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# Organizational Control and Technological Capabilities: The Moderating Role of Family Influence on the Firm

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# Organizational Control and Technological Capabilities: The Moderating Role of Family Influence on the Firm

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## Abstract

This dissertation examines the influence of organizational controls on technological capabilities in privately owned U.S. corporations, with a specific focus on family-owned businesses. The primary objective of the study was to investigate how formal controls (process and outcome) and clan controls (informal practices) impact technological innovation and competence. Using a quantitative approach, data were collected from 177 individuals and analyzed through partial least squares structural equation modeling (PLS-SEM) path analysis. The findings indicate a significant relationship between formal controls and technological capabilities. However, the interaction of family influence on this dynamic was not supported. Results also revealed a robust association between the combination of formal and clan controls and enhanced technological capabilities. Despite this, the anticipated weakening effect of the influence of family firms on this positive relationship was unsupported. Additionally, the hypothesis that clan control negatively impacts technological capabilities was not supported, and the moderating effect of family influence on this relationship was also unsupported. The hypothesis that family influence strengthens the positive interaction of the integration of formal and clan controls was partially accepted, showing a slight significance within the family power construct on the overall relationship. These insights offer practical guidance for family-owned businesses, suggesting that the effective integration of formal and clan controls along with the influence of family firms can enhance technological capabilities, optimizing their competitive position and long-term performance. This research contributes to the understanding of control mechanisms in family-owned businesses and their role in fostering technological improvements.

*Keywords:* family firms, technological capabilities, digital transformation, organizational controls, formal controls, clan controls

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## Introduction

Companies increasingly need solid technological capabilities to achieve and maintain a competitive advantage in a rapidly changing market environment (Zahra & George, 2002). By leveraging technology, companies can streamline their operations, improve efficiency, and enhance their customers' experience (Bharadwaj et al., 2013). Failure to implement technology may result in falling behind competitors and losing market share (Porter & Heppelmann, 2014; Teece, 2018). In fact, Naldi et al. (2013) found that the use of technology is a significant factor in the competitiveness of family firms. This finding is particularly relevant given that family businesses, which make up 80% of all for-profit businesses in the United States, make up over 5.5 million firms and employ more than 60% of the labor force (Pieper et al., 2021). Prior research has indicated that some family businesses develop technological capabilities more rapidly than others (De Massis et al., 2013). This may be due to factors such as the family's willingness to invest in technology, their ability to attract and retain skilled employees, or their openness to collaboration with external partners (Batt et al., 2020; De Groote et al., 2023; Soluk et al., 2021). However, there are also factors that may impede the development of technological capabilities in family firms, such as resistance to change, limited resources to invest, insufficient managerial skills to handle technological implementation, and a lack of innovative culture (Chirico & Salvato, 2008; De Massis, Audretsch, et al., 2018; Zahra et al., 2004). Such inconclusive findings (Batt et al., 2020) suggest that unaccounted-for mechanisms may explain why some family firms are better at developing technological capabilities than others.

While researchers have identified several factors that affect the development of technological capabilities in family and nonfamily firms (Soluk & Kammerlander, 2021; Zahra et al., 2007), relatively less attention has been paid to the role of administrative mechanisms, such as organizational controls, that can create a suitable organizational context to prioritize, develop, and leverage their technological capabilities (Turner et al., 2021). Ouchi (1979) defined organizational controls as mechanisms or systems that organizations use to regulate and monitor the behavior of their members, processes, and resources to achieve specific goals, keep order, and reduce risks. Formal control systems, such as performance management, goal setting, and incentive structures, can provide the necessary resources for technology-related projects and the motivation to work on them (Abubakre et al., 2015). Informal control systems, such as clan control, use social processes like norms, values, and culture to shape the attitudes and behaviors of employees toward technological innovation (C. E. H. Chua, Lim, et al., 2012). Considerable research has examined how different types of organizational control systems impact technological capabilities, innovation, and strategic renewal by influencing resource distribution, decision-making, employee collaboration, and knowledge management (Gopal & Gosain, 2010; A. Kock & Gemünden, 2016; Kreutzer et al., 2015; O'Reilly & Tushman, 2008; Teece et al., 1997; Turner & Makhija, 2006; Turner et al., 2021). Scholars have also studied how various control mechanisms operate together (Cardinal et al., 2004; Kreutzer et al., 2016; Tiwana & Keil, 2007).

An important yet overlooked factor in the literature is the impact of family influence, as family-owned enterprises are significantly impacted by their owners' power, involvement, generational experience, and expertise, as well as the overlap of their family and business values (Chrisman et al., 1998). The idiosyncratic influence of family-owned businesses varies across firms, depending on family ownership and family members' characteristics, qualifications, involvement, and espoused values (e.g., Chrisman et al., 2015). However, it is unclear how family influence impacts how much a firm can take advantage of different types of control systems to build their technological capabilities. To address such issues, this study examined the following research questions:

1. *How do formal and clan organizational control systems influence the technological capabilities of private firms?*
2. *How does family influence moderate the relationship between a private firm's organizational control systems and its technological capabilities?*

This study makes a few noteworthy contributions to the field of family business. First, the findings indicate that the overall performance of a firm, including the presence of technological capabilities, is enhanced when both formal and clan controls are utilized in tandem. This combination effectively manages complexity risk and promotes positive project outcomes (Kreutzer et al., 2016). Second, it explicates the moderating role of family influence, which has hitherto been largely ignored in the literature on organizational control systems and their impact on organizational outcomes. This is important because unlike nonfamily firms, which are mainly focused on financial goals, family firms also prioritize nonfinancial goals that relate to the family's reputation, their enacting their values through the firm, their transgenerational control, or the firm's long-term orientation (Arregle et al., 2007). Third, by examining various dimensions of family control, this study answered calls to consider the heterogeneity of family firms (Daspit et al., 2021), rather than comparing family firms as a whole to nonfamily firms. Finally, the findings have practical implications for helping family businesses understand how to approach organizational controls to enhance their technological capabilities.

The findings of this study offer insights for owners and investors on how to support family or nonfamily businesses in improving their technological capabilities, which can ultimately lead to economic growth and competitiveness for the businesses. From a practitioner's perspective, it is my hope that this study will assist business owners in formulating policies that promote technological growth in family-owned and nonfamily businesses. The results may also be helpful for investors and stakeholders in making informed decisions regarding investments in family and nonfamily businesses. Moreover, they could provide insights for business schools to incorporate technology-focused curricula in their programs. I see the potential for further research in technological process improvements in family firms and nonfamily businesses. Additionally, exploring the role of family dynamics in decision-making and innovation processes could be an exciting avenue for future research. The hypothesized model is listed below in the appendix.

The remainder of this dissertation is structured as follows: Chapter 2, Literature Review, presents a review of the literature on technological capabilities, organizational controls, and family influence, which became the study's primary constructs, followed by specific hypotheses that were formed based on the literature about the relationships between organizational controls, technological capabilities, and family influence.

Chapter three, Methods, outlines the methodology used to examine the influence of organizational control systems on the technological capabilities of private firms that are moderated by family influence. A criterion-based selection was employed for the sampling, focusing on private firms (both family and nonfamily) in the United States (LeCompte & Schensul, 2010). Participants were sourced through Prolific (Palan & Schitter, 2017), and a snowball sampling was conducted (Biernacki & Waldorf, 1981; Dusek et al., 2015), targeting CEOs, senior managers, family owners/managers, and board members who each influence technological decisions. The final sample size of 177 respondents (See Table 2a) was determined to be adequate for conducting structural equation modeling (SEM) via the SmartPLS software (Hair et al., 2017). This choice was made due to its effectiveness in managing complex models in business research, especially when dealing with non-normally distributed data (Hair et al., 2011). A comprehensive missing data analysis was conducted, leading to the exclusion of incomplete responses, thereby enhancing the robustness and reliability of the dataset. Little's (1988) Missing Completely at Random (MCAR) test was applied, revealing a nonrandom pattern of missing data in the combined dataset but randomness within the family business subgroup, simplifying the imputation process. Several validated scales were utilized for measurement. Formal controls were measured using Kreutzer et al.'s (2015) scale, and clan control was measured with Goebel and Weißenberger's (2017) scale. Technological capabilities were measured with adapted scales from Zahra et al. (2007) and Khin and Ho (2019). Family influence was assessed using the F-PEC scale (Astrachan et al., 2002; Klein et al., 2005; Rau et al., 2018). Control variables included the respondent's age, the number of years they worked at their firm, the firm's age, the firm's size, and the firm's industry (Bernerth & Aguinis, 2016).

Chapter four, Results, presents the overall results of the study, focusing on the impact of formal and clan control organizational systems on private firms' technological capabilities and how family influence moderates this relationship. Descriptive statistics and a correlation analysis are presented in Tables 3 and 4 respectively, that used the Pearson correlation coefficient calculated with the Jamovi statistical open-source software. Partial least squares structural equation modeling (PLS-SEM) was chosen over a traditional covariance-based SEM due to its predictive-causal analysis capabilities, flexibility, and ability to handle non-normally distributed measures. This method allows for a robust assessment of the measurement model, ensuring construct reliability and validity and a thorough examination of the structural model to test hypothesized relationships, including direct and moderation effects. The study employed SmartPLS, which efficiently handles nontransformed data and retains the original scales and meanings of measurements. Higher-order constructs were evaluated using SmartPLS, benefiting from its robust hierarchical component modeling capabilities. Measurement model analysis confirmed the construct validity, reliability, and discriminant validity through methods like the heterotrait-monotrait ratio of correlations. To address multicollinearity issues, the analysis was divided into two distinct models. Model 1 focused on formal and clan controls, allowing for an independent and detailed examination of these controls. Model 2 integrated these controls into combined controls, exploring their synergistic impact on a firm’s technological capabilities. Regarding the results, Hypothesis 1 was supported, showing that formal controls significantly enhance technological capabilities. However, Hypothesis 1a, which posited that the influence of family firms weakens this relationship, was not supported. Similarly, Hypothesis 2, which examined the impact of clan controls on technological capabilities, was not supported. Hypothesis 2a, suggesting the influence of family firms mitigates the negative effects of clan controls, also showed no significant moderation effects. The findings of Model 2 strongly supported Hypothesis 3, indicating that combined controls (formal and clan) positively impact a firm's technological capabilities. Hypothesis 3a, which proposed that family power moderates this relationship, showed marginal significance. A simple slope analysis revealed that family power strengthens the positive relationship between combined controls and a firm's technological capabilities, particularly at higher levels of family influence.

Chapter five, Results, integrates the study's findings with existing research, focusing on family firms' dynamics, technological capabilities, organizational controls, and influence. The results of the study confirm that formal controls enhance technological capabilities, aligning with Teece et al.'s (1997) view of the importance of structured governance for innovation. Family influence, and especially their power, may amplify the benefits of formal controls, which is consistent with the broader literature on family businesses (Chrisman et al., 2004; Gomez-Mejia et al., 2011). Though not statistically significant, family influence also seemed to boost the positive aspects of clan controls, supporting Bammens et al.'s (2011) work. The integration of formal and clan controls fosters an innovative environment, particularly in family firms, enhancing their technological capabilities (De Massis et al., 2012). This suggests that a mix of control mechanisms is vital for technological agility (Pfeffer, 1981).

## Literature Review

According to Boulton (2021), nearly 72% of U.S. firms are planning ways to expand their digital capabilities, and 30% of these intend to provide additional training resources for remote workers to handle forthcoming changes. The term *technological capabilities* refers to an organization's ability to significantly enhance its operations by leveraging digital and other technology.

Technological capabilities help firms to reimagine using technology, people, and processes to explore new business models and income streams, provide better customer experiences, improve internal operations, and build new skills (Ceipek et al., 2020; Fitzgerald et al., 2013; Gong & Ribiere, 2021; Tabrizi et al., 2019). They may involve cross-departmental collaboration in merging business-centric philosophies with rapid application development techniques (Boulton, 2021). Technological capabilities such as digital transformation can be used in many contexts and are gaining prominence in established businesses (Khin & Ho, 2019). Furr and Shipilov (2020) argued that for businesses to successfully undergo digital transformation, they should avoid being pulled in multiple directions; instead, they should use the technologies that are a good fit for them and implement change management to increase productivity, cut costs, and boost revenue. Firms that continuously build their technological capabilities have an advantage in identifying, planning for, absorbing, and leveraging new technologies, such as those involved in digital transformation.

Scholars have defined technological capability as a company's capacity to carry out any necessary technological function, including generating new products, processes, and technological knowledge to increase organizational efficiency (Guerra & Camargo, 2016; Tsai, 2004) and the set of skills the firm has in building and leveraging different technologies and systems (Zahra & Nielsen, 2002). Technological capabilities are multifaceted, involving R & D, skill and efficiency, new product development, process improvement, and the ability to forecast technological change in an industry (Zahra et al. 2007). Firms need a substantial investment of time, finances, and effort to develop and maintain their technological capabilities. Strong technological capabilities bring several advantages, facilitating targeted and effective investment in R & D, quick access to customers and markets, agile product customization, effective supply chain management, and strategic partnership formations, all of which allow for strong market responsiveness with low costs (e.g., Guerra & Camargo, 2016; Levy, 1997; Rugman & Verbeke, 2004; Wang et al., 2006; Zahra et al., 2007). Further, information-based technological capabilities allow firms to make informed decisions, optimize operations, and predict trends through big data analytics; scale resources and reduce costs by storing, processing, and managing data and applications on remote servers through cloud computing; and automate repetitive, rule-based tasks through robotic process automation (Chen et al., 2012; Lacity & Wilcocks, 2018; Marston et al., 2011). Thus, technological capabilities have an outsized impact on the overall strategic direction of an organization, allowing it to keep its technology current and thus maintain a competitive edge (Souder et al., 2016).

Various factors impact the strength of technological capabilities at the firm level. Research has shown that the size and structure of a firm can influence its technological capabilities (W. M. Cohen & Levinthal, 1990), its investment in R & D (Griliches, 1990), and its management teams to identify and exploit the firm’s technological opportunities (Teece et al., 1997). At the same time, knowledge processes are crucial in determining the direction and intensity of a firm's technological capabilities (Zahra et al., 2007). Accordingly, formal and informal controls that influence how a company's leaders and employees approach the identification and acquisition of technological knowledge and how it is shared, transformed, and applied are important in shaping its technological capabilities.

