CEO Succession and Innovation in Family Firms

1. Introduction

Family firms are highly prevalent around the world. Such firms may be led by professional managers or by family members. While many studies have analyzed the differences between family and professional leadership (Bandiera et al. 2018) in terms of the implications for financial performance (Anderson and Reeb 2003; Bennedsen et al. 2007; Perez-Gonzalez 2006; Villalonga and Amit 2006), corporate innovation has received less attention in the literature. Yet, understanding whether family leadership promotes or harms corporate innovation is important given the vital role of innovation for technological progress and growth. In this study, we use a comprehensive dataset of Danish firms to investigate the impact of hiring a family CEO or a professional CEO on the innovation effort of family firms.

Existing research argue that family and professional CEOs have intrinsically different priorities and style (Mullins and Schoar 2016). The core idea of our paper is that family CEOs are better positioned than non-family CEOs to promote corporate innovation. First, the implicit contracting literature suggests that family CEOs establish durable relationships with employees and other stakeholders thanks to their long-term perspective and high attachment to the company (Bertrand and Schoar 2006; Bach and Serrano-Velarde 2015). Second, family CEOs have longer investment horizons and lower career concerns, as suggested by, e.g., lower CEO turnover-performance sensitivity (Chen et al. 2013).[1] Stakeholder orientation and job protection

[1] By contrast, non-family CEOs have been shown to prioritize short-term operating efficiency at the expense of long-term investment (Yeh and Liao 2021).

are both expected to reduce the barriers to engage in innovation activities for family CEOs. Indeed, successful innovation is the outcome of an uncertain process which requires stakeholder orientation (Flammer and Kacperczyk 2016), long-term incentives, tolerance for failure, and job stability (Acharya et al. 2013; Manso 2011). Other arguments, however, have contrary implications. For instance, family CEOs tend to have a lower educational attainment than professional CEOs (Perez-Gonzalez 2006), seize private benefits via reduced effort (Bandiera et al. 2018) and generous pay (Chen et al. 2021), and hire employees with lower cognitive skills (Bennedsen et al. 2022)—all factors that may limit the innovation capability of firms. Ultimately, whether family CEOs spur or impair innovation remains an empirical question.

To discern the impact of family CEOs on innovation, we use a dataset covering 6,238 CEO successions experienced by Danish limited liability firms from 1990 to 2013, and estimate a differences-in-differences model comparing the change in the innovation activities of firms hiring family or professional CEOs. To measure innovation, we use the number of patents that the firms in our sample have filed at the Danish Patent and Trademark Office (DKPTO) and the European Patent Office (EPO). To account for the fact that patents differ widely in technological value, we use data on the number of forward citations received by each of those patents (cf. Hall et al. 2005; Lanjouw and Schankerman 2004).

Appointing a family or professional CEO is an endogenous choice which may be influenced by unobservable factors as well as firms' past innovation performance. To derive causality, we instrument the choice of hiring a family CEO or a professional CEO using the gender of the departing CEO's firstborn child. This approach was pioneered by Bennedsen et al. (2007) and then implemented by other studies on CEO succession (Tsoutsoura 2015). Consistent with these studies, we find that when the CEO's firstborn child is male, there is a

significantly higher likelihood that the incoming CEO is a family member rather than a professional non-family manager. Hence, using this instrument for CEO succession decisions satisfies the relevance condition. At the same time, the instrument is plausibly exogenous, i.e., a child's gender is randomly determined and unaffected by firm characteristics. To further validate the exogeneity condition, we show that the gender of a departing CEO's firstborn is not correlated with innovation before the succession occurs.

Our two-stage least squares estimates indicate that appointing a family CEO has a *positive* effect on corporate innovation, as measured by patent counts. In the 5-year period following CEO succession, firms which appoint a family CEO experience a 6% increase in the number of patents as compared to firms which appoint a non-family CEO. Following the appointment of a family CEO not only patents go up but also the number of forward citations received by those patents (i.e. their intrinsic quality). More intense patenting activity by newly-hired family CEOs may reflect their superior innovation ability (which should be conducive of higher innovation throughout their tenure), but also a desire to legally protect a firms' existing technological knowledge due to, e.g., higher fear of competition or more protective behavior toward family business knowledge (which should lead to more patents following CEO succession).

To explore these non-mutually exclusive interpretations, we estimate separate regressions using, alternatively, the first year and the second to fifth year after a CEO appointment as post-succession window. Our data indicate that the effect of family incoming CEOs on innovation is significant both in the time period immediately after the succession and in the medium to long term. Hence, the higher innovation activity of family CEOs is likely to

reflect a mix of mechanisms including more intensive innovation activity, but also defensive patenting and more focus on the legal protection of the family business' knowledge.

Next, we use Danish register data to access comprehensive information on CEOs' demographic characteristics and education. Family CEOs are significantly younger than professional CEOs and less likely to hold a university degree—suggesting that the innovation performance of family CEOs is not driven by a higher educational attainment; consistent with existing results (Perez-Gonzalez 2006), professional non-family CEOs fare better than family CEOs on this dimension. Therefore, it appears that the benefits of having a family CEO outweigh the potential disadvantage of weaker human capital in raising innovation performance. That said, family CEOs appear to benefit from education: the positive direct effect of an incoming family CEO on patent counts (citations) is as high as 22% (29%) when he/she also holds a university degree in engineering. Business degrees matter to a smaller extent, whereas other degrees like humanities do not matter at all.

