shim and Okamuro, 2011). We account for past patent productivity and quality using measures for the patent application stock over total assets (*PATENT/ASSETS*) and the patent citation stock over the patent stock (*CITATIONS/PATENTS*). Free cash (*FREE CASH/ASSETS*)(Block, 2012) and the *INVESTMENT RATE* (Bond et al., 2005) control for the available financial means for R&D. *SALES VOLATILITY* indicates the extend of competition for market shares (Li et al., 2018; Irvin and

Schuh; King and Slotegraaf, 2011; Anderson et al., 2013; Nath and Bharadwaj, 2020). *NEW FIRMS* foundations capture new opportunities arising in the sector (Crane and Decker, 2019). The variable is created using the National Establishment Time-Series (NETS) database. We also use the industry average of patents per firm *(INDUSTRY PATENTS/ASSETS*) to control for the taste of firms in a specific environment to patent and the costs associated with patenting in the specific field (Mansfield, 1968). Lastly, we use *YEAR DUMMIES* to control for time effects as well as *STATE DUMMIES* to control for possible firm location effects and *INDUSTRY DUMMIES*. The variable definitions are presented in Table 1.

Insert Table 1 about here

Methodology

We employ a difference-in-difference model (Angrist and Pischke, 2008) to test the effect of early disclosure on the R&D investments of FF vis-à-vis non-FF:

$$\frac{R\&D}{ASSETS_{i,t}} = \beta_0 + \beta_1 AIPA_t + \beta_2 (AIPA_t * FAM_i) + control\ variables_{i,t} + f_i + e_{i,t}$$

The variable $AIPA_t$ shows the reaction of all firms to the AIPA. The family firm status FAM_i does not vary over time so that it is included in the time-invariant fixed effects. The interaction term $AIPA_t$ * FAM_i is our parameter of interest as it shows how the reaction of *FF* to the AIPA compared to the control group of non-FF.

We use linear fixed effects regressions for the sample of firms which report R&D. In addition, following Anderson et al. (2012), Gomez–Mejia et al. (2014) and (Chi et al., 2020), we set missing values for R&D to zero and add a dummy variable indicating that R&D was not reported to the list of regressors. Here, we estimate a random effects tobit models to account for the fact that the dependent variable has many zero values.

RESULTS

Descriptive Statistics

Table 2 shows the descriptive statistics. Less than half of the firms are FF as shown by the mean 0.36. Table 3 presents the correlation coefficients among our variables.

Insert Table 2 and Table 3 about here

Regression Results

Main results. Our research question asks whether the AIPA has affected the R&D investment of FF more negatively as compared to non-FF. Table 4 shows results from fixed effects linear models for the matched sample of firms that report R&D (model 1) and for the full sample of firms that report R&D (model 2) as well as random effects tobit models for the matched (model 3) and full sample (model 4).

The different models 1-4 consistently show a negative estimated effect of the interaction term *AIPA * FAM* which indicates that FF invest less in R&D after the AIPA as compared to non-FF.

Regarding our control variables, we find that *AGE, TOBIN'S Q, ROA, DEBT/ASSETS, PATENT/ASSETS, FREE CASH/ASSETS, INVESTMENT RATE* and *SALES VOLATILITY* have a statistically significant effect on *R&D/ASSETS*.

Insert Table 4 about here

Further analysis. We further distinguish between founder-led and later generation-led FF. Block (2012) observes that SEW preservation is strongest in founder-controlled FF (see also Berrone et al., 2012; Arrondo-García et al., 2016; Bozec and Di Vito, 2019; Tsao et al., 2019; Issah et al., 2023). SEW considerations reduce as FF age and get passed on to heirs (Eddleston et al., 2013). Large heir-controlled FF behave in conformity to industry standards in terms of strategic

practices for the sake of legitimacy (Miller et al., 2013). Large founder-controlled FF, in contrast, are more likely to defy conformity by avoiding risky actions (Miller et al., 2013).