**Organizational Controls**

Organizational controls represent "mechanisms that managers use to direct attention, motivate, and encourage individuals to act in ways that support the organization's objectives" (Cardinal et al., 2017, p. 559). Control differs from other managerial functions such as coordinating, organizing, and planning (Fayol, 1949/2013) in three ways: it is goal-oriented, leading to complex situations when goals diverge, conflict, or change often; it represents top-down processes, being designed and implemented by managers; and it is multifaceted, often encompassing diverse practices (Cardinal et al., 2017). While scholars have taken several different approaches to examining organizational controls (Cardinal et al., 2017), this study focused on a frequently researched area of focus—the extent to which controls are used through formal or informal authority hierarchies (Ouchi, 1979, 1980; Sitkin et al., 2020). That is, formal controls are those "authorized and enforced through written directives, rules, and policies," while informal controls are "unwritten but understood and generally sanctioned norms, rules, and mores" (Sitkin et al., 2020, p. 347).

Ouchi (1979) presented two types of formal controls, outcome and behavioral. Outcome controls focus explicitly on the achievement of an organization's desired objectives, while with behavioral controls, managers observe and guide those working for them (Ouchi, 1979, 1980; Cardinal et al., 2004; Cardinal et al., 2017). Thus, outcome controls are oriented toward assessing the extent to which clear individual or group goals are achieved at the end of important periods or on an ongoing basis (Cardinal et al., 2017). On the other hand, behavioral controls refer to the policies, procedures, and practices that are put in place to regulate the behavior of employees during their ongoing execution of work (Cardinal et al., 2004; Cardinal et al., 2017; Kreutzer et al., 2015). Some formal control-based research has also focused on input controls; however, as these apply to the up-front and periodic work of setting up and updating how a firm or its units operate (Cardinal, 2001), this study did not examine them and instead focused on ongoing firms.

Informal controls, or clan controls, are implemented through direct personal contact, shared social experiences, and norms and beliefs that impact day-to-day behavior that are often supported by organizational stories and rituals (Cardinal et al., 2017). Although clan controls are not codified, they involve deliberate attempts to influence the means through which goals are achieved, the feedback of outcomes, and the shared values, socialization, and connections between individuals in an organization (Ouchi, 1979, 1980; Sihag & Rijsdijk, 2018). Thus, the traditional view of organizational controls distinguishes itself between formal behavioral controls, formal outcome controls, and informal clan controls (Kreutzer et al., 2016; Turner & Makhija, 2006). Next, I describe these various forms of control in greater detail and how they are likely to impact the technological capabilities of private firms.

## Formal Controls

Through formal controls, organizations are constrained to adhere to the standards imposed by the rationalized notions of organizational activity that have been formed in the greater community (Weber, 1978). As previously indicated, there are two forms of formal controls: behavioral and outcome (Cardinal et al., 2004; Kreutzer et al., 2015), with each having its own set of benefits and drawbacks.

***Behavioral Controls***

Formal behavioral controls, also known as process controls, "encompass highly formalized standard operating procedures and rules, clearly established routines, specialized job descriptions, hierarchical supervisor-subordinate relationships, and highly structured groupings and settings" (Turner & Makhija, 2006, p. 207). Managers observe employees and evaluate how their behavior compares to the company's standard operating procedures, which are explicitly communicated for each responsibility an individual may take on. In this manner, behavioral controls ensure that employee behavior aligns with their organization's goals and objectives (Cardinal et al., 2004). These clear expectations, rewards, and recognition for desired behaviors, as well as the consequences for noncompliance, can increase an employee's sense of fairness, accountability and motivation and hence, their performance. Furthermore, behavioral controls can help employees make better decisions by providing clear decision-making guidelines, thus helping organizations adapt to environmental changes and remain competitive (Ouchi & Maguire, 1975; Kreutzer et al., 2015).

The main disadvantages of behavioral controls are that they may stifle creativity and innovation by providing employees with predefined behaviors, limiting their ability to think outside the box (Sitkin et al., 1994). Employees used to operating in a certain way may resist change, making it difficult for them to adapt to new situations or technologies (Anderson & Oliver, 1987). Furthermore, behavioral controls can lead to increased bureaucracy by requiring employees to follow a set of rules and procedures, leading to decreased efficiency and increased costs for the company (Kreutzer et al., 2015). The lower employee autonomy that is associated with behavioral controls could lead to decreased job satisfaction and motivation. Further, behavioral controls may make employees feel like they are constantly being watched and judged, undermining trust and transparency within an organization (Costa & Bijlsma-Frankema, 2007). This could result in lower morale and higher turnover, both of which can be detrimental to an organization (Ferner, 2000; Ouchi & Johnson, 1978). These drawbacks should be considered when implementing behavioral controls, as they can potentially hinder an organization's competitiveness.

Behavioral controls are recommended for manager use if they have a strong knowledge of the work processes involved, if these processes are not complex enough to introduce errors, and if they are able to explicitly communicate the tasks and steps involved in the processes. That is, the knowledge of the work processes involved need to be explicit, complete, and limited in terms of the number and variety of considerations (e.g., functional areas, disciplines) associated with them (Cardinal et al., 2017: Turner & Makhija, 2006).

***Outcome Controls***

Formal outcome controls, also called output controls, “focus on the outcomes of tasks or the specific outputs desired by the organization,” specify clear outcome requirements for work done by employees, and use mechanisms such as performance-related contracts, bonuses, commissions, and profit sharing plans (Turner & Makhija, 2006, p. 203). Outcome controls prioritize the evaluation of outcomes but leave the behavior or processes used to achieve the results to the employee's discretion.

Outcome controls ensure that the organization's goals are aligned at various organizational levels and its resources are directed toward activities most likely to achieve its desired results, leading to improved efficiency and organizational performance (Evans et al., 2007; Ouchi, 1977). Similar to behavioral controls, outcome controls increase employee accountability by providing clear performance expectations and consequences for noncompliance. Lastly, outcome controls can help employees make better decisions by providing clear decision-making guidelines and reinforcing desired decision-making behaviors through rewards and recognition; this can help organizations adapt to changes in the environment by providing clear guidelines for reinforcing desired behaviors through rewards recognition (Kreutzer et al., 2015).

Despite their usefulness, outcome controls are not without drawbacks. Like behavioral controls, outcome controls can impede innovation and creativity by limiting a worker's ability to think critically and develop novel solutions. Outcome controls limit employee autonomy by dictating what outcomes should be achieved (Kreutzer et al., 2015). Additionally, as outcome controls necessitate that workers adhere to a set of rules and processes to attain preset goals, they can result in greater bureaucracy, reducing efficiency and raising costs for the business. Accordingly, they may lead to lower employee motivation and communication gaps between management and staff (Anderson & Oliver, 1987).

Outcome controls are recommended when process-related knowledge is difficult to specify or when there are no standard processes for achieving an outcome (e.g., due to hard-to-predict changes in the environment). That is, outcome controls are “best suited for process-related knowledge that is tacit, incomplete, and diverse, and outcome-related knowledge that is explicit, complete, and not diverse” (Turner & Makhija, 2006, p. 204).

Both types of formal controls provide structure and consistency to organizations, enabling them to effectively coordinate the activities of their employees. Indeed, Kreutzer et al. (2015) found that behavioral and outcome controls work well together. By employing formal controls, organizational leaders can create an environment that standardizes processes and unifies the organization (Meyer & Rowan, 1977). In addition, formal controls allow organizations to evaluate their effectiveness and determine what processes need improvement. Formal controls generally operate in conjunction with a hierarchical organizational structure and clear lines of authority, which can help ensure that decisions are made promptly and efficiently. Examples of this are rules and policies that dictate how employees should manufacture, handle, and transport goods; how employees should interact with their customers and vendors (Alharbi et al., 2016; Tse et al., 2019; how goods should be manufactured; how goods are to be delivered on time and in good condition; and how customer service standards are maintained (Tse et al., 2019). A company may also use formal controls to monitor and evaluate the performance of its employees and identify areas for improvement (Tse et al., 2019). Moreover, these controls can help ensure that the company operates in accordance with applicable laws and regulations, thus reducing the risk of legal repercussions or fines (Alharbi et al., 2016). In the healthcare industry, formal controls give a company a better chance of preventing medical mistakes and other types of misconduct that can lower the quality of care for patients, as well as meeting regulatory requirements and ensuring adherence to industry standards (De Harlez & Malagueño, 2016). Thus, formal controls are designed to increase the efficiency and accountability of a company while also helping protect it from legal liability.

Research has suggested that formal controls can have a direct positive impact on technological capabilities. Formal behavioral and outcome controls provide the framework for overseeing projects, facilitate cooperation amongst various functional groups, reduce errors and ambiguity, offer performance measurements and feedback mechanisms for learning (McCarthy & Gordon, 2011; Pak & Humphrey, 2011; Schultz et al., 2013), and provide the structure, routines, and accountability for the various knowledge management processes (acquisition, transfer, interpretation, and application; Turner & Makhija, 2006) involved in developing technological capabilities. Indeed, a number of empirical findings indicate that formal controls help large, complex, and geographically dispersed organizations develop strong technological capabilities (Argyres & Silverman, 2004; D. J. Miller et al., 2007) and innovation outcomes (Kemp & Pontoglio, 2011; Labitzke et al., 2014; Lukas et al., 2002). Schultz et al. (2013) suggested that this may be the case because of the increased clarity for decision-making that is enabled by formal controls. Other scholars have found that both outcome and behavioral controls are associated with firm-level outcomes related to a firm’s technological capability but that these controls should be tailored to specific activities related to the development of their technological capability (Bonner et al., 2003; Cardinal, 2001; Makri et al., 2006). Although most of the extant research has examined formal controls in the context of large public firms, it has been suggested that similar mechanisms would operate in a similar manner for private firms as well. Hence, the following hypothesis was formed:

*Hypothesis 1: The level of formal behavioral and outcome controls is positively associated with the strength of a firm's technological capabilities.*

**Informal (Clan) Controls**

Turner and Makhija (2006, p. 210) defined clan control as "the informal socialization mechanisms that take place in an organization and that facilitate shared values, beliefs, and understandings among organizational members." That is, clan control focuses on established norms, values, and traditions to drive employees to contribute to a firm's success (Ouchi, 1979, 1980) and is often utilized in contexts where originality is crucial, such as in high-tech corporations. According to Ouchi (1979), a clan is a group of people who are highly dependent on one another, show strong purpose congruence, demonstrate togetherness in their connections, have shared traditions, and hold organizational commitments (Kirsch et al., 2010). As an example of clans, Ouchi (1979) discussed research establishments and labor organizations, both of which have individual goals that align with the larger organization. These groups exhibit a high level of leadership connection among team members, disciplined ways of working, and a strong focus on assisting with learning and ensuring that work is done well. Clan control generally manifests as unofficial leadership, wherein individuals or groups exercise their power and authority through personal connections, shared values, and feelings of membership (Khanin et al., 2019). Ouchi (1979) and Kirsch et al. (2010) argued that clans govern their members through defining acceptable behavior by using traditions, implicit knowledge, and disciplined work habits. Often built on trust and loyalty, this control style is characterized by a strong feeling of community and an emphasis on the well-being of the organization and its members (Goebel & Weißenberger, 2017). Clan control is typically more subtle and difficult to detect than formal forms of control, yet it is very influential in affecting the behavior and decisions of organization members (Ouchi, 1979). Kirsch (1997) expounded upon this form of control, adding that an individual’s attitudes and actions in the workplace are shaped by the presence of authority figures and the prevailing norms of their environment. Thus, clan control involves encouraging or discouraging specific employee behaviors through verbal feedback, peer pressure, encouragement, praise and other rewards, along with the sharing of stories about prior activities, successes, and failures (Kreutzer et al., 2016).

Clan control has several potential advantages for a firm. For one, employees that feel connected to those in authority develop a strong sense of loyalty and devotion (Dyer, 2006). Also, there is the potential for long-term planning and decision-making, as employees may be more likely to consider a company's long-term success over its short-term profits. Furthermore, there is the potential for a resilient corporate culture since employees with strong personal ties to the corporation may be able to implant it with their shared values and objectives. Lastly, a sense of belonging, trust, and loyalty among employees can lead to enhanced team dynamics and performance (Goebel & Weißenberger, 2017). At the same time, clan control has the potential for adverse outcomes. The strong sense of loyalty and belonging fostered by clan control can result in groupthink, which is when group members value consensus and unity more than debate and critical thought, resulting in a lack of diversity in ideas and poor decision-making (Büschgens et al., 2013).

In the context of technology, clan control is reflected in techniques such as open office design, team-based projects, and regular meetings and feedback (C. E. H. Chua, Lim, et al., 2012). While clan control has the potential to foster a friendly, inclusive workplace where employees' creativity and innovation is fostered through the sharing of ideas and knowledge (Kirsch et al., 2010), there are disadvantages to the absence of strong and stable rules, a lack of clear regulations, and a lack of employee monitoring, all of which are characteristic of utilizing clan controls (Dekker, Lybaert, & Steijvers, 2013). Indeed, firms that rely on their culture, subjective concepts, and beliefs to build clan control often lack awareness of the potential gains that could arise from adopting new technologies (Dekker, Lybaert, & Steijvers, 2013) and are less likely to have success in adopting technologies (Sihag & Rijsdijk, 2018) or developing new products (Smets et al., 2013). Further, the focus on social capital and networks associated with clan control slows down business innovation by keeping out outsiders and limiting the flow of people and information (Jing et al., 2019). Finally, research has suggested that the longer a firm operates with clan controls, the less likely it is to be innovative (Jing et al., 2019; Mendi & Mudida, 2017). Given these findings, I formed the following hypothesis:

*Hypothesis 2: The level of clan control is negatively associated with the strength of a firm's technological capabilities.*

**Integration of Formal and Clan Controls**

The conflicting findings in the literature regarding the positive and negative consequences of formal and clan controls suggest the presence of nuanced mechanisms and contextual issues. Firms may have various types of controls in place at different levels, in different functions, and at different locations (Helsen et al., 2017). For instance, some firms may enact informal controls for top management but outcome controls for middle managers and behavior controls for lower-level employees (Audretsch et al., 2013; Helsen et al., 2017). Similarly, formal controls may be stronger in some areas, such as accounting and human resources, than in other areas (Davila, 2005; Helsen et al., 2017). Sitkin et al. (2020) pointed out that firms often use combinations of control systems in order to mitigate the disadvantages of each type of control.

Accordingly, researchers have investigated whether organizational controls can complement one another or be replaced. Consistently, research has demonstrated that when formal and clan controls are employed to complement one another, their link with positive organizational outcomes is strengthened. In contrast, when one control is substituted for another, their link is weakened (Kreutzer et al., 2016; Sihag & Rijsdijk, 2018; Tiwana, 2010). For instance, a study of 184 teams who were involved in specific organizational initiatives in a cross-industry sample of businesses from multiple countries supported the complementarity approach to organizational control (Kreutzer et al., 2016), the findings showing that the performance impact of formal and informal organizational controls' complementarity depends on the work environment and type of task. Furthermore, the positive effects of joining both formal and informal organizational controls was even more pronounced when teams were engaged in complex and exploratory tasks.