We offer several contributions to the literature. First, we expand research on the unsettled question of whether family firms are more or less innovative than other organizations. Anderson et al. (2011) show that publicly-held family firms in the US do less R&D and have fewer patent citations than non-family firms. Similarly, Chi (2023) finds that family ownership impairs corporate innovation. In contrast, Duran et al. (2016) find that family firms achieve a higher innovation output, especially when led by family CEOs. Other works in this area are Carney et al. (2019) and Zybura et al. (2021). Generally, this literature confronts the problem of endogeneity which has proven hard to solve. In addition to suggesting a plausible mechanism, we contribute by exploiting exogenous variations in CEO succession decisions, using information on the family structure of the departing CEO. We thus provide causal evidence of

how family CEOs impact corporate innovation around succession. Based on a cross-sectional comparison, we find that family firms are less innovative than non-family firms, as in Anderson et al. (2011). However, this finding reverses once we account for endogeneity by randomizing CEO succession decisions by using the gender of departing CEOs' firstborn.

Second, we contribute to the literature on CEO characteristics and corporate innovation. Hirshleifer et al. (2012) show that overconfident CEOs foster innovation due to a higher propensity to take risk. Acemoglu et al. (2022a) document a significant, albeit small, effect of young CEOs on disruptive innovation. Custodio et al. (2019) show that firms led by generalist CEOs produce more patents. Regarding education, He and Hirshleifer (2022) show that firms led by CEOs with a PhD are more innovative and perform generally better than other firms. Perez-Gonzalez (2006) shows that family CEOs who hold a college degree from elite institutions achieve the same level of operating performance than professional CEOs. Barker and Mueller (2002) show that firms led by CEOs with experience in engineering/R&D or holding science-related degrees have higher R&D intensity, whereas Amore et al. (2019) show that firms led by better-educated CEOs have a smaller environmental footprint. Our analysis shows that CEOs drawn from the business family are more innovative, and this effect is largest when they also hold a university degree in technical domains. Thus, human capital is complementary to family ties in shaping the prospects of family businesses.

2. Empirical Strategy

We focus on CEO succession events in which the departing CEO appoints a family or professional CEO to replace him/her. To evaluate the impact of the incoming CEO on innovation, we employ a difference-in-difference regression where the first difference captures the change in firm innovation before and after the CEO successions, and the second difference

captures the difference of these changes between firms that chose a family CEO and firms that chose a non-family (professional) CEO:

$$\Delta\log(1+innovation)_{ij} = \alpha + \beta FamCEO_{ij} + \gamma\Delta X_{ij} + \delta_t + \varepsilon_{ij} \quad (1)$$

Here, Δlog(1+innovation) is the difference between a 5-year average innovation after and before the succession event i for firm j. Alternatively, to study the timing of the change in innovation, we employ different post-succession windows which focus on the immediate aftermath of the succession (t+1) or the medium-long term (t+2 to t+5). We log-transform the innovation variable because when comparing innovation among firms of different sizes a relative change in innovation is more appropriate than an absolute change. FamCEO is an indicator variable equal to one for firms that appoint a family CEO, i.e., from the same family of the departing CEO, and zero otherwise.[2] X_{ij} is a vector of controls measured one year prior to the succession, and include the logarithm of the book value of total assets (in 2005 real Danish Krone), the logarithm of one plus firm age, and industry-adjusted operating return on assets, defined as operating income over total assets less its four-digit NACE industry average. Year dummies δ_t are included to control for innovation trends during the succession years. ε_{ij} is an error term (estimated by adjusting for heteroskedasticity).

In equation (1), β measures if the appointment of a new family CEO is significantly associated with changes in innovation output relative to new non-family CEOs. However, it hardly provides causal evidence because appointing a new CEO is an endogenous decision which is likely to be correlated with unobservable variables that may also explain the firm's changes in innovation outcome. For example, the departing CEO might only offer the position

[2] We define if the departing and incoming CEO are from the same family by using heirs, in-laws, cousins, spouses and parents.

to a family heir if the firm has a high innovation potential. Alternatively, a high-potential heir may have attractive career opportunities and he/she will only accept to join if the family firm's future looks bright. In both cases, the firm hiring a family CEO would experience an increase in innovation regardless of the managerial actions of the incoming CEO. However, we cannot control for innovation potential or for the motivations of the departing CEO to hire a family or non-family successor.

To identify the causal impact of family CEO appointments on firms' innovation, we follow the instrumental variable methodology proposed by Bennedsen et al (2007). In particular, we instrument the FamCEO dummy with the gender of the departing CEO's first-born child, which is arguably an exogenous event unaffected by corporate outcomes.[3] For this event to be a valid instrument, two criteria must be met. First, it shall correlate with the incoming CEO being a professional or a family member (i.e., our endogenous variable). Consistent with Bennedsen et al. (2007), we find that when the departing CEO has a male first-born child, the incoming CEO is more likely to be a family member. Second, the gender of the departing CEO's first-born child shall only impact the firm's innovation through the CEO succession channel. We provide support for this exclusivity criterion by documenting the lack of correlation between the gender of departing CEOs first born child and the average innovation pre-succession.[4]

3. Data Sources

Assembling the sample for our empirical analysis requires multiple data sources which we discuss below. Next, we provide summary statistics on the key variables used in the analysis.