This is why we run additional analyses with using only founder-controlled and only heir-controlled FF and compare them to non-FF. Table 5 shows the results which indicate that only founder-controlled FF react more negatively to the AIPA than non-FF.[5]

Insert Table 5 about here

Parallel trends. It is important for a difference-in-difference analysis to show parallel trends before the event. Figures 1 and 2 show that we observe a parallel trend of R&D over assets before the AIPA for all FF (Figure 1) and founder-controlled FF (Figure 2). The figures also show that founder-controlled FF react more strongly to the AIPA than non-FF (both in relation to non-FF).

Insert Figures 1 and 2 about here

DISCUSSION AND CONCLUSION

Discussion

We examine the effects of early disclosure of patent applications at the USPTO on the R&D investment of FF. We find that FF reduce their R&D investment after the AIPA as compared to non-FF which is in line with the view that strategic actions of FF are, next to financial considerations, aimed at preserving SEW. Early disclosure of patent applications can constitute a threat to SEW because it facilitates imitation and reverse engineering of not protected inventions.

Our further analysis shows that heir-controlled FF are not affected by the AIPA in different ways than non-FF which is in line with the notion that SEW-related motives, which are more

[5] Note that the tobit regressions only converge for the full sample. Since the main results in Table 4 were very similar for the full and matched sample we are confident that this would be also the case for this further analysis.

prevalent in FF (Block, 2012; Arrondo-García et al., 2016; Bozec and Di Vito, 2019; Tsao et al., 2019; Issah et al., 2023), are responsible for the reduction of R&D by FF rather than a less diversified portfolio or lower R&D investments by heirs.

Contribution to Research

Our study makes four contributions the literature. First, we draw attention to the differential responses of FF to innovation policies which typically aim at the average firm in an economy. An extant literature that evaluates the effects of innovation policies (Zúñiga-Vicente et al., 2014; Png, 2017a; Czarnitzki and Hussinger, 2018; Hussinger, 2008) coexists side-by-side with a large literature that investigates FF' innovation behavior (e.g. De Massis et al., 2018; Block et al., 2022), but little attention has been paid to a potentially differential response of FF to innovation policies (see Hussinger and Issah, 2022, for an exception). We contribute to the literature by exploring the intersection between innovation policy and the FF literature. Therewith, we point to a field of opportunities for reflecting upon how public policy reforms affect the innovation activities of FF differentially.

Second, we contribute to the scarce literature on the effects of the AIPA on corporate innovation (Williams, 2017; Kim and Valentine, 2021). We show that FF react more sensitively to the AIPA than non-FF and reduce their R&D investment in response. FF tend to be less diversified and a large share of the personal wealth of the family is invested in the firm thereby intensifying risks of financial and SEW losses (Anderson et al., 2012). We, hence, extend the evidence on the impact of the AIPA to include FF as a distinctive ownership type of firms.

Third, we extend the literature on SEW by showing how SEW can create distinctive responses to legislative changes of IP protection. Heir-controlled FF, for which SEW-relayed motivations are less pronounced as compared to founder-controlled FF (Block, 2012; Arrondo-García et al., 2016; Bozec and Di Vito, 2019; Tsao et al., 2019), are affected by the AIPA in the same way as non-FF,

while first-generation FF react more sensitively. This is in line with the interpretation that SEW-related motives which are more prevalent in first-generation FF are responsible for the reduction of R&D by FF rather than a less diversified portfolio or lower R&D investments by heirs.

Practical Implications

There have been calls on the U.S. government to start analyzing FF separately due their importance for the U.S. economy (Astrachan and Shanker, 2003; Pieper et al., 2021). Our study shows how the AIPA affects R&D disadvantageously for this important segment of the economy. Hence, we present an important reason for why policy makers should expedite actions towards creating a special focus on FF that have been shown to contribute significantly to innovation and economic growth (Memili et al., 2015).