Hence, the complementarity effect seems particularly salient with regard to the technological capabilities of a firm. Research has suggested that firms using both formal and clan controls can leverage technology successfully (Herriau & Touchais, 2015; Jing et al., 2019; Smets et al., 2013). Gopal and Gosain (2010) examined boundary spanning in the context of software development, paying special attention to how external vendors and inside organizational resources were brought together to collaborate on software development projects. Their findings showed that both formal and clan control methods have the potential to considerably impact the success of a final software output if they are fine-tuned and directed toward the correct objectives. Gopal and Gosain (2010) found that effective formal controls can help clan controls reach their full potential and allow for successful collaboration across boundaries. Additionally, the researchers found that using these two control methods together can reduce the risk of failure in meeting the original goals and objectives of software projects. Similarly, research from Tiwana (2010) showed that both forms of control are more effective when used together, while Liu (2015) discovered that formal and clan controls do indeed complement one another and more so as a project's complexity increases; this is important because complexity risk plays a vital role in IT projects.

Thus, research has suggested that the general performance of a business, as well as the presence of technological capabilities within a business, is stronger when both formal and clan controls are used together, as this blend of controls helps to manage complexity risk and ensure positive project outcomes (Kreutzer et al., 2016; M. Schulze & Heidenreich, 2017; Tiwana, 2010). I came to the conclusion that these findings and associated arguments also apply to the development of technological capabilities in small private firms, and hence, I suggested the following hypothesis:

*Hypothesis 3: The integration of formal and clan controls positively impacts the strength of a firm's technological capabilities.*

**Influence of Family Firms**

Unlike nonfamily enterprises, which are primarily focused on financial goals, family firms value both financial and nonfinancial outcomes. In particular, family owners prioritize their establishment's long-term growth and familial control rather than exclusively concentrating on immediate profitability (Gomez-Mejia et al., 2011). Furthermore, their decision-making reflects familial values, though these may evolve to accommodate the requirements of each successive generation (Pistrui, 2005). As they are motivated not only by financial gain but also by a sense of family legacy and responsibility, family owners may be more willing to make long-term investments in the firm; they also value the family's reputation and ties to the community (J. H. Chua et al., 1999; Dekker, Lybaert, Steijvers, & Depaire, 2013; D. Miller & Le Breton-Miller, 2005b). Adopting a long-term orientation may incentivize allocating resources toward the development of technologies that may not generate immediate profits but could potentially augment a firm's competitive edge in the future. At the same time, according to Gomez-Mejia et al. (2007), family-owned businesses frequently exhibit risk aversion due to their emphasis on safeguarding the family's assets and reputation. A potential consequence of this could be a reduction in their propensity to engage in investment activities pertaining to novel technologies, which are frequently linked to elevated levels of risk and ambiguity. According to Sirmon and Hitt (2003), the consistent leadership and robust internal connections characteristic of family-owned enterprises often foster knowledge exchange and facilitate organizational learning, factors that are crucial for the development of technological capabilities. Similarly, Chrisman, Chua, and Sharma (2005) suggested that family firms' hands-on supervision and atmosphere of strong confidence can cultivate an innovative culture and lead family owners toward taking measured risks and exploring novel technologies. At the same time, family influence may also negatively impact a firm if family members who are active in the business lack the requisite managerial acumen and expertise to formulate strategic determinations concerning the enterprise's future trajectory (Ogbonna & Harris, 2005). Due to nepotism, family executives and employees may encumber an organization with their extensive tenure and resist embracing technological innovations within their sector (König et al., 2013). Furthermore, family executives may lack the requisite managerial acumen and expertise to formulate strategic determinations concerning their enterprise's future trajectory. Thus, given that family business owners significantly influence the direction of their organization (Voordeckers et al., 2007), the nature and extent of the family owner's involvement and influence is likely to interact with the firm's control mechanisms to impact its technological capabilities.

While scholars have defined family firms in various ways, Astrachan et al. (2002) argued that the family owners' involvement in their firm is multidimensional and best examined as a continuum. They identify three categories of family influence: power, experience, and culture, referred to as the F-PEC scale. Power is the degree of control family owners have over their organization that influences their ability to determine strategic, personnel, and operational decisions. Experience refers to the contribution of various generations of family members, while culture captures the values and beliefs that permeate an organization. The extent of family influence along all three dimensions matters; for instance, recent research has suggested that family enterprises exhibit an increased proclivity for embracing novel technologies in regard to each aspect of the F-PEC scale (Pitchayadol et al., 2018). The extent of family influence on firms can range from minor to significant, depending on factors such as the size of the family and their level of involvement in decision-making processes.

### *Family Power*

The power dimension of F-PEC scale assesses multiple variables that are specifically associated with the ability to exercise control over a firm (see Klein et al., 2005; Rau et al., 2018). As an illustration, a higher percentage of ownership gives a family greater leverage to shape decisions and steer the strategic direction of their business (Chrisman et al., 2005a). In addition, the presence of family members in prominent managerial roles can significantly impact strategic priorities and the enterprise's routine administration and functioning (D. Miller et al., 2003). Finally, family members' involvement in governance positions can impact strategic decision-making, facilitate oversight, and contribute to establishing the organizational culture and values of the firm (Astrachan & Jaskiewicz, 2008).

The research on family firms speaks to the critical significance of familial influence. The strategic decisions of a business are significantly impacted by a family's power, which is exerted through their ownership, management, and governance. According to Carney (2005), a family's power and influence facilitates the synchronization of their enterprise with the family's enduring vision and principles. Research has indicated that the influence of a family, as measured by the power dimension, significantly affects organizational innovation activities. Zahra and Sharma

(2004) posited that a family firm's proclivity to undertake risks and innovate can be impacted by their taking ownership of their family's values and traditions.

Family owners' power and control can impact their firm's technological capabilities and mechanisms related to organizational controls. For instance, a family's control over the strategic decision-making processes can shape their firm's technological trajectory (Diéguez-Soto et al., 2016). If the family leadership values tradition and stability over innovation, they may resist adopting new technologies or investing in R & D. This can limit the firm's technological capabilities and prevent it from responding effectively to changes in the external environment. On the other hand, if the family has a more forward-thinking orientation, they might actively invest in technology and innovation, leading to the increased competitiveness of their firm (Cruz & Nordqvist, 2012). Furthermore, the degree of family power also shapes how controls operate within a firm. In firms where family power is concentrated, there might be more reliance on informal controls, such as socialization and cultural norms. In contrast, organizations might de-emphasize formal controls like performance metrics and bureaucratic procedures, which can lead to both positive and negative outcomes, as informal controls can facilitate trust and cohesion but also inhibit accountability and professionalism (Chrisman et al., 2004).

***Family Experience***

The experience subscale constitutes a pivotal component of the F-PEC scale, as it concerns the capacity of a family to leverage its acquired knowledge and skills over an extended period for the betterment of their enterprise (Klein et al., 2005; Rau et al., 2018). For example, it considers the length of time that a family has been engaged in their business. According to Sirmon and Hitt (2003), the longevity of a family business is indicative of increased experience, which in turn may contribute to a greater understanding of business operations and more effective decision-making. The F-PEC scale also considers the multigenerational aspect of the family's participation in the enterprise. According to De Massis et al. (2013a), the involvement of multiple generations may suggest a significant accumulation of knowledge and experience. In a study by Chrisman, Chua, and Steier (2005), the extent of family members' participation in both their routine activities and strategic decision-making procedures was also considered, highlighting the comprehensive nature of the F-PEC framework in evaluating family influence on the business's success.

The experience dimension of the F-PEC scale holds significant importance within the realm of family enterprises due to various reasons. The intergenerational transmission of industry-specific, company-specific, and tacit knowledge often confers significant advantages to family-owned enterprises. The possession of experiential knowledge can confer a competitive edge for a business, owing to its facilitation of sound decision-making and contributing to its sustained existence (Sirmon & Hitt, 2003). According to Zellweger, Kellermanns, et al. (2012), family businesses can benefit from maintaining and upholding their core family values, its mission, and its culture. This can contribute to the development of a robust organizational identity that is advantageous for both internal cohesion and external perception. In addition, family-owned enterprises, leveraging their accumulated multigenerational knowledge, tend to exhibit a greater proclivity towards long-term strategic planning. According to D. Miller and Le Breton-Miller (2005a), firms have the ability to prioritize sustainable growth over short-term profitability by making strategic decisions, which can ensure their resilience and continuity. Finally, it is worth noting that multigenerational family enterprises have forged enduring connections with diverse stakeholders, including their employees, customers, and suppliers, potentially fostering their allegiance, confidence, and dedication (Deephouse & Jaskiewicz, 2013).

The technological capabilities and organizational controls of firms are also influenced by its collective experience. As an illustration, the experience of a family can be a contributing factor to their company's capacity to adjust to technological advancements and innovations. According to De Massis et al. (2013b), accumulating knowledge and experience over time can enable families to better comprehend the ramifications of technological advancements for their enterprise and potentially enhance their ability to respond more efficiently. Proficient family enterprises can also leverage their prior expertise to engage in technology-oriented innovation and endeavors. Furthermore, an individual's familial background can impact the implementation of managerial mechanisms within their organization. According to Chrisman, Chua, and Sharma (2005), families possess a profound understanding of their business, enabling them to create tailored control mechanisms that are suited to their unique business models and obstacles. In addition, families with more experience may possess a greater comprehension of the equilibrium between formal controls, such as bureaucratic procedures, and clan controls, such as trust and social norms. Individuals owners can proficiently utilize both controls to oversee their enterprise and efficiently address familial matters. De Massis, Frattini, et al. (2018) pointed out that the transfer of technological capabilities and effective control system management can be ensured by experienced owners who guide the next generation, thereby ensuring their firm's continuity.

***Family Culture***

The familial and cultural dimensions of F-PEC reflect the extent to which a family's values and norms are embedded within their business through various organizational facets, such as the company's mission, corporate strategy, leadership succession, involvement of its employees, managerial approach, operational procedures, relationships with clients and suppliers, and ties to the family legacy (Klein et al., 2005; Rau et al., 2018; Krishnan, 2020). One aspect of assessing a family's cultural influence involves examining the extent to which their familial values and traditions impact their decision-making. The familial and cultural dimensions also include a family's dedication to the perpetuation of their enterprise for forthcoming cohorts and the preservation of familial concordance within the business (Astrachan et al., 2002).

An organization's vision, strategic choices, and operational style are influenced by its culture. This holds particular relevance in the context of family-owned enterprises, wherein family members frequently wield significant sway over their organization's strategic trajectory. Family-owned enterprises are frequently established on the basis of common familial principles and customs, which function as guiding tenets for the enterprises, molding their mission and objectives. Astrachan et al. (2002) argued that integrating values and traditions into a business, as reflected by its culture, can significantly influence its operations. In addition, family-owned enterprises often exhibit a robust dedication to enduring continuity and sustainability with a desire to transfer their enterprise to subsequent progenies. According to Zellweger et al. (2010), the viewpoint on continuity and sustainability has the potential to impact strategic choices, leading to the adoption of more cautious and future-oriented business approaches. Finally, it is worth noting that culture can exert a substantial influence on the process of conflict resolution within family-owned enterprises. Kellermanns et al. (2008) pointed to the cultivation of a robust family culture that fosters solidarity and collaboration and can effectively mitigate and forestall disputes. This is especially crucial in the context of a family enterprise, where the demarcation between personal and professional spheres is often indistinct.

The operations of a family firm, such as its control mechanisms and focus on developing technological capabilities, are notably influenced by its family culture. The approach of a family business towards technological change is frequently influenced by the shared values and norms of the family. According to Cruz and Nordqvist (2012), family-owned enterprises that prioritize tradition and stability as part of their organizational culture may exhibit reluctance towards adopting novel technological advancements. Conversely, family-owned enterprises that foster a culture that prioritizes innovation and adaptability should exhibit greater openness toward technological advancements (Urbinati et al., 2017). At the same time, the impact of familial involvement on a company's culture can significantly shape its control mechanisms. The significance of informal control mechanisms, such as trust, shared values, and traditions, is often observed in family firms alongside their formal controls, as noted by Eddleston and Kellermanns (2007). While the presence of a robust familial culture that prioritizes values, such as integrity and responsibility, could mitigate the necessity for stringent formal control mechanisms, excessive dependence on informal controls may result in a sense of self-satisfaction and a dearth of responsibility in certain situations. The resolution of conflicts and decision-making processes are frequently influenced by the cultural norms and values of a family. An example of a cultural orientation that prioritizes consensus is one in which decision-making procedures are designed to secure the concurrence of all members of a family unit. The aforementioned phenomenon has the potential to cultivate a sense of cohesion and dedication among team members. However, it may also impede the expeditiousness of decision-making processes and impede the organization's agility in adapting to fluctuations in the commercial landscape (Gómez-Mejía et al., 2011).

## The Moderating Effect of Family Influence

Given the significance of family influence as found in the literature, the subsequent research was examined to discover how family firms might influence the relationship between formal controls and technological capabilities. At high levels of family influence, the family holds power through the strong control of their firm's ownership and governance, the family has controlled the firm for generations and has the involvement of several family members and multiple generations, there is an overlap between the values of the family and their business, and family members are highly supportive, loyal, and inclined to work together (Astrachan et al., 2002).

Formal controls provide structure, routines, and accountability and are most useful in conjunction with an explicit hierarchical organizational structure and clear lines of authority, which can help ensure that decisions are made promptly and efficiently (Turner & Makhija, 2006). At the same time, formal controls should be easy to monitor and evaluate, and clear guidelines should be offered for individual employee behavior as well as the specific outcomes the organization aims to achieve (Turner & Makhija, 2006). Since formal control characteristics are helpful for developing and maintaining various knowledge processes and other mechanisms (e.g., formal scanning behavior, project management, product and process development, or R & D) necessary for the development of technological capabilities, I proposed that when family influence is strong, formal controls are less effective for developing technological capabilities.

Family firms differ from nonfamily firms in important ways. First, family owners and members identify strongly with their firm and hence are emotionally connected to it (Gomez-Mejia et al., 2007, 2011). This not only leads them to prioritize noneconomic goals, sometimes even over economic goals, but may also result in a lack of goal clarity as family values and objectives are often implicitly, though deeply, held. Consequently, family owners are likely to continually assess and adjust a firm's goals to maintain family priorities in response to environmental and organizational conditions. Doing so may lead to the bypassing of formal control systems for goal setting and working toward specific goals; in the long-term, this in turn, would result in a lack of clarity of goals for employees. When a family has a significant stake, they may have more control over decision-making and resource allocation (Duran et al., 2016), thus influencing the need for technological investment. In the context of a family businesses characterized by a high degree of ownership concentration, it is common for decision-making processes to be centralized (Zahra & Sharma, 2004). This may result in lower autonomy granted to middle-level managers to enable them to adapt to changing external circumstances, thus reducing the efficacy of formal control mechanisms (Turner et al., 2021).