3.1.1 Innovation Data

[3] See Bennedsen et al. (2007) for a discussion on the exogeneity condition.

[4] Since this identification strategy is based on CEOs with children, its external validity may not apply to childless CEOs (which, however, are rare in our sample).

We use data on corporate patents filed at the Danish Patent and Trademark Office (DKPTO) and the European Patent Office (EPO) as or measure of innovation. To account for variation in technological value, we also collect data on the number of forward citations received by each patent, which is a well-known measure of patent quality in the innovation literature (Hall et al. 2005; Lanjouw and Schankerman 2004).

3.1.2 Financial Data

Financial data are from Experian and the Statistical Business Register (SBR) at Statistics Denmark. Experian assembles the dataset from the financial statements and management information of all limited liability firms in Denmark, which are required to file to the Ministry of Economics and Business Affairs. Firms are required to disclose the number of total assets, as well as the number of their operating and net income. Although most of the firms in Experian are privately held, external accountants audit firm financial subject to Danish corporate law. Experian includes the unique firm-level identifier, the CVR number, issued by the Danish Commerce and Companies Agency, which serves as firm identifier in all interaction with the Danish authorities. The CVR numbers allow us to match Experian data with other data sources. We supplement Experian's financial information with financial information from the SBR, which is held by Statistics Denmark, a Danish government entity that is responsible for data collection and record keeping for a large number of economic variables.

3.1.3 CEO Data

To identify the firms' CEOs, we rely on three data sources: (a) Experian, (b) Erhvervs-og Selskabsstyrelsen (ES), a dataset assembled by the Danish Commerce and Companies Agency, and (c) employment information from the "Integrated Database for Labour Market Research" (IDA) at Statistics Denmark. Experian reports the names of firms' top executives but does not

contain individual identifiers. To merge the names reported in Experian with other data sources, we use ES, which contains the Danish Personal Identification number (CPR) for all managers of limited liability firms. Under Danish corporate law, firms are required to file with ES any change in CEO positions within two weeks of its occurrence. Lastly, we use IDA to verify that CEOs are indeed registered in the reporting firms. IDA provides information on persons and workplaces at the individual level. Each person in this database is identified by a CPR number, and their workplaces by CVR numbers. Using these identifiers and matching with the CEO data, we identify all CEO successions occurred between 1990 and 2013. The individual-level data sources provide us with information on the entire job history of departing and incoming CEOs since 1980.

3.1.4 Defining a family

The Danish Civil Registration System contains the family information of all Danish citizens. It includes the person identifier (CPR number), birth date, gender, immediate family members, namely, spouse, children, parents, and siblings. We extend this dataset to cover other familial relationships between in-laws, uncles/aunts and nieces/nephews, grandparents and grandchildren. Using this extended dataset, we identify a) the gender of first-born child of each departing CEO, b) ages of departing and incoming CEOs, c) whether or not the departing and incoming CEOs belong to the same extended family.

3.1.5 Education

The Educational Register (UDDA) contains an individual's CPR number, the highest level of education, and the field of education. Using this dataset, we determine if each incoming CEO has a university degree using their highest level of education. Since there are in total 35 fields of education, we group them into the following categories for ease of interpretation: 1) engineering

(field numbers: 70-72), 2) business (field number: 41), 3) arts (field numbers: 21-23), 4) science (field numbers: 50-54), and 5) other fields.

3.2. Samples

Our analysis requires two different samples. The first sample is used to analyze the differences in corporate innovation by family and non-family firms. The purpose of this analysis is to establish the correlation between innovation efforts and these two kinds of firms. The second sample is used for the two-stage least squares (2SLS) analysis of innovation around CEO succession.

We start by merging innovation data from DKPTO and EPO with financial statement data from KOB covering the universe of Danish limited liability firms from 1990 to 2013. Then, we identify family firms by looking at the group of individuals on the board of directors and major shareholders. If at least two individuals on these bodies are family-related, that firm on that year is classified as family firm. Using this approach may, in some instances, result in a classification problem. In particular, if one of the two family members leaves the firm only for a few years, their firm classification will switch from family to non-family during that period. This is problematic since this firm should have always been classified as family firm. We account for this possibility by checking if at least one family member from last year still remains on the board or major shareholders in the current year. If so, even though only one family member remains, the firm is still classified as family firm. The final sample for this analysis contains 242,834 firms for a total of 543,192 observations.