For FF, our results show that they are more careful when it comes to R&D investment than non-FF and that they react more strongly to changes in the patent legislation. While in the short run, this protects their R&D, in the long run competitors might be able to secure a competitive advantage because of larger R&D investments. FF should take these potential long run disadvantages into account when taking their R&D investment decision.

Non-FF can learn from our results that FF react differently. Their strong reaction to the AIPA shows their hesitation to disclose innovation activities. This means that non-FF should keep in mind that it is difficult to be aware of the full innovation potential of FF.

Limitations and Future Research

Our sample focuses on the S&P 500 firms. Our choice is motivated by the fact that these firms are heavily engaged in R&D so that they have some discretion when it comes to strategic decisions about their R&D investment. Nevertheless, we are mindful that the observed reduction in R&D

investment might be of a different size for smaller FF. It is plausible that smaller FF reduce their R&D investment even further, but this needs to be empirically shown in future research.

Another limitation is that we cannot control for changes of the ownership structure over time due to data limitations (Skorodziyevskiy et al., 2022).

Our analysis also does not allow to directly disentangle the effects of different motivations such as SEW and poorly diversified portfolios. This is an interesting avenue for future research.

Another promising direction for future research is the intersection between innovation policies and family ownership of firms. A recent study has shown that FF react differently than non-FF to changes in trade secret protection (Hussinger and Issah, 2022). Here, we add evidence on the differential reaction of FF to a change in patent legislation. This leaves a lot of room to investigate further innovation policies and law changes and how they affect the sensitive R&D investment decision of FF.

Conclusion

At the intersection of innovation policy studies and the family firm literature, our study provides empirical evidence for a reduction of FF' R&D investment in response to the early disclosure of patent applications through the AIPA, one of the most far-reaching legislative reforms of the U.S. patent system (Campbell Jr, 2001; Ergenzinger Jr, 2006). As we do not find an equal response by non-FF, we underline the differential behavior of FF and raise attention to the fact that the AIPA had an unintended negative effect on FF.

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TABLES

Table 1: Variables

Variable	Measurement
R&D/ASSETS	R&D investment over firm assets
FAM	Binary variable which takes the value of one for FF and zero otherwise
AIPA	Measured as a discrete change in the year of the AIPA, 1999.
UTSA	Index for the strength of trade secret protection developed by Png (2017a, 2017b).
AGE	Years since firm foundation
ROA	Return on assets
TOBIN'S Q	Logarithm of Tobin's Q
DEBT/ASSETS	Debt to asset ratio
PATENTS/ASSETS	Patent application stock over total assets, using a depreciation rate of knowledge of 15%.
CITATIONS/PATENTS	Citation stock over the patent stock, using a depreciation rate of knowledge of 15% for both.
CASH/ASSETS	Free cash over total assets
INVESTMENT RATE	capital investment over replacement value
SALES VOLATILITY	Mean of the squared deviations from the two-digit industry level for the past ten years
NEW FIRMS	number of new firm foundations with more than 5 employees in the same two-digit industry and year, divided by 1000
INDUSTRY PATENTS/ ASSETS	Number of patents applied for per year by firms in the same 2-digit industry class
NON-REPORTED R&D	Dummy variables for observations wit missing information for R&D
INDUSTRY DUMMIES	Dummy variables for the 2-digit SIC industry
STATE DUMMIES	Dummy variables for the firm location
YEAR DUMMIES	Dummy variables