Second, the welfare of a family is generally an important priority for family owners. While this pushes the owners toward ensuring their firm’s long-term survival, it can also result in a more risk-averse stance towards technological investments and capabilities, which are frequently linked with elevated levels of risk (Chrisman et al., 2005a; Gomez-Mejia et al., 2007). Further, focusing on the family’s welfare can engender problematic behaviors like altruism and nepotism that benefit family employees based solely on their blood ties and not their competence (Bloom & Van Reenen, 2007; Gomez-Mejia et al., 2011). Accordingly, tenured family employees may not necessarily be the most suitable for their positions and hence, may not be able to effectively administer formal controls to build the firm’s technological capabilities (De Massis, Frattini, et al., 2018).

Moreover, in cases where family members have predominantly been employed within the family enterprise, they may have limited exposure to diverse management and innovation techniques, thereby constraining the firm's capacity to implement formal controls and cultivate technological proficiencies (D. Miller et al., 2003). According to Hayward et al. (2006), prolonged exposure to a particular field of work may result in excessive self-assurance, which can hinder the impartial evaluation of formal regulations and technological competencies. Another possible consequence of nepotism is asymmetric altruism, where some family members are more favored over others (W. D. Schulze et al., 2001), leading to discord within the family, in turn impacting the smooth operation of formal controls as they relate to developing technological capabilities. Moreover, as family influence increases in terms of the number and generation of family members, the complexity of family interactions rises, potentially exacerbating family conflict and the diversity of various family owners' goals (Helsen et al., 2017). For instance, younger generations of family owners and employees may be more inclined to utilize technology to optimize operations, while older generations may be less familiar with technological advancements (De Massis et al., 2008). Accordingly, alignment between a family firm's goals and activities is reduced, lowering the efficacy and effectiveness of formal controls (Turner et al., 2021). Finally, family-owned businesses frequently exhibit an informal culture due to the intimate personal connections shared among family members (Eddleston et al. 2012). Promoting flexibility may adversely affect the efficacy of formal controls and impede the administration of intricate technological procedures (Zhou & Wu, 2009).

Given these observations, the following hypothesis was suggested:

*Hypothesis 1a: The influence of family firms weakens the positive relationship between formal control and technology capabilities.*

As opposed to formal controls, informal controls are best used when knowledge is tacit and complex (Turner & Makhija, 2006), as in the case of implicitly held family values and goals. The common interests and high level of interactions and communication associated with clan controls (Turner & Makhija, 2006) should help both family firm members and nonfamily employees develop a shared understanding of the family's values, enabling them to respond effectively to the ambiguity and change associated with organizational priorities and processes. Additionally, clan controls possess characteristics that are compatible with family power, experience, and culture.

First, clan controls involve the important role of socialization processes, such as rituals, ceremonies, meetings, and teams (Turner & Makhija, 2006). Given that family firms tend to have long-tenured family managers and employees, as well as long-tenured nonfamily employees (e.g., Bassanini et al., 2011; D. Miller, Le Breton-Miller, & Scholnik, 2007), they are likely to develop a “strong and enduring sense of organizational identification” while also exchanging and sharing diverse knowledge associated with the firm (Turner & Makhija, 2006, p. 210; Schein, 2016). Relatedly, family-owned businesses tend to foster an environment of mutual reliance and teamwork, thereby enabling the joint creation and utilization of technological proficiencies (Eddleston & Kellermanns, 2007).

Second, family firms are known to take a stewardship perspective with respect to their employees (D. Miller, Le Breton-Miller, & Scholnik, 2007), creating a sense of belonging that encourages their employees to embrace and adopt the owners’ goals and priorities, as well as to take ownership of their efforts, such as those associated with the development of technological capabilities (Köhn et al., 2022).

As family influence rises, these advantages are likely to become stronger in the presence of clan control, which shares several practices and mechanisms with that of the operation of family businesses (Helsen et al., 2017). In fact, several scholars have suggested that family businesses have an affinity for clan control systems and tend to perform better when they use them (Dekker, Lybaert, & Steijvers, 2013; Moores & Mula, 2000; Sanchez-Marin et al., 2016; Songini & Gnan, 2015). Indeed, family businesses often make decisions based primarily on consensus and relationships as opposed to official rules and procedures (Moores & Mula, 2000). If the culture and power of a family are strong, family members may be more inclined to share a vision for the company's future development and be willing to make decisions based on this objective instead of on short-term gains, leading to performance advantages for the company, such as gaining better technological capabilities (Duran et al., 2016; Mustakallio et al., 2002). As per Sirmon and Hitt (2003), the effective development, adoption, and guidance of technological capabilities can be facilitated by clan controls when power is concentrated in individuals or groups with a clear and future-oriented vision. According to Eddleston et al. (2008), in family-owned enterprises where power is equitably distributed and acknowledged among members, clan controls can cultivate a climate of collaboration and agreement, thereby augmenting the integration and application of technology. They further argued that the culture of a family firm frequently exhibits a robust sense of trust and unity, which can augment the efficacy of clan controls and cooperation in assimilating new technologies. Zahra and Sharma (2004) argued that influential members of family firms can utilize clan controls to enhance the firm's resilience and adaptability, which are both crucial in managing technological changes and disruptions.

Given this evidence, it was postulated that family influence has a positive impact on the relationship between clan control and technological capabilities, and I therefore proposed the following hypothesis:

*Hypothesis 2a: The influence of family firms weakens the negative relationship between clan control and its technology capabilities.*

Research has suggested that implementing formal and clan controls within an organization can yield favorable outcomes for the organization's capacity building (Turner & Makhija, 2006). A family's influence on both of these controls may further enhance the organization's technological capabilities (Chrisman, Chua, & Steier, 2005). These controls combined can help improve communication, increase accountability, and foster a culture of innovation within the organization (Ouchi, 1979; Kirsch, 1997). However, balancing these controls with flexibility and adaptability to changing market conditions is essential (De Massis et al., 2013a).

For instance, the power of family firms, which often manifests as decision-making authority held by family members, can significantly influence both formal and clan controls over its technological capabilities (Sirmon & Hitt, 2003). When used effectively, power can guide the firm's development, acquisition, and utilization of these capabilities (Chrisman et. al., 2005a). For instance, the concentration of power in family firms can enhance decision-making efficiency (Chrisman et al., 2004). This can positively influence their formal and clan controls by promoting quick decisions regarding changes to rules, systems, or procedures related to a firm's technological capabilities. Also, family power allows for decisive resource allocation, which is critical for the technological capabilities of a firm (Sirmon & Hitt, 2003); family members in power can prioritize investments in technology, strengthening their formal and clan controls. Furthermore, family members in power can effectively communicate and enforce a unified vision across their firm (D. Miller & Le Breton-Miller, 2006), strengthening their formal and clan controls by fostering shared values, beliefs, and norms that guide behavior related to the firm's technological capabilities. Family power often leads to long-term commitment and continuity, which is vital for a firm's technological capabilities (Gersick et al., 1997); this commitment and continuity facilitates both the adoption of formal controls and the strengthening of clan controls, as both require consistency over time. Lastly, the autonomy afforded by a family's power can stimulate innovation (Zahra, 2005), which is critical to maintain and develop its technological capabilities; family power can support formal and clan controls that in turn, encourage innovation.

The collective experience of family members in a family firm is a significant resource that can positively influence its formal and clan controls in relationship to a their technological capabilities. The positive impact can be seen through improved decision-making, increased efficiency, effective resource management, and the fostering of innovation. Family firms often possess a deep reservoir of industry-specific knowledge and skills accumulated over generations (Habbershon & Williams, 1999) that can be instrumental in designing and implementing effective formal control systems for managing technological capabilities. Also, the historical learnings of past successes and failures can inform the creation of formal and clan controls, enabling these firms to avoid past mistakes and replicate successes (D. Miller & Le Breton-Miller, 2005a). Lastly, experienced family firms can better manage risks which gives them the ability to navigate uncertainty and can strengthen organizational control systems by incorporating well-informed risk management strategies (Zahra, 2005).

The culture of family firms, rooted in strong traditions, shared values, trust, and close-knit relationships, can contribute significantly to the effectiveness of both formal and clan control in regard to its technological capabilities. For instance, the balance of formal and clan controls can positively influence the management of technological capabilities by providing a comprehensive control framework that incorporates both the rigidity of formal controls and the flexibility of clan controls (O'Boyle et al., 2012). Also, family firms usually have robust communication channels due to their close-knit relationships (Zahra, 2003), which can enhance the effectiveness of formal and clan controls by promoting transparent, timely, and effective communication regarding its technological capabilities. Furthermore, family firms tend to have a shared vision and set of values, which can reinforce both formal and clan controls (Miller et al., 2007b) and enhance the understanding and acceptance of formal control systems; shared values can underpin clan control systems, promoting consistent decision-making and actions related to a firm's technological capabilities. Lastly, family firms are typically characterized by a long-term orientation (Sirmon & Hitt, 2003), which can improve the effectiveness of both formal and clan controls by encouraging a long-term perspective on the management of its technological capabilities, which in turn can foster continuous improvement and innovation.

Based on the available literature, family influence positively affects the complementary relationship between formal and clan-based control mechanisms and a firm's technological capabilities. Consequently, I suggested the following hypothesis:

*Hypothesis 3a: The influence of family firms strengthens the positive relationship between the combined integration of formal controls with clan controls and its technology capabilities.*

# Methods

## Sample, Participants, and Procedures

To identify information-rich cases while focusing on the context of family, this study used criterion-based selection for sampling (LeCompte & Schensul, 2010), implementing the participant inclusion and exclusion criteria listed in Table 1.

Response rates were obtained through Prolific (325 respondents; Palan & Schitter, 2017), and snowball sampling (77 respondents) was utilized as a supplementary source of data. The sample consisted of private firms (family and nonfamily) based in the United States, which were recruited using multiple networks, including family business networks, university family business programs, academic networks, family business consultants, and direct contacts in family firms. Snowball sampling was also used to access more firms by utilizing email through social networks like LinkedIn (Biernacki & Waldorf, 1981; Dusek et al., 2015).

Respondents within the firms included CEOs, senior managers, family owners/managers, and board members. Individuals within firms who had an influence and power over technological decisions for the organization were surveyed. In addition, participants who possessed knowledge of the impact of family influence on their corresponding organizations were surveyed. The final sample size for analysis was 177 (derived from a total of 402 respondents). There was no statistically significant difference between the two groups, likely attributable to the small number of respondents obtained through the snowball sampling method (See Table 2a).

I determined that the sample size met the necessary criteria for conducting an SEM analysis via SmartPLS, a preferred tool due to its effectiveness in managing intricate models prevalent in business research (Hair et al., 2014). According to the established norms for PLS-SEM, a sample size that is at least tenfold the number of items in the largest construct is deemed adequate (Hair et al., 2011). The study featured 177 unique participants with the largest construct containing 13 items. There were 47 more participants than the 130 that were originally sought. This substantial sample size not only enhanced the statistical power of the analyses but also improved the stability and accuracy of the parameter estimations within the model (Hair et al., 2014).

Adhering to these best practice guidelines for SEM, in which a larger sample size relative to the number of constructs in the model often yields more reliable and generalizable results, I significantly reduced the risk of underpowered analyses, thereby increasing the reliability of the findings generated through SmartPLS.

**Missing Data**

The dataset, consisting of 71 variables related to technological skills, formal and clan control, and the F-PEC scale, underwent a comprehensive missing data analysis to ensure the integrity and reliability of subsequent analyses. This analysis is crucial for addressing the distribution and extent of missing responses, a pivotal aspect of maintaining statistical accuracy (Little, 1988).

In the process of refining the data sample, the initial dataset comprised 402 responses gathered through a comprehensive survey. However, upon closer examination, it became apparent that a significant portion of these responses contained empty answers, which required a rigorous distillation process. Consequently, the dataset was screened for completeness, resulting in the exclusion of 83 responses that lacked essential information, thereby reducing the sample size to 319.

The sample of 319 responses demonstrated variability in the context of nonmissing data. On average, each variable was represented by approximately 285 responses, with a standard deviation of about 57, highlighting disparities in response rates across surveyed items (Anseel et al., 2010). The range of nonmissing sample sizes spanned from a minimum of 104 to a maximum of 319.

To further enhance the robustness and reliability of the analyses, I implemented an additional layer of scrutiny, focusing on the depth and completeness of the answers. A significant portion of missing data was noted in the Power and Experience subscales, leading to a reduction in sample size from the 319 observations to 177. This strategic decision, informed by the research's focus on family businesses, aimed to enhance the dataset's relevance and purity without relying heavily on imputation to restore sample size (Brick & Kalton, 1996; Cummings, 2013). This choice reflects a deliberate effort to concentrate on the unique dynamics of family businesses, avoiding potential biases from noncomparable entities (Chrisman et al., 2005b; Kellermanns & Eddleston, 2006). I chose not to impute items for power and experience because these values are unique to each individual in the same manner that a categorical variable would be. For these items, no imputation was performed. This refined dataset was instrumental in ensuring the accuracy and validity of the research findings, as it comprised data of the highest quality and relevance to the study's objectives.

The analysis revealed a mean missing data percentage of approximately 13.81%, with a standard deviation of 17.17%, indicating a wide variance across variables—from none to as high as 68.58%. This kind of variance underscores the challenges of achieving a comprehensive dataset and highlights the importance of addressing missing data with suitable methods like imputation, sensitivity analysis, or robustness checks (Rubin, 1976; Little & Rubin, 2002).

Employing Little's (1988) MCAR test revealed a nonrandom pattern of missing data in the combined dataset of family and nonfamily businesses, indicating randomness in missing data for family businesses alone, simplifying the imputation process for this subgroup and mitigating bias risks.

Data from 177 participants were collected. The technological skills scale had 9 items, technological capabilities had 5, formal output controls had 3, formal behavioral controls had 4, clan control had 6, Power (F-PEC) had 3, Experience (F-PEC) had 3, and Culture (F-PEC) had 3. Little's (1988) MCAR test indicated that the missing data were not missing completely at random, $\chi 2 = 1291.818$ (1133), $p > .001$. Given that the variables related to power and experience exhibited the highest number of missing entries, and these entries were unique to each individual, I decided to reapply the MCAR test solely to the latent constructs. The subsequent Little's (1988) MCAR test showed that the items were missing completely at random, $\chi 2 = 196.635$ (201), $p = .574$. To address this, I utilized the missing data function in SmartPLS, which implemented a mean replacement to input the missing values. Please see Table 2b for a record of the missing data.