To construct the sample for the CEO succession analysis, we begin by searching for CEO succession events in the period 1990-2013. A CEO succession occurs if the following conditions are met: (1) there is a change in the firm's CEO (we disregard the events in which the

old CEO remains as a co-CEO after succession); (2) the departing (incoming) CEO has been in their position for at least two years before (after) the succession (useful to remove interim transitions); (3) financial data for the sample firms are available during the CEO employment; (4) the departing CEO must have at least one child (which is necessary for our 2SLS analysis). These steps yield 6,238 CEO succession events. We determine if each event involves a family or unrelated CEO appointment by checking the family relationship between the departing and incoming CEOs, classifying departing and incoming CEOs as related if they belong to the same family.

4. Findings

4.1. Innovation differences between family and non-family firms

We estimate an OLS regression in which the dependent variable is patent counts, or patent citations, and the key explanatory variable is the dummy equal to one for family firms. We include firm profitability, size, and age as control variables in order to keep these factors constant across family and non-family firms, and we further control for the interactions between 4-digit industry dummies and year dummies to remove industry-specific shocks. All accounting variables are winsorized at the 1% and 99% to reduce concerns of outliers. Standard errors are clustered at the firm level to account for both heteroskedasticity and serial correlation by firm. Table 1 shows that family firms have 1% fewer patents and 4% less patent citations as compared to their non-family counterpart (Columns 1-2). These magnitudes increase to 2% and 7%, respectively, if we focus on the subsample of innovative firm, i.e., firms with at least one patent during the sample period (Columns 3-4). For descriptive evidence on the sample used in this analysis, please refer to Appendix Table A2 (Supplementary Material). These findings are consistent with the evidence in Anderson et al. (2011), which suggests that family firms tend to

be less innovative due to risk avoidance strategies. While interesting, this result suffers from endogeneity concerns: family and non-family firms are likely to differ along unobservable characteristics that are also correlated with corporate innovation. Finding exogenous variations in family control (i.e. randomizing whether a company is a family or non-family firm) is notoriously challenging. To tackle this identification problem, we restrict the analysis to succession firm and estimate a 2SLS difference-in-differences model whose results are reported next.

Insert Table 1 Here

4.2. Results

Panel A of Table 2 presents summary statistics of firm characteristics prior to the CEO succession. Compared to firms with professional CEO succession, those that undertake a family CEO succession are significantly less innovative, smaller in total assets, older and more profitable. These differences point to an endogeneity concern in that CEO succession decisions are associated with corporate outcomes and so they may affect future innovation for reasons other than the CEO succession itself. As anticipated, we ameliorate this concern by using the departing CEO's firstborn gender as instrumental variable for CEO succession decision. Panel B of Table 2 shows that all firm differences wane when we group the successions using genders of departing CEOs' first-born children. This lack of significance is helpful to validate that the instrument effectively randomizes the likelihood of undertaking a family (vs. non-family) CEO succession.[5]

[5] Chen et al. (2021) argue that having a male firstborn increases the long-term orientation of founders and thus affect the firms' innovation activities. Focusing on the time-window prior to succession, and using a sample of CEO successions which is 20 times larger than Chen et al. (2021), we do not find evidence of this sort.

Insert Table 2 Here

In Table 3, we evaluate whether the relevance condition is satisfied, i.e., whether the instrument is significantly associated with CEO succession decisions. We do so by using the indicator for family CEO successions as dependent variable, and the indicator for a male firstborn as main explanatory variable. In Column (1) we show the probit results, which confirm that when the departing CEO's firstborn is male, there is a significantly higher probability of appointing a family CEO. In Column (2), we show the robustness of this finding to the inclusion of firm size, age, profitability and year dummies as control variables. Larger firms are less likely to appoint family CEOs, whereas older and better performing firms are more likely to appoint family CEOs. Regardless of the influence of these controls, the coefficient of the male firstborn dummy remains positive and significant. Finally, in Columns (3)-(4) we provide the OLS results. Following Bennedsen et al. (2007), we use in the second-stage regression the predictions of Columns (3)-(4), rather than those of the probit, so as to avoid potential misspecification problems occurring from having a non-linear model in the first-stage regression.

Insert Table 3 Here

Table 4 shows the second-stage estimates. As Column (1) indicates, the coefficient of the family CEO dummy is positive and statistically significant: as compared to a professional CEO, the appointment of a family CEO increases the number of patents by around 6%. This result withstands the inclusion of the usual set of controls, as shown in Column (2). Moreover, Columns (3)-(4) show that the appointment of a family CEO also raises the firm's citation

count, though the effect is estimated less precisely. Collectively, the findings so far provide a strong indication that family managers raise innovation in the aftermath of the CEO succession.[6]

Insert Table 4 Here

4.3. Additional analyses

The increase in innovation in the post-succession years might reflect a superior innovation ability of incoming family CEOs and a higher desire to protect existing knowledge and innovative projects. These motives may arise, e.g., from the fact that family CEOs fear more competition or wish to legally protect their family firm's innovative project due to a longer-term orientation and higher attachment with the company. The post-succession window used in the baseline specification ranges from t+1 to t+5, and thus pools together the immediate aftermath of the succession with the medium to long term. In Appendix Table A3 (in Supplementary Material), we show the results obtained by using, separately, t+1 or t+2 to t+5 to construct the post-succession window. As shown, the positive effect of incoming family CEOs on innovation is significant when using both approaches. This result suggests that family CEOs increase the patenting activity of their firm due to a mix of the different motives outlined above. In Appendix Table A4 (in Supplementary Material) we further show that our results are robust to: (1) considering a binary operationalization of innovation; (2) removing top patenting firms; (3) removing firms with no patents before succession (which leads only to a 10% significance for patent counts).