Table 2: Descriptive statistics

Variables	Mean	SD	P25	P50	P75	N
AIPA	0.54	0.50	0.00	1.00	1.00	6509
FAM	0.36	0.48	0.00	0.00	1.00	6509
AGE	41.65	41.75	14.00	14.00	62.00	6509
TOBIN'S Q	0.32	0.16	0.24	0.33	0.42	6509
ROA	0.05	0.08	0.02	0.05	0.09	6509
DEBT/ASSETS	0.18	0.15	0.06	0.16	0.28	6509
PATENT/ASSETS	0.03	0.07	0.00	0.00	0.03	6509
CITATIONS/PATENTS	6.72	10.74	0.00	3.92	8.71	6509
FREE CASH/ASSETS	0.09	0.07	0.05	0.09	0.12	6509
INVESTMENT RATE	0.22	0.14	0.13	0.20	0.27	6509
SALES VOLATILITY	26.01	20.64	9.23	22.73	37.43	6509
NEW FIRMS	0.50	0.64	0.00	0.00	0.93	6509
INDUSTRY PATENTS/ASSETS	0.03	0.04	0.00	0.01	0.05	6509
UTSA	0.20	0.25	0.00	0.00	0.44	6509
NON-REPORTED R&D	0.45	0.50	0.00	0.00	1.00	6509

Table 3: Correlations

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	AIPA	1													
2	FAM	-0.01	1												
3	AGE	-0.01	-0.25***	1											
4	TOBIN'S Q	-0.04***	0.22***	-0.02*	1										
5	ROA	-0.05***	0.05***	0.12***	0.27***	1									
6	PATENT/ASSETS	-0.05***	0.04***	0.23***	0.21***	0.02*	1								
7	CITATIONS/PATENTS	-0.19***	0.02*	0.08***	0.14***	0.10***	0.21***	1							
8	FREE CASH/ASSETS	-0.02	0.12***	0.05***	0.35***	0.52***	0.14***	0.13***	1						
9	INVESTMENT RATE	-0.12***	0.20***	-0.11***	0.30***	0.15***	0.16***	0.19***	0.24***	1					
10	SALES VOLATILITY	0.33***	-0.12***	-0.04***	-0.10***	-0.15***	0.03**	-0.05***	-0.08***	0.04***	1				
11	NEW FIRMS	-0.06***	0.08***	0.44***	0.19***	0.12***	0.45***	0.19***	0.13***	0.10***	-0.09***	1			
12	INDUSTRY PATENTS/ASSETS	-0.08***	0.08***	0.33***	0.29***	0.06***	0.64***	0.25***	0.18***	0.24***	0.05***	0.70***	1		
13	UTSA	-0.02	-0.00	0.08***	-0.03**	0.04***	0.00	-0.02	-0.04***	-0.15***	-0.08***	0.10***	-0.03***	1	
14	NON-REPORTED R&D	-0.04***	-0.10***	-0.41***	-0.28***	-0.11***	-0.40***	-0.20***	-0.21***	-0.19***	0.09***	-0.42***	-0.56***	0.05***	1

Statistical significance level: *p < .10. **p < .05. ***p < .01.

Table 4: The Effect of Early Disclosure on the R&D investment of FF

	Only reported R&D		Non-reported R&D replaced	
	Matched sample	Full sample	Matched sample	Full sample
	Linear fixed effects models		Randome effects tobit models	
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
AIPA	-0.004	-0.004	-0.005*	-0.005*
	(0.003)	(0.003)	(0.003)	(0.003)
FAM*AIPA	-0.004**	-0.005**	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
FAM			-0.001	-0.001
			(0.006)	(0.005)
AGE			-0.000***	-0.000***
			(0.000)	(0.000)
TOBIN'S Q	-0.040***	-0.040***	-0.043***	-0.042***
	(0.007)	(0.006)	(0.008)	(0.008)
ROA	-0.093***	-0.092***	-0.097***	-0.097***
	(0.007)	(0.007)	(0.008)	(0.008)
DEBT/ASSETS	-0.041***	-0.041***	-0.054***	-0.052***
	(0.007)	(0.007)	(0.008)	(0.008)
PATENTS/ASSETS	0.114***	0.114***	0.121***	0.122***
	(0.013)	(0.013)	(0.013)	(0.013)
CITATIONS/PATENTS	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
FREE CASH/ASSETS	0.054***	0.054***	0.061***	0.061***
	(0.010)	(0.010)	(0.011)	(0.011)
INVESTMENT RATE	0.013**	0.013***	0.016***	0.016***
	(0.005)	(0.005)	(0.006)	(0.006)
SALES VOLATILITY	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
NEW FIRMS	0.003	0.003	0.001	0.001
	(0.002)	(0.002)	(0.003)	(0.003)
INDUSTRY PATENTS/ASSETS	-0.053	-0.058	-0.135**	-0.124**
	(0.055)	(0.053)	(0.063)	(0.056)
UTSA	0.017	0.017	0.006	0.006
	(0.020)	(0.020)	(0.016)	(0.016)
constant	0.076***	0.075***	0.095	0.091
	(0.007)	(0.007)	(91.128)	(99.246)
TIME DUMMIES	Yes	Yes	Yes	Yes
INDUSTRY DUMMIES			Yes	Yes
STATE DUMMIES			Yes	Yes
N	3470	3568	6133	6509