**Demographics**

The demographic profile of the respondents in this study encompassed a diverse array of characteristics, as detailed in Table 2c. There was a strong minority of female respondents and multiple racial and ethnic identities were represented. Education levels among the respondents varied, with a significant portion having attained at least an undergraduate degree. Respondents held a variety of roles at their firms from entry-level positions to senior management, with their tenure ranging from being a new hire to having over two decades of experience with the company.

### *Age*

There was a diverse age range among participants. The most represented group was 30–39 years old, accounting for 28.6% of the sample, followed closely by 40–49 years old at 28%. The 50–59 years old group comprised 20% of the sample, while both the 20–29 and 60–70 years olds groups were less represented, making up 9% and 14.3% of the sample, respectively.

### *Gender Identity*

Regarding gender identity, the majority of participants were male (58.8%), with females accounting for 40.1% of the sample. The categories of "Nonbinary" and "Prefer not to say" were minimally represented at 0.6% each.

### *Racial and Ethnic Identity*

The racial and ethnic identities of the respondents was predominantly Caucasian, constituting 79.7% of the dataset. Participants who were African American accounted for 9% of the sample, followed by the category of "Other" at 7.3%. Participants who were Asian made up 2.8% of the sample.

### *Education*

A significant portion of participants held a bachelor's degree (43%). Those with a graduate or professional degree accounted for 26.6% of the sample, while 15.8% of participants had some college education but no degree. Participants who held an associates or technical degree accounted for 7.9% of the sample, those with high school diplomas or GEDs accounted for 5.7%, while the categories of “Prefer not to say” and “Some high school or less” were less common.

### *Occupation*

The participants who were senior management made up 39.6% of the sample, reflecting the significant participation of higher-level decision-makers. Participants in operations (22.65%) and IT (14.7%) also held substantial proportions of the sample, indicating the importance of these functional areas in contemporary business operations. There was also a balanced representation of participants who had occupations in sales and service (9%), finance and accounting (5.7%), and marketing and merchandising (5.7%).

### *Roles Held*

The most common role of participants at their firm was director/senior manager, comprising 26% of the sample, highlighting the presence of senior-level management in the dataset. Manager/supervisor roles accounted for 20.3% of the sample and CEO positions made up 4.5%, indicating significant leadership representation. Employee/manager roles constituted 5.7% of the sample, and C-level roles represented 3.4%, reflecting the diversity and complexity of roles within modern organizations.

### *Tenure at Firm*

The data revealed that most participants had a tenure at their firm from 0–4 years (21%) and 5–9 years (35.2%), the latter being the most represented category. Participants with a tenure of 10–14 years followed at 18.75% of the sample, and those with a tenure of 15–19 years made up 13.1%. Longer tenures were less common, indicating potential trends in job mobility or career transitions.

### ***Year Firm Was Founded***

The majority of the participant's firms were founded from 1980–2019. Twenty-seven percent of the firms were founded after 2010. Twenty-two-and-one-half percent of the participant's firms were founded between 2010–2019, 26% were founded between 2000–2009, 14.8% were founded between 1990–1999, and 10.7% were founded between 1980–1989, reflecting the growth of newer businesses. Older firms, especially those founded before 1970, were even less represented in the dataset.

### ***Firm a Family Business or Not***

The participants were almost evenly split in terms of whether their firm was a family business or not, with 52.5% of participants indicating their firm was a family business and 47.0% indicating their firm was not a family business.

### ***Primary Business***

There was a wide range of industries that the participants worked in represented in the dataset. The technology sector emerged as the most prominent, constituting 16.4% of the participants' firms, highlighting its pivotal role in the modern business landscape. This was closely followed by retail and consumer products (14.1%), distribution and manufacturing (13.6%), and media, arts and entertainment (11.3%), indicating significant representation in these dynamic sectors. The industries of real estate and construction followed (7.9%), along with services (7.9%), health care services (7.3%), and financial services (6.2%). Notably, the less represented industries included hospitality and leisure (2.3%) and automotive (1.1%), while the industries of oil and gas, power and utilities, telecommunications, and mining and metals were the least represented in the sample.

## **Formal Controls—Independent Variable**

The validated 7-item formal control scale developed by Kreutzer et al. (2015), which is comprised of formal behavior controls and formal outcome controls, was utilized in the present study. A 7-point Likert scale was also used (1 = *Strongly disagree* to 7 = *Strongly agree*). This scale has been used in multiple other studies, including studies of team performance (Kreutzer et al., 2016), job satisfaction (Walter et al., 2021), and innovative capabilities (Turner et al., 2021). Consistent with the findings of Kreutzer et al. (2015), it was observed in the current study that the combination of the seven items under consideration exhibited a loading pattern indicative of two distinct factors: formal behavior control with three items (α = 0.831) and formal outcome control with four items (α = 0.86). The overall combined scales demonstrated high internal consistency (α = 0.895). The Appendix contains a complete list of the items included in the scale.

Using the statistical tool Jamovi, I determined that the sample sizes for the formal control factors ranged from 176 to 177 respondents. The data were screened for outliers and normality, and none of the items exhibited high skewness or kurtosis exceeding the cutoffs of ∓ 2.00 for skewness and ∓ 7.00 for kurtosis (Hair et al., 2010). Skewness values ranged from −1.514 to −0.885, and kurtosis values ranged from 0.33 to 3.53. Univariate outliers were examined using boxplots for extreme cases, and nine were detected, but they were not extreme values (i.e., they were not beyond three standard deviations). Please see Figure 2a and 2b for a boxplot and histogram that illustrate the outliers of the full construct and both of the factors.

The descriptive analysis of each item revealed that the mean scores ranged from 4.78 to 5.52, indicating a general agreement of the statements across both scales. The median scores were closely aligned with the means, further reinforcing this trend.

However, the standard deviations, ranging from 0.868 to 1.08, suggested a moderate level of variability in the responses. Notably, all items exhibited non-normal distributions, as evidenced by the significant Shapiro-Wilk test results ($p < .001$), and most items displayed a negative skew. This was further corroborated by the skewness and kurtosis values, which deviated from the norms of a standard normal distribution. The reliability of the scales was robust, as indicated by a Cronbach's alpha measurement of 0.895 for the overall scale.

**Clan Control—Independent Variable**

The cultural control scale developed by Goebel and Weißenberger (2017) was utilized to assess clan control ($\alpha = 0.90$). Goebel and Weißenberger (2017) employed cultural controls by integrating two indicators previously utilized by Wargitsch (2010), which closely aligned with Ouchi's (1979) concept of clan control, and four indicators from Widener's (2007) framework were employed by Goebel and Weißenberger to evaluate the value systems of organizations. Their cultural control scale has been adopted for studying organizational commitment (Boff et al., 2021), job satisfaction (Da Cruz et al., 2022), and environmental innovation (Da Rosa et al., 2022). The same 7-point Likert scale Goebel and Weißenberger (2017) utilized in their prior research was adopted in the current study to ensure consistency, with anchor labels ranging from 1 = *Does not apply at all* to 7 = *Does completely apply*. The Appendix contains a complete list of the items included in the scale.

Using the statistical tool Jamovi, I determined that the sample sizes ranged from 176 to 177 respondents. The mean scores for the Clan Control items exhibited a range that spanned from 5.11 at the lower end for ClanControl_2 to 5.76 at the higher end for

ClanControl_5. This range encapsulated the average responses for each factor, indicating a moderate to high level of agreement or occurrence of the attributes measured by the scale. Specifically, ClanControl_1 had an average score of 5.26, while the scores for ClanControl_3 and ClanControl_4 were close, with means of 5.67 and 5.52, respectively. ClanControl_6 showed a mean score of 5.38, situating itself towards the higher end of the spectrum. The standard deviations, ranging from 1.37 to 1.48, and the variances, ranging from 1.87 to 2.19, suggested moderate response variability. I observed skewness values ranging from −1.539 to −0.913, indicating a negative skew towards higher scores. Kurtosis values ranged from 0.1967 to 2.35, suggesting a range of distributions from nearly normal to moderately peaked. Using the Shapiro-Wilk test, I found that the *p* values were less than .001 for all factors, indicating a significant deviation from normality. The descriptive analysis of the Clan Control items revealed a tendency for respondents to score towards the higher end of the scale. The moderate to high mean scores, combined with the observed skewness and significant deviation from normality, highlighted the distribution characteristics of the responses. The calculated standard deviations and variances indicated moderate variability across these factors, while the confidence intervals provided reliable estimates of the mean scores. Please see Figure 3a and 3b for a boxplot and histogram that illustrate the outliers of the full construct and both of the factors.

The reliability statistics demonstrated a mean score of 5.31 with a standard deviation of 1.18. To evaluate the scale's internal consistency, I calculated Cronbach's alpha, which resulted in a value of 0.873. This value indicated good internal consistency among the scale items, suggesting that the scale was a reliable instrument for my research. I examined the item-level reliability to further examine the scale's reliability. This involved analyzing the impact of each item on the overall scale of reliability. For each item, I calculated the mean and standard deviation, item-rest correlation, and Cronbach's alpha.

**Technological Capabilities—Dependent Variable**

The technological capabilities dependent variable was measured through two scales. The first was Zahra et al.'s (2007) Technological Skills scale ($\alpha = 0.81$),, which was comprised of nine items (TechSkill_1 to TechSkill_9); this scale assesses various technological skills of an organization compared to a competitor's technological skills. Zahra (2020) also measured organizational social capital using this scale indicating the versatility and applicability of the scale in different research contexts. The second scale was the Technological Capabilities Likert scale used by Khin and Ho (2019), consisting of five items (TechCap_1 to TechCap_5); this scale measures the impact of a business's technological capabilities on their innovation (Zhou & Wu, 2010). This scale has been adopted in several other studies, including those examining organizational agility (Almahamid et al., 2010), self-efficacy (Wahab et al., 2017), and technology investment effectiveness (Voudouris et al., 2012). Both scales use a 5-point Likert scale and encompass questions about an organization's capacity to innovate, leverage technology, and allocate resources toward R & D.

To reduce survey bias, I adapted the two scales in the current study to measure factors on a sliding scale of 1–100 (1 = *Much weaker than the competition* to 100 = *Much better than the competition*). The Appendix contains a complete list of the items included in the scale.

Using the statistical tools employed, including Jamovi, I analyzed the scale factors of Technological Skills and Technological Capabilities that revealed significant variability. The sample sizes for these factors varied between 174 and 177 respondents. The mean scores ranged from 49.9 to 67.5, and the standard deviation values (22.0 to 29.7) indicated a wide response spread. Skewness values ranged from −0.832 to −0.374, and kurtosis values ranged from −0.8261 to 0.4807, suggesting a general left skew and flatter distribution. The Shapiro-Wilk test confirmed non-normal distributions for all factors ($p < .001$). Please refer to Figure 4a and 4b for a boxplot and histogram that illustrate the outliers of the full construct and both of the factors.

The overall reliability of the scales showed high internal consistency. Technological Skills had a Cronbach’s alpha of .934 and Technological Capabilities had a Cronbach’s alpha of .957. When both scales were combined, a good internal consistency was demonstrated with a Cronbach’s alpha of 0.953. The high Cronbach’s alpha values for both the overall scale and individual scales indicated a high level of internal consistency, surpassing the generally accepted benchmark of 0.7, thereby denoting commendable internal consistency (Nunnally & Bernstein, 2007). This degree of reliability corroborates the scale's coherence and the interconnectedness among its constituents.

**F-PEC—Moderator**

For the moderator, the F-PEC scale was used to measure the influence of the family firms (Astrachan et al., 2002; Klein et al., 2005; Rau et al., 2018). The F-PEC scale measures the dimensions of Power, Experience, and Culture (Astrachan et al., 2002), and its primary purpose is to quantify family members' varying degrees of impact, leading researchers to better understand a family's influence on their firm. The F-PEC scale is a reliable and standardized instrument that evaluates family influence on a continuous scale instead of treating it as a categorical variable (Astrachan et al., 2002; Klein et al., 2005; Rau et al., 2018). It is comprised of a set of questions designed to assess family involvement and engagement in various decision-making processes. The scale is one of the most widely used and validated scales to measure the influence of family firms and has been used to study a firm's strategic direction (Yazdi, 2018), international business (Hoang et al., 2013), performance (Rutherford et al., 2008), and innovation (Pitchayadol et al., 2018). The scale has also been continually refined (Holt et al., 2010; Rau et al., 2018).

The Power subscale ($\alpha = 0.75$; Klein et al., 2005) considers three distinct items: ownership, governance, and management. Members of a family business can fit into any of these categories. A business could have multiple family members, such as owners, managers, and board members. Due to their overall participation, their relative power might be more significant. This means that a family business can have a concentrated ownership structure in which multiple family members own and participate in the company's governance and management. Compared to Klein et al.'s (2005) model, the Power subscale for the current study was lower at $\alpha = 0.45$.

The Experience subscale ($\alpha = 0.96$; Klein et al., 2005) measures the degree to which family members are involved in the management and governance of a business based on their experience and knowledge gained over time. This could include their involvement in decision-making processes, succession planning, strategic planning, and daily operations. This scale aims to assess the depth and breadth of family involvement in the business and thus evaluates the family's experience with the firm over generations. Compared to Klein et al.'s (2005) model, the Experience subscale for the current study was significantly lower at $\alpha = 0.61$.

The Culture subscale focuses on the aspects of family's values, loyalty, and commitment. Using a Likert scale, this subscale examines the direct impact of values and norms on family businesses. The subscale assesses how much the family's values and norms are integrated into the culture of their business and its practices. This includes areas like decision-making processes, missions, visions, strategies, policies, and other operational aspects of a business. The subscale investigates the commitment of family members and the intersection of family values and business principles. The Culture subscale in the present study had a high $\alpha = 0.93$ (Klein et al., 2005).

The Power subscale offers insights into the distribution and characteristics of family ownership, family governance, and management board participation. Specifically, the dataset of the current study was comprised of observations of the power of family ownership in a firm (133, with 44 missing), the power of its family governance (64, with 113 missing), and the power of its management board (84, with 93 missing), reflecting the various extents of participation or ownership levels across the sample.