[6] Please pay attention to the fact that this result is estimated on the subsample of succession firms and it only captures the effect of incoming family CEOs; hence, this is not directly comparable with the result in Table 1.

Finally, we explore how human capital characteristics shape the positive impact of family CEOs on innovation. One third of incoming family CEOs in our sample hold a university degree, whereas that fraction is above 50% for professional CEOs. Family CEOs are also less likely than professional CEOs to hold a university degree in engineering and business (see Appendix Table A5). In Appendix Table A6 we interact the family CEO dummy from our baseline model with a set of dummies for different university degrees (using as baseline no university education). Results show that family CEOs who hold a university degree in engineering drive a sizeable increase in both patent counts and citations. Business degrees drive an increase in patent citations, albeit only significant at the 10% level. All other university degrees have an insignificant effect.

5. Conclusion

Family firms represent a large fraction of all business worldwide. Given the importance of innovation to the growth process, understanding the innovativeness of family firms is of huge importance. While economists and organizational scholars are increasingly turning their attention to family firms (Bennedsen et al. 2007; Doepke and Zilibotti 2008), existing findings on innovation are conflicting (Anderson et al. 2011; Duran et al. 2016; Chi 2023).

The contribution of this paper was to causally identify the effect of family leadership on corporate innovation. We used a dataset covering 6,238 CEO successions experienced by Danish firms from 1990 to 2013, estimated a differences-in-differences model comparing the change in the innovation activities of firms hiring family or professional CEOs, and instrumented the choice of hiring a family CEO or a professional CEO. Consistent with recent works on the advantages of family leadership (Amore et al. 2021), we found that appointing a family CEO has a positive effect on both the quantity and the quality of innovation, effects that

hold both in the immediate aftermath of a succession and in the longer run. The innovation performance of family CEOs is not driven by a higher educational attainment; rather, the benefits in terms of innovation of having family CEOs outweigh the disadvantages from, on average, lower educated.

In sum, our contribution was to provide causal evidence of how family CEOs impact innovation around succession: accounting for endogeneity by randomizing CEO succession decisions, we found that family-led firms are more innovative than professionally-led family firms. The contribution of this study needs to be assessed in the light of some limitations. The first concerns the use of patents to measure innovation: while patents are widely used in the literature, they are antecedents of innovation rather than innovation itself. The second limitation is the use of only Danish data, and the third concerns the exclusion restriction of our IV, which like every instrument, can be validated only indirectly. We hope our analysis will stimulate future research on family firms and innovation using different settings.

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Table 1. *Level Results*

This table shows OLS results that compare the innovation of family and non-family firms. Columns (1)-(2) report results from the full sample, while Columns (3)-(4) report those from the subsample of innovative firms (i.e. with at least one patent in their lifetime). Variables are defined in Appendix Table A1 (see Supplementary Material). Standard errors are clustered by firm. Numbers in parentheses are p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

	Full Sample		Innovative Firms	
	Log(1+#Patents)	Log(1+#Citations)	Log(1+#Patents)	Log(1+#Citations)
	(1)	(2)	(3)	(4)
FamilyDummy	-0.0115***	-0.0171***	-0.0381**	-0.0747***
	(0.000)	(0.000)	(0.040)	(0.004)
OROA	-0.0005***	-0.0009***	-0.0030***	-0.0051***
	(0.000)	(0.000)	(0.000)	(0.000)
Log(RealTotalAsset)	0.0300***	00418***	0.1821***	0.2632***
	(0.000)	(0.000)	(0.000)	(0.000)
Log(1+FirmAge)	-0.0015*	-0.0028**	-0.0923***	-0.1446***
	(0.068)	(0.012)	(0.000)	(0.000)
Industry x Year FE	Yes	Yes	Yes	Yes
R^2	0.053	0.049	0.158	0.167
N	543,192	543,192	31,432	31,432

Table 2. *Firm Characteristics Before CEO Succession*

This table shows the characteristics of the firms before CEO successions. Panel A splits the sample into family successions and professional successions. Panel B splits the sample by the gender of the outgoing CEO's first-born child. Variables are defined in Appendix Table A1 (see Supplementary Material). The last column reports p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Panel A: Family vs Professional Successions

	Family Succession			Professional Succession			Difference	
	N	Mean	SD	N	Mean	SD	Fam-Profes	p-Value
Log(1+#Patents)	2,030	0.0052	0.066	4,208	0.0224	0.176	-0.017***	0.000
Log(1+#Citations)	2,030	0.0034	0.061	4,208	0.0280	0.247	-0.025***	0.000
Log(RealTotalAsset)	2,030	2.29	1.040	4,208	2.83	1.510	-0.540***	0.000
Log(1+FirmAge)	2,030	2.88	0.800	4,208	2.69	0.906	0.190***	0.000
OROA	2,030	3.65	11.84	4,208	2.94	16.930	0.710*	0.000