Coefficients are reported; standard errors in parentheses
*p < .10. **p < .05. ***p < .01.

Table 5: The Effect of Early Disclosure on the R&D investment of Founding-Controlled and Later Generation FF (Only Reported R&D)

	Founding Controlled FF		Later Generation FF	
	Matched sample	Full sample	Matched sample	Full sample
	Linear fixed effects models			
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
AIPA	-0.004	-0.004	-0.006**	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)
FAM*AIPA	-0.011***	-0.011***	0.004*	0.004
	(0.003)	(0.002)	(0.002)	(0.002)
TOBIN'S Q	-0.040***	-0.040***	-0.039***	-0.039***
	(0.008)	(0.008)	(0.006)	(0.006)
ROA	-0.098***	-0.097***	-0.067***	-0.066***
	(0.008)	(0.008)	(0.007)	(0.007)
DEBT/ASSETS	-0.048***	-0.047***	-0.036***	-0.036***
	(0.008)	(0.008)	(0.007)	(0.007)
PATENTS/ASSETS	0.108***	0.109***	0.041**	0.043***
	(0.014)	(0.014)	(0.016)	(0.016)
CITATIONS/PATENTS	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
FREE CASH/ASSETS	0.061***	0.061***	0.051***	0.052***
	(0.011)	(0.011)	(0.010)	(0.010)
INVESTMENT RATE	0.012**	0.012**	0.015***	0.015***
	(0.006)	(0.006)	(0.006)	(0.005)
SALES VOLATILITY	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
NEW FIRMS	0.002	0.002	0.007***	0.007***
	(0.003)	(0.003)	(0.002)	(0.002)
INDUSTRY PATENTS/ASSETS	-0.058	-0.064	-0.096*	-0.099*
	(0.063)	(0.061)	(0.056)	(0.053)
UTSA	0.021	0.021	0.010	0.010
	(0.021)	(0.021)	(0.024)	(0.024)
constant	0.084***	0.083***	0.067***	0.066***
	(0.008)	(0.008)	(0.007)	(0.007)
TIME DUMMIES	Yes	Yes	Yes	Yes
N	2854	2952	2636	2734

Coefficients are reported; standard errors in parentheses
*p < .10. **p < .05. ***p < .01.