For the power of family ownership variable, the mean value was reported at 65.4 with a standard deviation of 34.6, indicating a considerable spread around the mean. This variable also showed a slight negative skewness (−0.556), suggesting a tail extending towards lower values, with the kurtosis (−1.088) pointing towards a flatter peak compared to a normal distribution. In contrast, the power of family governance variable presented a lower mean of 33.9 and a similarly high standard deviation of 32.8, revealing substantial variability within family governance and partnerships. Its positive skewness (0.548) hinted at a distribution with a tail leaning towards higher values, and the negative kurtosis (−0.857) implied a flatter distribution. Lastly, the power of management board variable had a mean of 58.0 with a standard deviation of 27.7, signifying a moderately wide dispersion of values. This variable's skewness (0.145) and kurtosis (−1.092) suggested a distribution that was relatively symmetric but flatter compared to a normal distribution. The varied mean values across these three variables indicated differing levels of family ownership, family governance collaboration, and management board involvement within the entities examined. Additionally, the substantial standard deviations underscored the diversity within each category, emphasizing the complexity and heterogeneity of family ownership and management structures in the sample. The presence of missing data in all three variables also suggested potential limitations in the dataset, which may have affected the generalizability of the findings. The range between the three factors was from 87.5 to 100.

The Experience subscale used in the current study had three key variables, the experience of generational ownership, the experience of generational governance, and the experience of generational management, capturing insights into the nature of experience across these domains within a specific sample. The experience of generational ownership variable, with a sample size of 169 observations (and 8 missing), revealed a mean experience level of 1.94 on a scale from 1 to 5, with a median of 2 and a standard deviation of 1.22. This indicated a modest average experience level with a relatively wide spread of responses. The skewness (1.38) suggested a distribution with a longer tail on the right, indicating more respondents with higher experience levels than the median, and the kurtosis (1.01) pointed towards a distribution with heavier tails than a normal distribution, suggesting more extreme values. The experience of generational governance variable showed a slightly lower mean experience level of 1.63, with a median of 1 and a standard deviation of 1.31 for its 170 observations (with 7 missing). The skewness of 1.25 and kurtosis of 1.11 indicated a positively skewed distribution with more extreme values than a normal distribution, reflecting a concentration of lower experience levels but a presence of individuals having significantly higher experience levels of generational governance. Finally, the experience of generational management variable encompassed 153 observations (with 24 missing), presenting a mean of 1.85, a median of 1, and a standard deviation of 1.21. The skewness (1.41) and kurtosis (1.02) were consistent with the patterns observed with the other variables, suggesting a distribution that leaned towards higher experience levels but with a wide dispersion of responses. The overall range of generations in the three scales was from 4 to 5 generations.

For the Culture subscale, the descriptive statistics revealed that the sample sizes for various culture-related items ranged between 168 and 170, with a relatively small number of missing responses, indicating a robust dataset. The mean scores across these items varied from 5.02 to 5.32, suggesting moderate to high levels of cultural attributes among the participants. The standard deviation values, which ranged from 1.75 to 1.96, pointed to a moderate spread in the responses. An analysis of skewness (−1.2565) and kurtosis (2.2473) indicated a slight leftward skew in the distribution of responses and distributions that were neither excessively peaked nor flat.

The Shapiro-Wilk test results, with *p* values less than .001 for all items, confirmed that the data did not follow a normal distribution. In assessing the overall reliability of the scale, the Cronbach's alpha assessment was low at 0.556, demonstrating poor internal consistency. This was mostly due to the low alpha of the Power scale ($\alpha$ = .492). The results of Cronbach's alpha for the Experience scale ($\alpha$ = .948) and the Culture scale were excellent ($\alpha$ = .979) when run separately.

**Control Variables**

To eliminate alternative explanations for the hypothesized relationships in the study, I followed Bernerth and Aguinis's (2016) review of control variables including the respondent's age, their tenure at the firm, the age of the firm based on the year it was founded, the firm's size, and the firm's industry. Sirmon and Hitt's (2003) research suggested that possessing significant industry knowledge can help family business members understand their business environment, establish effective controls, invest in technology, and assimilate new technology (Gersick et al., 1997). In the current study, I controlled for the respondents' age and their tenure at their firm because these elements are commonly used demographic control variables (Bernerth & Aguinis, 2016). I determined the age of the firm by calculating the difference between the year of its establishment and the reference year (2023) and the firm's size by the number of its employees. Finally, the firm's industry was incorporated as a control variable to mitigate potential issues with the generalizability of the findings. Measurement of the firm's industry was based on the organization's Standard Industrial Classification code.

# Results

In this chapter, I show how each proposed hypothesis was tested in my theoretical model in an attempt to answer my research questions:

1. *How do formal and clan organizational control systems influence the technological capabilities of private firms?*
2. *How does family influence moderate the relationship between a private firm's organizational control systems and its technological capabilities?*

As stated in the literature review, this study examined the influence of formal and clan organizational control systems on the technological capabilities of private firms. Additionally, it was also crucial to examine the moderation of the relationship between private family firms' organizational control systems and technological capabilities by its family's influence. Both aspects were pivotal in understanding the dynamic interplay between organizational structures and technological advancement within private firms.

## Descriptive Statistics

Table 3 shows the descriptive statistics defined in the Methods chapter. In addition to utilizing the concept of central tendency, I compiled a table encompassing many of the pertinent characteristics of the data. Please see Table 3 for more details.

## Correlation Analysis

In order to accomplish a correlation analysis, the Pearson correlation coefficient was calculated within the Jamovi statistical open-source software tool (Arora et al., 2020; Hashim et al., 2020). Please refer to Table 4 for the results obtained from the analysis.

## Method of Analysis

The PLS-SEM was selected over traditional covariance-based SEM methods for several reasons. First, my model's focus on the predictive-causal analysis of antecedent variables on specific outcomes aligned well with PLS-SEM's strengths, as noted by Chin (2001). This method is particularly advantageous in scenarios requiring predictive analysis, fitting my research objectives. Second, PLS-SEM offers a more flexible approach with fewer statistical prerequisites and data constraints than its covariance-based counterparts, making it suitable for models like mine that incorporate multiple regressions (Cassel et al., 2000).

Another critical factor in choosing PLS-SEM was its nonparametric nature, accommodating the non-normally distributed measures identified in my data evaluation (see the Methods chapter). This characteristic of PLS-SEM ensures that the analysis is not compromised by the non-normality of data, avoiding violations of the assumptions inherent in traditional SEM and regression analyses (Ringle et al., 2014). This methodological choice allowed for a robust assessment of the measurement model, ensuring construct reliability and validity and a thorough examination of the structural model to test the hypothesized relationships, including direct effects and moderation effects, further enriched by a simple slope analysis to gage interaction effects.

Furthermore, PLS-SEM is particularly beneficial in family business research due to its ability to handle complex models with multiple interrelated variables. This capability was crucial for accurately representing the nuanced dynamics of family businesses. Additionally, PLS-SEM is suitable for use with small to medium sample sizes and is robust against deviations from normality. This flexibility is vital in family business research, where large and perfectly distributed samples may be difficult to obtain. The

PLS-SEM is also focused on maximizing the explained variance of dependent constructs, making it ideal for predictive studies, which are common in this field, and for understanding the impact of various factors on business outcomes, which is essential (Sarstedt et al., 2014).

The PLS-SEM is exceptionally well-suited for analyses involving  the F-PEC scale. The F-PEC scale measures the level of family influence in a business through dimensions of Power, Experience, and Culture, making it inherently multidimensional. The PLS-SEM efficiently handles these multidimensional constructs and their complex interrelations, offering deep insights into how these dimensions affect various business outcomes. Furthermore, the F-PEC scale often plays a role as a mediator or moderator in research models, affecting outcomes related to performance, succession planning, and strategic decision-making. The PLS-SEM excels in path modeling involving mediators and moderators, providing detailed views into the paths through which family influence impacts business results (Hair et al., 2014, 2021).

In my analysis, I used SmartPLS, which excels at managing data without requiring transformation because of its nonparametric nature. The PLS-SEM is the methodology behind SmartPLS, and contrary to standard models that necessitate normally distributed data, the PLS-SEM does not make assumptions about normal distribution. As a result, it can handle data with skewness and kurtosis. The ability to handle deviations from normalcy is essential for assessing real-world data. In addition, SmartPLS has the capability to directly handle ordinal and nominal data by utilizing coding techniques, such as dummy coding (Hair et al., 2020). This eliminates the requirement for any transformations that would often be required in parametric testing.

SmartPLS maintains the original scales and meanings of measurements by reducing data processing. This is important in situations where these aspects have important interpretative and theoretical implications. Moreover, PLS-SEM prioritizes prediction over inference, which eliminates the need for data transformations that are typically required to meet the statistical assumptions necessary for inferential statistics (Hair et al., 2014).

## Confirmatory Composite Analysis

In this study, I employed confirmatory composite analysis (CCA) to assess the quality of the measurement models within the framework of PLS-SEM. This approach follows the advanced guidelines and validation criteria established by Hair et al. in their 2020 study on measurement model assessment through PLS-SEM. Their research provides a comprehensive set of metrics for confirming the integrity and accuracy of composite models used in PLS-SEM. This methodology was particularly advantageous for the analysis of the current study due to its emphasis on the practical application of statistical standards in complex model evaluation.

In a reflective model analysis, a seven-step process in CCA is required (Hair et al., 2020). The first step in CCA is to evaluate the indicator loadings and their significance. In the second step, the measurement models are examined for item reliability, followed by the third step, which assesses the construct's reliability. The fourth step involves assessing the validity of the construct (convergent) by calculating the average variance extracted (AVE). The fifth step examines discriminant validity using the heterotrait-monotrait ratio of correlation. Subsequently, the nomological validity of the constructs is evaluated. Finally, the seventh step involves assessing the predictive validity of the structural model.

I evaluated multicollinearity within the PLS-SEM models by analyzing three distinct configurations. Multicollinearity, the correlation between predictor variables, can significantly affect the reliability of model results, leading to potentially misleading interpretations (Hair et al., 2014). I calculated the variance inflation factor (VIF) values for each model, with thresholds above five indicating problematic levels requiring corrective measures (Kock & Lynn, 2012). The research faced significant methodological challenges, initially using the F-PEC scale as a singular construct to assess family influence on its business practices (Astrachan et al., 2002). However, issues such as negative outer loadings in the Power and Experience scales and pronounced multicollinearity arose when treating formal, clan, and combined controls as distinct independent variables. These difficulties necessitated a strategic overhaul.

To address these challenges, power, experience, and culture were separated as individual moderators. This approach aligned with methodologies adopted by other scholars (Rutherford et al., 2008; Holt et al., 2010; Yazdi, 2018) and preserved the nuanced representation of family influence, ensuring a robust analytical process.

To address multicollinearity issues exposed in the formal, clan, and combined controls, the analysis was divided into two discrete models (Model 1 and Model 2), each focusing on different facets of organizational controls and associated constructs. This bifurcation aimed to enhance analytical precision by segregating formal and clan controls (Figure 5a) and combined control (Figure 5b) variables. This methodological adjustment underscores the importance of adaptability in research methodologies. This approach is supported by Hair et al. (2019), who emphasized the importance of separate structural model evaluations to avoid the interference of multicollinearity. Updated collinearity variance inflation factor tables are shown in Table 8a and 8b, separated by Model 1 and Model 2.

Model 1 examined formal and clan controls as separate independent variables, allowing a concentrated examination of their distinct operational mechanisms within institutions. Model 2 introduced the combined controls structure, integrating clan and formal controls into a higher-order construct and included constructs such as culture, experience, power, and technological capabilities. This model aimed to investigate the interplay between these constructs and the collective impact of clan and formal controls.

This dual-model approach enabled a more comprehensive and nuanced investigation of each construct, capturing the impacts of both individual and collective elements. By conducting discrete analyses in Model 1 and combining them in Model 2, a holistic understanding of organizational dynamics was achieved through the interplay of various organizational controls and constructs. An analysis of the measurement model validated the factor structure of the constructs, ensuring each item or indicator represented the latent construct it was designed to assess (Hair et al., 2010). This validation was critical for upholding the validity of the study's findings.

By employing CCA as advocated by Henseler et al. (2015), I confirmed the composition of latent constructs without assuming factorial invariance, providing a robust assessment of construct validity within the PLS-SEM framework (Hair et al., 2020). SmartPLS 4 was used for this analysis due to its integrated support for both PLS-SEM and CCA, facilitating a comprehensive evaluation of the model’s integrity and hypothesized relationships.

Moreover, within Model 2, the combined control variable measure was evaluated as a higher-order construct due to its inherent complexity and multidimensional nature. A higher-order construct as defined by Edwards (2001) and Hair et al. (2014) is a latent variable formed by other latent variables, representing a broader concept with multiple dimensions. These constructs are essential for capturing nuanced relationships within theoretical frameworks, allowing for a hierarchical structuring of variables where general constructs are reflected through specific underlying factors. SmartPLS is particularly effective in handling these higher-order constructs due to its robust capabilities in hierarchical component modeling. As noted by Tan (2018), SmartPLS simplifies the conceptualization and operationalization of research variables through higher-order construct modeling, which is especially beneficial in PLS-SEM for providing a comprehensive understanding of the studied relationships.

### ***Model 1—CCA***

**Model 1—Factor Loadings.** The reflective measurement models were initially examined based on the size of the outer indicator loadings, which measured indicator reliability. Indicators are associated with constructs of the measurement model, and their outer loadings should be statistically significant, ideally meeting or exceeding a threshold of 0.708 (Hair et al., 2021). The formal control construct had outer loadings ranging from 0.772 to 0.841. For the clan control construct, the outer loadings ranged from 0.875 to 0.933, indicating high reliability. The technological capability construct had outer loadings ranging from 0.758 to 0.885, indicating good reliability. For the technological skills construct, the outer loadings ranged from 0.768 to 0.820, showing strong reliability. The power construct had loadings ranging from 0.721 to 0.919. One indicator (0.721) was below the ideal threshold but still acceptable. The experience construct had outer loadings ranging from 0.860 to 0.950, showing that the indicators were highly reliable. The culture construct exhibited impressively high outer loadings, ranging from 0.807 to 0.956, demonstrating strong reliability. The majority of the constructs demonstrated high indicator reliability with outer loadings significantly exceeding the 0.708 threshold. Only a few indicators fell below this ideal threshold but still maintained acceptable reliability (Hair et al., 2021). This analysis confirmed the robustness of the measurement models used in the study.

I evaluated the removal of items due to low factor loadings (< 0.7: Hair et al., 2021). Seven items were identified as below the threshold. The first item, the power of family governance, had a factor loading of 0.118, potentially due to the lower number of respondents (*n* = 64) compared to other items. Initially, I considered retaining it despite its low loading; however, for better construct reliability, it was ultimately removed. In the clan control scale, two items, CC_1 and CC_2, had loadings of 0.317 and 0.506, respectively, warranting their removal. Following this, Culture 2_10 (0.592; part of F-PEC) and Formal_beh_4 (0.605; Formal Control scale) were also identified for removal. Lastly, for the technology capabilities items, Techskills_7 and Techskills_8 were removed, with loadings of 0.692 and 0.657, respectively. I employed a stepwise approach to ensure the robustness of the construct's validity and the overall research findings. Each item was removed sequentially, starting with the lowest loading. After each removal, the model was rerun, and the impact on other loadings was assessed. Every time an item was removed, the other factors continued to remain below the threshold, necessitating further removals. This iterative process was repeated until all low-loading items were addressed. This approach ensured that the construct's validity and the overall research findings remained robust. Please see Table 5 for all CCA factor loadings.