Panel B: CEO's first-born child is Male vs Female

	Male firstborn			Female firstborn			Difference	
	N	Mean	SD	N	Mean	SD	Male-Female	p-Value
Log(1+#Patents)	3,198	0.0170	0.147	3,040	0.0165	0.152	0.001	0.891
Log(1+#Citations)	3,198	0.0204	0.207	3,040	0.0195	0.205	0.001	0.862
Log(RealTotalAsset)	3,198	2.68	1.44	3,040	2.62	1.360	0.055	0.124
Log(1+FirmAge)	3,198	2.77	0.87	3,040	2.73	0.889	0.038*	0.082
OROA	3,198	3.35	14.39	3,040	2.97	16.510	0.379	0.332

Table 3. *First-Stage Results*

This table shows coefficients from the first-stage regressions using Probit and OLS techniques. The dependent variable is an indicator variable equal to one if the outgoing CEO is related to the incoming CEO (i.e., family succession) and zero otherwise. The outgoing CEO's first-born child being male significantly affects the decision to pass on the CEO position to a family member. MaleFirstBorn equals one if the gender the outgoing CEO's first-born child is male, and zero otherwise. Variables are defined in Appendix Table A1 (see Supplementary Material). Numbers in parentheses are p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

	Pr{Family Succession}			
	Probit		OLS	
	(1)	(2)	(3)	(4)
MaleFirstBorn	0.3038***	0.3185***	0.1086***	0.1100***
	(0.000)	(0.000)	(0.000)	(0.000)
Log(RealTotalAsset)		-0.2342***		-0.0720***
		(0.000)		(0.000)
Log(1+FirmAge)		0.2339***		0.0756***
		(0.000)		(0.000)
Ind Adj OROA		0.0020*		0.0005
		(0.054)		(0.103)
Year FE	No	Yes	No	Yes
N	6,238	6,233	6,238	6,233

Table 4. *Second-Stage Results*

This table presents the effects of family succession on firm innovation performance. The estimated coefficients are from IV-2SLS regressions. The dependent variable is the 5-year average after succession minus 5-year average before succession of Log(1+#Patents) or Log(1+#Citations). FamilySuc equals one if the succession is family succession, and zero otherwise. This variable is instrumented by MaleFirstBorn, an indicator variable equal to one if the outgoing CEO's first-born child is male, and zero otherwise. Variables are defined in Appendix Table A1 (see Supplementary Material). Numbers in parentheses are p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

	ΔLog(1+#Patents)		ΔLog(1+#Citations)	
	(1)	(2)	(3)	(4)
FamilySuc	0.0616**	0.0611**	0.0757**	0.0742**
	(0.027)	(0.025)	(0.048)	(0.047)
Log(RealTotalAsset)		0.0030		0.0022
		(0.930)		(0.618)
Log(1+FirmAge)		-0.0043		-0.0048
		(0.160)		(0.250)
Ind Adj OROA		0.0003**		0.0003
		(0.047)		(0.145)
Year FE	No	Yes	No	Yes
N	6,238	6,238	6,238	6,238

SUPPLEMENTARY MATERIAL

Appendix Table A1. *Variable Definitions*

Variable	Definition
#Patents	The number of patents produced by the firm in a given year
#Citations	The number of citations received by all patents of the firm in a given year
ΔLog(1+#Patents)	A difference between an average of log(1+ #Patents) five years before and five years after the succession
ΔLog(1+#Citations)	A difference between an average of log(1+ #Citations) five years before and five years after the succession
FamilyDummy	An indicator variable equal to one if the firm is classified as a family firm, and zero otherwise
FamilySuc	An indicator variable equal to one if the succession is within the departing CEO's family, i.e. the departing and incoming CEOs are related, and zero otherwise
MaleFirstBorn	An indicator variable equal to one if the departing CEO's first-born child is male, and zero otherwise
Degree	An indicator variable equal to one if the incoming CEO has a university degree, and zero otherwise
Engineering	An indicator variable equal to one if the incoming CEO has a university degree in engineering, and zero otherwise
Business	An indicator variable equal to one if the incoming CEO has a university degree in business, and zero otherwise
Science	An indicator variable equal to one if the incoming CEO has a university degree in science, and zero otherwise
Arts	An indicator variable equal to one if the incoming CEO has a university degree in arts and humanities, and zero otherwise
Rest	An indicator variable equal to one if the incoming CEO has a university degree in generic program, education, social science, health and welfare, services and unknown fields, and zero otherwise
RealTotalAsset	Real total assets in constant 2005 million Danish Krones
FirmAge	Firm age in years
OROA	Operating return on assets, defined as a ratio of operating income to book value of assets
Ind Adj OROA	Industry-adjusted OROA, defined as the firm's OROA minus its industry average in a given year

Appendix Table A2. *Summary Statistics for the Sample Used in Table 1*

This table reports summary statistics by firm type, i.e. family and non-family. Summary statistics for the full sample are reported in Panel A, and those for a subsample with only innovative firms in Panel B. Innovative firms are defined as those with at least one patent in their lifetime. Firms are classified as family firm if they have at least two family members on the board of directors or the list of major shareholders, otherwise they are classified as non-family firms. #Patents is the number of patents produced by the firm in a given year. #Citations is the number of citations received by all patents of the firm in a given year. RealTotalAsset is real total assets in constant 2005 million Danish Krones. FirmAge is firm age in years. OROA is operating return on assets, defined as a ratio of operating income to book value of assets. The last column reports p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