FIGURE

Figure 1: R&D Investments of FF relative to Non-FF

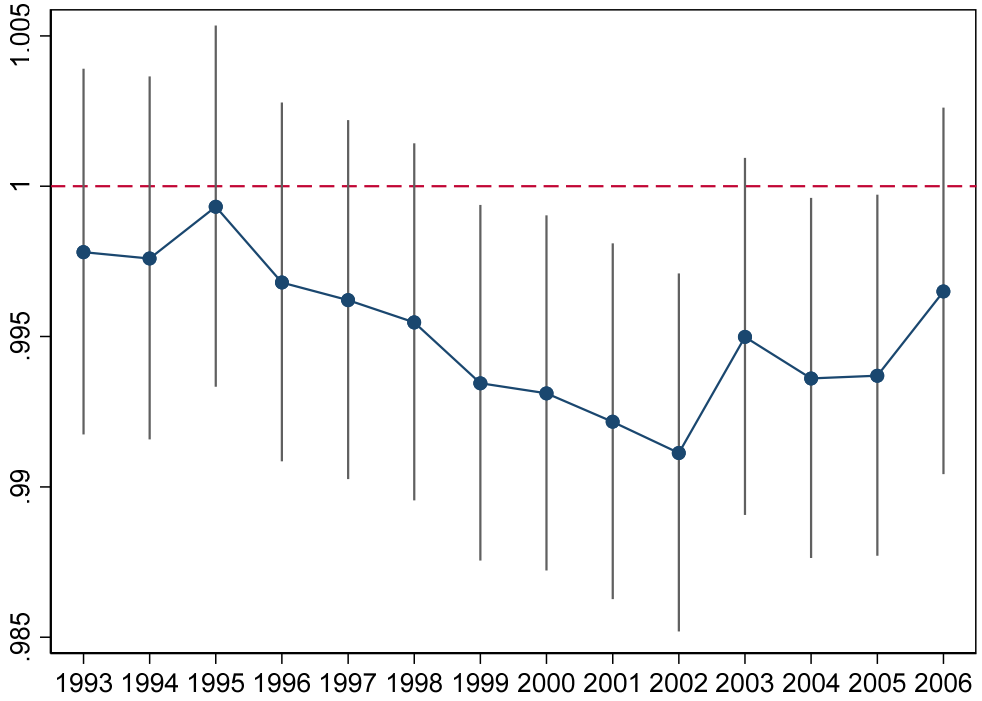
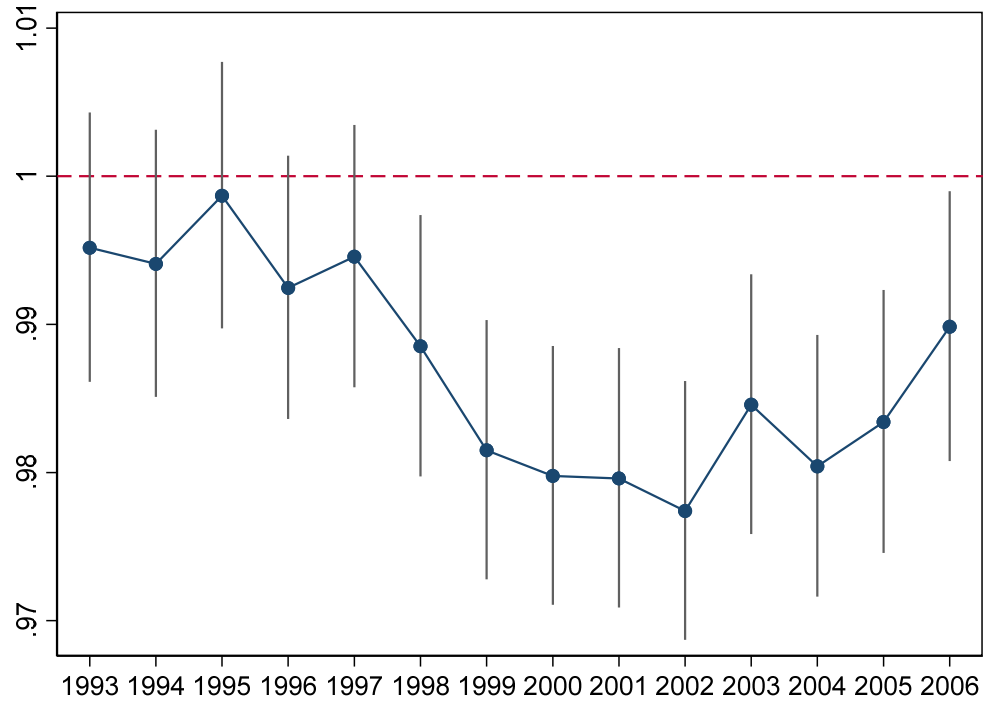


Figure 2: R&D Investments of Founder-Controlled FF relative to Non-FF



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