**Model 1—Reliability.** In Model 1 (Table 6a) formal and clan controls were examined with a Cronbach's $\alpha$ of 0.924 for clan control, indicating a high level of internal consistency supported by high composite reliabilities (rho_a = 0.925 and rho_c = 0.946). These values suggested that the items within the clan control construct were measuring a single underlying attribute with good reliability. Moreover, the AVE of 0.816 exceeded the threshold of 0.5, which is commonly recommended (Hair et al., 2010) to indicate a satisfactory level of convergent validity.

The construct of formal control showed an alpha of 0.905, again suggesting strong internal consistency. The composite reliability indices (rho_a = 0.908 and rho_c = 0.927) were well above the acceptable threshold of 0.7 (Nunnally & Bernstein, 2007), reinforcing the reliability of the construct. The AVE for formal control was 0.678, which, while above the 0.5 mark, signaled a slightly lower level of convergent validity compared to clan control construct. In the context of Model 1, the reliability and validity metrics suggested that both the clan control and formal control constructs were measured with good reliability, ensuring that repeated measurements would yield consistent results. The validity of the constructs, as indicated by the AVE values, confirmed that a majority of the variance in the observed variables was due to the hypothesized latent construct.

The Technological Capabilities scale showed a high Cronbach $\alpha$ at 0.953, further demonstrating the strength of the model with very high internal consistency (rho_a = 0.955 and rho_c = 0.959), and had an AVE of 0.661, which was above the 0.5 threshold.

In looking at the moderator, it revealed significant variations across the culture, experience, and power constructs. The culture construct demonstrated exceptional reliability and validity, with Cronbach's α, rho_a, and rho_c all exceeding the threshold of 0.70, and it had an AVE of 0.838, indicating that a large proportion of the variance in the construct was captured by its indicators. Similarly, the experience construct showed excellent reliability and validity, with Cronbach's α at 0.913, rho_a at 1.006, rho_c at 0.939, and an AVE of 0.837.

In contrast, the power construct presented notable concerns. Its Cronbach's α was at 0.560, with a rho_a of 0.677, rho_c of 0.809, and AVE of 0.682. While the AVE was above the 0.5 threshold, indicating a satisfactory level of convergent validity, the internal consistency and composite reliability indices were below the acceptable thresholds. This indicated issues with the reliability of the power construct. The significant amount of missing data and the relatively low number of observations for key indicators impacted the reliability and validity of the power construct. These findings indicated that while the culture and experience constructs were robust and reliable, the power construct required significant refinement to meet the required standards, underscoring the importance of rigorous construct development and validation processes to ensure robust measurement models.

**Model 1—Discriminant Validity.** I first did an analysis of Model 1 (Formal and Clan Controls; Table 7a). According to Henseler et al. (2015), to affirm adequate discriminant validity, heterotrait-monotrait ratio of correlations values should be below 0.90 and more stringently, below 0.85. The data presented showed that all heterotrait-monotrait ratio of correlations values were beneath this strict criterion, with technological capabilities and formal controls showing the highest heterotrait-monotrait ratio of correlations ratio of 0.575. This suggested that the constructs within the model maintained distinct empirical identities, indicative of robust discriminant validity. The Fornell-Larker (1981) criterion was visibly met for constructs like technological capabilities and culture, which had values of 0.791 and 0.916, respectively, each exceeding their correlations. The nondiagonal elements represented the correlations between the constructs. For example, the correlation between technological capability and the formal control was 0.538, suggesting a moderate positive link. Similarly, the correlation coefficient between clan control and culture was 0.336, indicating that both constructs had a moderate positive relationship, sharing some similar variance but also being unique from each other. The existence of negative values, such as the correlation of −0.231 between the factors of technological capability and power, signified a reciprocal connection, implying that while one factor rises, the other tends to decline. As suggested by Autor (2015), a negative association may indicate that increased technological capabilities are linked to a decrease in the need for power-based control methods.

**Model 1—Structural Model Evaluation.** The model's predictive validity was further confirmed by outer loadings ranging from 0.807 to 0.953 and $Q^2$ values from 0.073 to 0.228, with variance inflation factors well below 5 (see Table 8a), attesting to the absence of multicollinearity and the statistical integrity of the analysis (Bagozzi & Yi, 1988; Hair et al., 2014; N. Kock, 2015).

Using Cohen's $f^2$ (J. Cohen, 1992), I noticed a substantial effect from formal control mechanisms ($f^2 = 0.177$). This large effect size aligned with the work of Williams and Van Triest (2017), suggesting that structured procedures and systems were vital for enhancing a firm's technological framework and capabilities. Moreover, organizational culture also appeared to have a moderate influence on these capabilities ($f^2 = 0.046$), reinforcing the view from Cameron and Quinn (2011) that the values, beliefs, and norms intrinsic to a firm significantly contribute to its ability to adopt and integrate technology.

The Power subscale demonstrated a modest effect size ($f^2 = 0.028$), resonating with Finkelstein's (1992) findings that power can both facilitate and obstruct technological progress. Additionally, interaction effects such as power x clan control ($f^2 = 0.015$) and power x formal control ($f^2 = 0.005$) had small to modest effect sizes, suggesting that family power can alter the effectiveness of both formal and informal control mechanisms, a notion supported by Pfeffer's (1981) exploration of power in organizations.

The minimal effect sizes for culture x clan control ($f^2 = 0.004$), culture x formal control ($f^2 = 0.006$), and experience x clan control ($f^2 = 0.002$) indicated that these interactions had a limited impact on technological capabilities, hinting at complexities that may not have been fully captured within the model's scope. Similarly, generational experience appeared to have a very small effect ($f^2 = 0.004$), which suggested that its direct influence on technological capabilities was less significant when compared to the overarching impact of formal control and culture.

In summary, the analysis positioned formal control mechanisms and organizational culture as primary influencers of technological capabilities within firms.

The notable role of power and the nuanced interactions between experience, clan control, and formal control also highlighted the multifaceted nature of factors that influence technological progress in organizational settings.

**Model 1—Direct & Interaction Relationships.** For Model 1, I examined the relationship between formal controls, clan controls, and various control variables with technological capabilities. I further examined the moderated relationship with family influence (Technological Capabilities [TC]; See Table 9a and Figure 6a). The analysis confirmed Hypothesis 1, showing that formal controls significantly enhance technological capabilities, evidenced by a strong positive path coefficient ($\beta = 0.422$, $p < 0.05$; Hair et al., 2019; Speckbacher et al., 2003; Cardinal, 2001). This underscores the critical role that structured governance frameworks play in advancing technology within firms. Hypothesis 1a, which posits that the influence of family firms weakens the positive relationship between formal control and its technology capabilities, found no support through the analysis (Power $\beta = 0.087$, $p > 0.365$; Experience $\beta = -0.011$, $p > 0.897$; Culture $\beta = 0.062$, $p > 0.430$) as seen in Table 9a.

Regarding Hypothesis 2, I observed a nonsignificant relationship between clan controls and technological capabilities. This was supported by the path coefficient ($\beta = 0.053$, $p > 0.551$). This inferred that clan control by itself may not have a strong influence on technological capabilities, and thus, Hypothesis 2 was not supported. Furthermore, Hypothesis 2a posited that the influence of family firms mitigates the negative effects of clan controls on its technological capabilities. This also didn't show significance in the analysis (Power $\beta = 0.152$, $p > 0.120$; Experience $\beta = -0.038$, $p > 0.626$; Culture $\beta = -0.065$, $p > 0.509$) as seen in Table 9a.

Age showed a slight negative correlation with technological capabilities, with an original sample coefficient of −0.055 and a sample mean of −0.046. Despite this, the statistical tests indicated this relationship was not significant ($t = 0.831$, $p > 0.406$), and the confidence interval ranging from −0.194 to 0.062 crossed zero, suggesting no real effect of a firm's age on its technical capabilities. Gender also appeared to negatively impact technical capabilities (coefficients of −0.060 and −0.048 in the original and mean samples, respectively); however, like age, this effect was statistically insignificant ($t = 0.891$, $p > 0.373$) with a confidence interval from −0.200 to 0.061 that included zero. Conversely, employee growth with a firm positively correlated with technical capabilities, indicated by coefficients of 0.160 and 0.160. This relationship was statistically significant ($t = 2.348$ and $p = 0.019$). The confidence interval for this variable (0.022 to 0.292) did not include zero, emphasizing its significance in predicting technical capabilities. The tenure of respondents and their firm's age presented very weak correlations with its technical capabilities. Specifically, an employee's tenure had a low positive effect (coefficients of 0.070 and 0.066) that was not statistically significant ($t = 1.041$, $p > 0.298$, confidence interval −0.072 to 0.193). A firm's age negatively correlated with even lower significance (coefficients of −0.015 and −0.018, $t = 0.206$, $p > 0.837$, confidence interval −0.166 to 0.117). Lastly, if a firm was a family business, it showed a nonsignificant positive correlation with its technical capabilities (coefficients of 0.245 and 0.230, $t = 1.523$, $p > 0.128$, confidence interval −0.060 to 0.581). Again, this wide confidence interval indicated a lack of significant predictive power. Among the control variables analyzed, only employment growth within a firm showed significance related to its technological capabilities; this may highlight that as an organization grows their employee base, they embrace new technology through innovation (Okumu et al., 2019) as new hires are brought on. Other factors like the respondent's age, gender identity, and tenure at a firm, along with the firm's age and whether the firm was family-owned or not, did not exhibit significant effects on its technological capabilities. Please see Table 10 for hypothesis results.

### *Model 2—CCA*

**Model 2—Factor Loadings.** Like Model 1, Model 2 used a CCA reflective measurement model to examine the size of its outer indicator loadings, which indicated the reliability of each indicator in representing its respective construct. The combined controls construct had outer loadings between 0.712 and 0.795, demonstrating acceptable reliability. The technological capability construct had outer loadings ranging from 0.799 to 0.862, indicating good reliability. For the technological skills construct, the outer loadings ranged from 0.757 to 0.817, showing strong reliability as well. The power construct demonstrated strong reliability with outer loadings ranging from 0.721 to 0.919. For the experience construct, outer loadings ranged from 0.860 to 0.950, indicating robust reliability. Finally, the culture construct exhibited strong reliability, with outer loadings ranging from 0.807 to 0.956. These results suggested that the constructs in the measurement model exhibited strong and reliable indicator associations, with most outer loadings meeting or exceeding the recommended threshold of 0.708 (Hair et al., 2021). Similar to Model 1, the low factor loading results for each item in Model 2 were virtually identical. I assessed the removal of items from the study due to low factor loadings (< 0.7; Hair et al., 2021), with seven items identified as below the threshold, the same number of items as was identified with Model 1. The first item, the power of family governance had a factor loading of 0.118. The Clan Control scale had two items, ClanControl_1 and ClanControl_2, with loadings of 0.377 and 0.520, respectively, warranting their removal. Following this, Culture 2_10 (0.592; F-PEC) and Formal_beh_4 (0.591; Formal Controls) were also identified for removal. Lastly, for the technology capabilities variable, Techskills_7 and Techskills_8 were removed, with loadings of 0.692 and 0.657, respectively.

I applied the same stepwise removal approach as I did for Model 1 with Model 2 to ensure the robustness of the construct's validity and the overall research findings. Each item was removed sequentially, starting with the lowest loading. After each removal, the model was rerun, and the impact on other loadings was assessed. Every time an item was removed, the other factors continued to remain below the threshold, necessitating further removals. This iterative process was repeated until all low-loading items were addressed. This approach ensured that the construct's validity and the overall research findings remained robust. Please see Table 5 for all CCA factor loadings.

**Model 2—Reliability.** In Model 2 (Table 6b), the combined controls construct demonstrated a good level of internal consistency with a Cronbach's $\alpha$ of 0.910. This was further corroborated by robust composite reliability values (rho_a = 0.911 and rho_c = 0.925), indicating that the items within the combined controls construct consistently represented the concept being measured. These figures were well above the standard acceptability threshold of 0.7 (Nunnally & Bernstein, 2007), pointing to high reliability. The AVE for the combined controls was 0.553, which was slightly above the recommended value of 0.5 (Hair et al., 2010), suggesting an acceptable level of convergent validity.

The technical capabilities construct showed excellent reliability with a Cronbach's $\alpha$ of 0.954 and composite reliability (rho_a = 0.957 and rho_c = 0.959) near the ideal. The AVE for technical capabilities was 0.626, which was above the suggested benchmark, indicating a decent level of convergent validity.

The F-PEC moderator construct showed similar results to previous models. The culture construct continued to show exceptional reliability with a Cronbach's $\alpha$ of 0.982 and its composite reliability scores (rho_a = 0.985 and rho_c = 0.984). The high AVE of 0.838 exceeded the suggested benchmark, indicating excellent convergent validity and suggesting that the items within the culture construct were highly indicative of the latent construct.

Similarly, the experience construct showed strong reliability ($\alpha$ = 0.913, rho_a = 0.987, and rho_c = 0.940) and an AVE of 0.839, matching the culture construct in terms of internal consistency and convergent validity.

The power construct, though improved, remained the weakest of the constructs with a Cronbach's alpha of 0.560 and a moderate composite reliability (rho_a = 0.677 and rho_c = 0.812), which were above acceptable levels but still relatively low compared to other constructs. The AVE of 0.686 indicated a good level of convergent validity. Despite this improvement, the relatively low number of observations for key indicators may still have impacted the reliability and validity of the power construct.

**Model 2—Discriminant Validity.** For Model 2 (Table 7b) the heterotrait-monotrait ratio of correlations values between technological capabilities and combined controls (0.590), the power construct (0.144), the experience construct (0.075), and the culture construct (0.268) suggested distinct constructs as they were all significantly below the conservative threshold of 0.85. This indicated a good level of discriminant validity, meaning the constructs were empirically unique and not measuring the same phenomenon. For the Fornell-Larker (1981) criterion, the diagonal elements should be larger than the off-diagonal elements in their corresponding rows and columns. In this case, technical capabilities (0.791), the combined controls (0.744), the power construct (0.828), and the culture construct (0.916) demonstrated good discriminant validity, as their AVE square roots exceeded any correlations with other constructs. Furthermore, the experience construct showed a very high AVE square root (0.915), which exceeded all its correlations with other constructs, reinforcing its discriminant validity.