	Family			Non-Family			Mean Difference	
	N	Mean	SD	N	Mean	SD	Family-Nonfamily	p-Value
Panel A: Full Sample								
#Patents	277,722	0.043	1.391	265,470	0.205	4.206	-0.162***	0.000
#Citations	277,722	0.164	6.975	265,470	1.151	49.706	-0.987***	0.000
RealTotalAsset	277,722	60.271	1,436.031	265,470	421.187	17,109.493	-360.916***	0.000
FirmAge	277,722	22.371	20.072	265,470	18.823	21.172	3.548**	0.000
OROA	277,722	7.082	14.260	265,470	5.843	19.282	1.239***	0.000
Log(1+#Patents)	277,722	0.011	0.142	265,470	0.030	0.267	-0.019***	0.000
Log(1+#Citations)	277,722	0.014	0.207	265,470	0.042	0.393	-0.028***	0.000
Log(RealTotalAsset)	277,722	2.855	1.029	265,470	3.115	1.407	-0.260***	0.000
Log(1+FirmAge)	277,722	2.811	0.891	265,470	2.532	0.999	0.278***	0.000
Panel B: Only Innovative Firms								
#Patents	13,416	0.893	6.270	18,016	3.024	15.878	-2.131 ***	0.000
#Citations	13,416	3.396	31.562	18,016	16.956	190.106	-13.560***	0.000
RealTotalAsset	13,416	127.173	639.063	18,016	813.845	6,216.168	-686.672***	0.000
FirmAge	13,416	27.102	22.808	18,016	30.268	28.990	-3.166***	0.000
OROA	13,416	8.162	17.909	18,016	1.836	28.185	6.325***	0.000
Log(1+#Patents)	13,416	0.233	0.606	18,016	0.448	0.929	-0.215***	0.000
Log(1+#Citations)	13,416	0.280	0.899	18,016	0.617	1.386	-0.337***	0.000
Log(RealTotalAsset)	13,416	3.482	1.325	18,016	4.327	1.832	-0.845***	0.000
Log(1+FirmAge)	13,416	3.037	0.825	18,016	3.005	1.013	0.032***	0.000

Appendix Table A3. *IV Results Over Different Time Windows*

This table presents the effects of family succession on firm innovation performance. The estimated coefficients are from IV-2SLS regressions. The dependent variable in Panel A is the 1-year value after succession minus 5-year average before succession of Log(1+#Patents) or Log(1+#Citations). FamilySuc equals one if the succession is family succession, and zero otherwise. The dependent variable in Panel B is the 2-to-5 year average after succession minus 5-year average before succession of Log(1+#Patents) or Log(1+#Citations). FamilySuc equals one if the succession is family succession, and zero otherwise. This variable is instrumented by MaleFirstBorn, an indicator variable equal to one if the outgoing CEO's first-born child is male, and zero otherwise. RealTotalAsset is real total assets in constant 2005 million Danish Krones. FirmAge is firm age in years. Ind Adj OROA is industry-adjusted operating return on assets, defined as a ratio of operating income to book value of assets less mean OROA of firms in the same industry. Numbers in parentheses are p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Panel A. Post succession only including t+1

	ΔLog(1+#Patents)		ΔLog(1+#Citations)	
	(1)	(2)	(3)	(4)
FamilySuc	0.0717**	0.0718**	0,0648	0,064
	(0.043)	(0.038)	(0.214)	(0.209)
Log(RealTotalAsset)		0,0005		0,0012
		(0.888)		(0.815)
Log(1+FirmAge)		-0.008**		-0,0089
		(0.030)		(0.1100)
Ind Adj OROA		0.0000		-0,0001
		(0.863)		(0.823)
Year FE	No	Yes	No	Yes
N	6,238	6,238	6,238	6,238

Panel B. Post succession from t+2 to t+5

	ΔLog(1+#Patents)		ΔLog(1+#Citations)	
	(1)	(2)	(3)	(4)
FamilySuc	0.0589**	0.0582**	0.0774*	0.0756*
	(0.048)	(0.046)	(0.064)	(0.064)
Log(RealTotalAsset)		0.0001		0.0021
		(0.976)		(0.661)
Log(1+FirmAge)		-00031		-0.0031
		(0.354)		(0.503)
Ind Adj OROA		0.0003**		0.0004*
		(0.019)		(0.054)
Year FE	No	Yes	No	Yes
N	6,238	6,238	6,238	6,238

Appendix Table A4. *IV Results Over Different Time Windows*

This table presents the effects of family succession on firm innovation performance. The estimated coefficients are from IV-2SLS regressions. The dependent variable in Panel A is the 5-year average after succession minus 5-year average before succession of a dummy equal to one if the firm has any patent, or any patent citation. The dependent variable in Panel B is the 5-year average after succession minus 5-year average before succession of Log(1+#Patents) or Log(1+#Citations) excluding the top 5% of firms in terms of patent counts. The dependent variable in Panel C is the 5-year average after succession minus 5-year average before succession of Log(1+#Patents) or Log(1+#Citations) excluding firms without patents before succession. FamilySuc equals one if the succession is family succession, and zero otherwise. This variable is instrumented by MaleFirstBorn, an indicator variable equal to one if the outgoing CEO's first-born child is male, and zero otherwise. Variables are defined in Appendix Table A1 (see Supplementary Material). Numbers in parentheses are p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Panel A. Binary innovation variable

	Δ(Patent dummy)		Δ(Citation dummy)	
	(1)	(2)	(3)	(4)
FamilySuc	0.0396**	0.0396**	0.0251**	0.0247**
	(0.018)	(0.016)	(0.048)	(0.047)
Log(RealTotalAsset)		-0.0000		0.0002
		(0.992)		(0.839)
Log(1+FirmAge)		-0.0036**		-0.0019
		(0.045)		(0.152)
Ind Adj OROA		0.0002**		0.0001*
		(0.019)		(0.075)
Year FE	No	Yes	No	Yes
N	6235	6235	6235	6235

Panel B. Exclude top 5% patenting firms

	ΔLog(1+#Patents)		ΔLog(1+#Citations)	
	(1)	(2)	(3)	(4)
FamilySuc	0.0666**	0.0660**	0.0801**	0.0784**
	(0.021)	(0.019)	(0.043)	(0.041)
Log(RealTotalAsset)		0.0003		0.0024
		(0.912)		(0.592)
Log(1+FirmAge)		-0.0046		-0.0051
		(0.142)		(0.233)
Ind Adj OROA		0.0003**		0.0003
		(0.048)		(0.151)
Year FE	No	Yes	No	Yes
N	6136	6136	6136	6136

Panel C. Excluding firms without patents before succession

	ΔLog(1+#Patents)		ΔLog(1+#Citations)	
	(1)	(2)	(3)	(4)
FamilySuc	0.0390*	0.0384*	0.0510	0.0487
	(0.098)	(0.098)	(0.111)	(0.120)
Log(RealTotalAsset)		-0.0020		-0.0004
		(0.480)		(0.923)
Log(1+FirmAge)		-0.0006		0.0007
		(0.815)		(0.839)
Ind Adj OROA		0.0002*		0.0002
		(0.058)		(0.213)
Year FE	No	Yes	No	Yes
N	6235	6235	6235	6235

Appendix Table A5. *Incoming CEOs' Educational Background*

This table shows the summary statistics of incoming CEO's university education. The sample contains 6,238 CEO succession events of all limited liability firms in Denmark from 1990 to 2013. The sample is split into a subsample of family successions and that of professional successions. A CEO succession is considered family succession if the outgoing CEO is related to the incoming CEO, otherwise it is considered professional succession. Each variable indicates whether the CEO holds a university degree in a specific discipline (zero for no university degree). All variables are defined in Appendix Table A1. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

	Family Succession			Professional Succession			Difference	
	Obs	Number	Share	Obs	Number	Share	Fam-Profes	p-value
Engineering	1,887	187	0.099	3,865	544	0.141	-0.042**	0.049
Science	1,887	8	0.004	3,865	36	0.009	-0.005	0.826
Business	1,887	211	0.112	3,865	808	0.209	-0.097***	0.000
Arts	1,887	65	0.034	3,865	70	0.018	0.016	0.469
Rest	1,887	163	0.086	3,865	579	0.150	-0.063***	0.003

Appendix Table A6. *Incoming CEOs' Education and Innovation*

This table presents the effects of incoming CEOs' education on their firm innovation performance around successions. The estimated coefficients are from IV-2SLS regressions. The dependent variable is the 5-year average after succession minus 5-year average before succession of Log(1+#Patents) or Log(1+#Citations). FamilySuc equals one if the succession is family succession, and zero otherwise. This variable is instrumented by MaleFirstBorn, an indicator variable equal to one if the outgoing CEO's first-born child is male, and zero otherwise. FamilySuc is interacted with a set of dummies equal to one for each of the university degrees (and zero for no university degree). The direct term of each university degree is included but not tabulated to save space. Firm controls include RealTotalAsset, FirmAge and Ind Adj OROA. Variables are defined in Appendix Table A1 (see Supplementary Material). Numbers in parentheses are p-values. ***, ** and * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

	ΔLog(1+Patents)	ΔLog(1+#Citations)
	(1)	(2)
FamilySuc	0.0209	0.0001
	(0.300)	(0.309)
FamilySuc × Engineering	0.2188**	0. 2992**
	(0.038)	(0.046)
FamilySuc × Business	0.1339	0. 2018*
	(0.124)	(0.074)
FamilySuc × Science	0.1179	0.9081
	(0.854)	(0.572)
FamilySuc × Arts	0.0165	-0,0017
	(0.762)	(0.978)
FamilySuc × Rest	-0. 3433	-0.5756
	(0.183)	(0.136)
Firm Controls	Yes	Yes
Year FE	Yes	Yes
N	5,749	5,749