**Model 2—Structural Model Evaluation.** The analysis of $f^2$ and $Q^2$ values from the CCA offered definitive insights into the combined control model. The provided data revealed that the combined model exhibited excellent predictive accuracy, with a $Q^2$ predict value of 0.996 and root-mean-square error of approximation of 0.063. Furthermore, the absence of multicollinearity and the statistical integrity of the analysis were confirmed by variance inflation factors well below 5 (see Table 8b; Bagozzi & Yi, 1988; Hair et al., 2014; Kock, N., 2015).

In contrast, the technological capabilities model showed moderate predictive accuracy with a $Q^2$ predict value of 0.293 and root-mean-square error of approximation of 0.851. The $f^2$ effect sizes indicated that the combined variable significantly impacted technical capabilities (0.208), while the culture construct (0.042) and power construct (0.029) had modest effects. The experience construct had a minimal impact (0.005). Interaction terms showed varying influence, with power x combined controls having a small effect (0.033) and experience x combined controls having a negligible effect

(0.004). Culture x combined controls showed no effect (0). The combined model was highly accurate, while the technical capabilities model had moderate accuracy with higher errors. Interaction effects were generally minimal.

**Model 2—Direct & Interaction Relationships.** The investigation into the impact of combined controls on technological capabilities within firms provided significant insights. I investigated the relationship between formal controls, clan controls, and various control variables with a firm's technological capabilities. Additionally, I explored the moderated relationship involving a family's influence on their firm (See Table 9b and Figure 6b). The study's findings strongly supported Hypothesis 3, which posited that the integration of formal and clan controls (combined controls) positively impacts a firm's technological capabilities. This was indicated by their significant relationship ($\beta = 0.422$, $p < 0.000$). This suggests that when formal systems (structured management controls) and clan controls (informal, culturally embedded practices) are effectively integrated, they collectively enhance a firm's ability to innovate and maintain their technological competence. This integration could adopt an environment where structured procedures complement and synergize with the tacit knowledge and informal networks within an organization, boosting innovative capacities and technological advancement (Adler & Borys, 1996; Cardinal, 2001).

There was also a slight significance with the moderator related to Hypothesis 3a. The interactive effect of a firm's power and combined controls on the firm's technological capabilities ($\beta = 0.199$, $p < 0.051$) illustrates the complex role of power within family organizations in shaping technological outcomes, supporting the idea that a diverse mix of control mechanisms may be needed for technological agility (Pfeffer, 1981). The overall framework and significant effects suggests that family-owned businesses may possess strong clan controls when amplified with the benefits of combining it with formal controls. The cohesive system of governance in family firms potentially enhances the efficacy of combined controls, leading to a firm's more pronounced technological capabilities. This assumption aligns with theoretical perspectives that suggest family firms often have deeply ingrained values and norms that can effectively integrate with formal management practices to drive innovation (Sharma, 2004).

Concerning the control variables, I observed a slight negative impact (coefficients: −0.060 original, −0.052 mean) on the variable of a firm's age, although the effect was not statistically significant as evidenced by $t = 0.916$ and $p > 0.360$. The confidence interval spanning from −0.194 to 0.060 included zero, suggesting an ambiguous influence of a firm's age on its technological capabilities. The variable of the respondent's gender identity also showed a similar slight negative correlation with the firm's technical capabilities (coefficients: −0.081 original, −0.071 mean), but like the respondent's age, it lacked statistical significance ($t = 1.225$, $p > 0.221$), and the confidence interval (−0.218 to 0.039) crossed zero, indicating minimal impact. In contrast, the variable of a firm's employment growth exhibited a notable positive relationship with its technological capabilities, with more pronounced coefficients (0.162 original, 0.165 mean) and statistical support ($t = 2.337$, $p = 0.019$); the confidence interval (0.020 to 0.294) not crossing zero highlighted a significant positive effect. The variable of a respondent's tenure at a firm offered a very weak positive correlation (coefficients: 0.051 original, 0.051 mean) that did not achieve statistical relevance ($t =$

0.819, $p > 0.413$), as indicated by the confidence interval (−0.085 to 0.160) that included zero. The variable of the age of the firm presented an almost negligible negative effect (coefficients: −0.015 original, −0.018 mean), confirmed by its nonsignificance ($t = 0.211$, $p > 0.833$) and wide confidence interval (−0.163 to 0.114). Lastly, the variable of the firm being a family business seemed to positively impact its technical capabilities (coefficients: 0.199 original, 0.190 mean), yet this relationship, while suggestive, remained statistically unconfirmed ($t = 1.370$, $p > 0.171$) due to the broad confidence interval (−0.074 to 0.499) that included zero. Similar to Model 1, the variable of employment growth within a firm was significantly associated with its technological capabilities. This suggests that as an organization expands its workforce, it increasingly adopts new technologies through innovation (Okumu et al., 2019). Other variables such as the respondents' age, gender identity, tenure at their firm, the firm's age, and whether the firm was a family business showed no significant effects. Please see Table 10 for hypothesis results.

**Simple Slope Analysis**

The analysis of simple slopes revealed insights into the moderating role of F-PEC on the relationship between formal controls and a firm's technological capabilities. Employing a simple slope analysis, I assessed the impact of F-PEC at varying levels: one standard deviation below the mean, one standard deviation at the mean, and one standard deviation above the mean.

For both formal and clan controls (Model 1) and the combined controls (Model 2) there was only one moderating relationship that showed some importance. The relationship between combined controls and a firm's technological capabilities when moderated by a firm's power showed slight significance ($p > 0.051$; See Figure 7). The empirical data reflected the interaction between family firms' power and the combined controls (integrated application of formal and clan controls) that somewhat impacted a firm's technological capabilities. This influence, articulated in Hypothesis 3a, suggests a positive strengthening of the effects of combined controls on a family firm's technological aptitude as the influence of the family escalates. Analytical depiction through a three-tiered simple slope analysis—representing low power ($p$ −1 *SD*), average power (*M*), and high power (+1 *SD*)—revealed a gradational strengthening in the relationship as a firm's power ascended. The graphical slope intensified notably at one standard deviation above the mean, illustrating the hypothesis's projected outcome. The beta coefficient of .201 confirmed a moderate positive effect size, which, along with a statistically significant $p$ value of 0.020, reinforced the hypothesis that the influence of family firms robustly enhances the relationship between control mechanisms and technological capabilities, notwithstanding a $t$ statistic of .125.

In assessing the interactions within the constructs of Model 1 and Model 2, it was important to recognize that not all proposed moderator relationships exhibited statistical significance. Specifically, the influence of a firm's power, experience, and culture on the relationship between formal and clan control and its technological capabilities in Model 1 did not show significant effects. This pattern was also observed in Model 2, where a firm's experience and culture did not demonstrate a significant impact when analyzed in conjunction with the combined controls.

These results suggested a need for a closer examination of the factors at play. They pointed to the possibility of reevaluating the initial assumptions or perhaps revising the research design to capture more subtle interactions. The absence of significance in these relationships underlines the complex and often unpredictable nature of organizational behaviors, especially in family-run businesses.

# Discussion

In this chapter, I incorporate and interpret the study's findings in the context of the existing research and the study's empirical results. This study comprehensively explored the dynamics at play in family firms, particularly focusing on its technological capabilities, organizational controls, and family influence.

The empirical support for Hypothesis 1 was appropriate, affirming that formal controls—comprising both behavioral and outcome-based mechanisms—are positively linked to the enhancement of technological capabilities within firms. This supports theoretical assertions by Teece et. al (1997), who contended that structured governance frameworks are essential for fostering innovation by enabling more effective alignment of resources towards innovative efforts. This finding is corroborated by the work of Davila et al. (2009), who noted that structured environments not only encourage innovation but also ensure that it is strategically aligned with a firm's objectives, providing a structured pathway for its technological capabilities. Furthermore, the studies by Eisenhardt and Martin (2000) highlighted those dynamic capabilities, including that robust formal controls are crucial for firms to reconfigure and integrate their resources in response to technological changes. Additionally, Zahra and George (2002) emphasized the role of absorptive capacity—enabled by structured controls—in recognizing and assimilating new technological knowledge in a firm, thereby enhancing its innovation outcomes. The research by Jansen et al. (2006) also supports this view, suggesting that formal controls can facilitate exploratory innovation by providing the necessary stability and predictability in organizational processes. Finally, Kogut and Zander (1992) argued that formal controls and governance structures are fundamental in leveraging a firm's knowledge base for continuous technological innovation.

However, Hypothesis 2 was not supported. The study's findings indicate a positive nonsignificant role for clan controls, which contradicts traditional views labeling these informal controls as potentially stifling innovation due to their less structured nature (Ouchi, 1980). There could be a number of reasons for this. Contextual factors such as industry variations and external environmental influences play a significant role. The relationship between clan control and technological capabilities can also vary significantly across industries. For instance, in high-tech industries, strong technological capabilities are often essential, potentially diminishing the role of clan control. In contrast, traditional industries might rely more heavily on clan control mechanisms to manage organizational culture and behavior. Scherer (1982) and Teece (1996) provided insights into how technology and productivity dynamics differ across industries. Also, external factors such as market volatility, regulatory changes, and competitive pressures can influence the effectiveness of clan control in comparison to a firm’s technological capabilities. In dynamic and rapidly changing markets, a firm’s technological capabilities may take precedence over the use of clan control to maintain competitiveness and adaptability. Sørensen (2002) discussed how corporate culture and performance reliability can be impacted by these external factors.

The results regarding Hypothesis 1a did not achieve statistical significance, revealing an unexpected positive interaction between the influence of family firms and the effectiveness of formal controls. Contrary to the anticipated weakening effect, family influence, specifically its power, appears to amplify the benefits provided by its structured governance systems. This potential trend aligns with the broader literature on family business, which has posited that the involvement of family members in governance can introduce a layer of commitment and long-term orientation that may be beneficial for strategic initiatives, including the adoption of technology (Gomez-Mejia et al., 2011). Further research with a larger sample size or different methodological approaches might better capture this interaction and provide more definitive conclusions.

The findings for Hypothesis 2a did not reach statistical significance, indicating an unexpected interaction between the influence of family firms and the effect of clan rules on its technological ability. This could be due to sample characteristics and contextual factors. Smaller sample sizes might lack statistical power, while the composition of the sample, such as the size and industry of the family firms, can influence results. Industry variations play a role, with certain sectors inherently requiring more formal controls. Cultural differences, in which family firms rely on personal relationships over formal controls, and an institutional environment, such as market development levels and nepotism, further impact the dynamics between a family's influence, their formal control, and their firm's technology capabilities (Lu et al., 2015). Contrary to the idea that family influence would reduce the negative components of clan controls, the research at hand revealed that the impact of families might rather increase the positive aspects of their clan controls. Although this conclusion was not significant, it points at a prospective trend in which family enterprises uniquely benefit from clan control systems. These systems, which are usually more noticeable in family contexts, might create a conducive atmosphere for collaborative creativity and the exchange of knowledge (Bammens et al., 2011). This emerging pattern is consistent with studies that have suggested the trust and social capital cultivated inside family firms can greatly improve the efficiency of informal control mechanisms (Klein et al., 2005). Subsequent investigations employing a more extensive sample size or alternative methodological approach may more accurately capture this relationship and yield more conclusive findings.

The analysis of the present study supported Hypothesis 3, which posited that there is a synergistic effect from the integration of formal and clan controls, suggesting that their combination fosters a dynamic and innovative organizational environment. Research has suggested that this is particularly true in family firms where such integration aligns well with both professional and family-oriented values, enhancing a firm's overall technological capabilities (De Massis et al., 2012).

Moreover, Hypothesis 3a stated that family influence strengthens the positive effects of integrating formal and clan controls on a firm's technological capabilities, and this was slightly supported by the Power subscale. This supports the notion that a diverse mix of control mechanisms is essential for growing a firm's technological capabilities (Mucci et al., 2021). Family-owned businesses often possess strong clan controls due to their relational dynamics, which amplifies the benefits of combining these with formal controls. This cohesive governance system in family firms likely boosts the efficacy of combined controls, enhancing its technological capabilities. The impact of combined controls on a firm's technological capabilities reaffirms that integrating structured and informal practices significantly advances technological capabilities, as noted by Cardinal (2001). Additionally, power within a firm marginally moderates the impact of its governance controls on its technological capabilities. This aligns with W. S. Schulze et al. (2003) and Finkelstein (1992), who discussed the implications of power on organizational efficacy. While the influence of power on technological capabilities suggests it can drive technological initiatives, its variable impact highlights potential challenges if not carefully managed. This underscores the complex interplay of family control and governance mechanisms in fostering their firm's technological capabilities. This discussion underscores a critical insight: navigating the integration of formal and clan controls in family firms involves a complex interplay of strategic considerations and potential benefits, demonstrating that effectively aligned governance structures can maximize technological innovation.

**Limitations**

This study has several limitations that should be acknowledged to contextualize the findings. Firstly, the sample predominantly consisted of U.S. firms, which may not accurately represent global perspectives on technological capabilities. Regional variations and market conditions could influence the applicability of the findings to firms in other countries (Boulton, 2021; Fitzgerald, 2013). Additionally, the data primarily included established firms, potentially overlooking the unique challenges and capabilities of startups and smaller enterprises in adopting and leveraging technological capabilities (Ceipek et al., 2020; Tabrizi et al., 2019). Furthermore, the study captured a snapshot in time without considering the longitudinal effects of technological capability development and implementation over an extended period (Khin & Ho, 2019).

The broad scope of technological capabilities used in this study may potentially overlook other critical areas such as advanced manufacturing technologies, biotechnology, or renewable energy technologies (Furr & Shipilov, 2020). Additionally, the operationalization of technological capabilities may lack granularity in specific technological domains, limiting the precision and applicability of the conclusions drawn (Guerra & Camargo, 2016; Tsai, 2004).

Regarding organizational control measures, the distinction between formal and informal controls might be oversimplified. In reality, firms often employ a blend of controls that could be more nuanced than the binary classification used (Cardinal et al., 2017). The impact of organizational controls on technological capabilities might be moderated by other unexamined factors, such as leadership style, or external environmental pressures (Ouchi, 1979, 1980; Sitkin et al., 2020).

The influence of family firms introduces another layer of complexity. The study assumed a homogeneous influence of family firms without accounting for the diversity within family-owned businesses. Differences in family values and management practices can lead to varied outcomes (Gomez-Mejia et al., 2011). Furthermore, defining what constitutes a family business is inherently challenging due to variations in definitions and criteria used across different studies and contexts. Some definitions focus on ownership and control, while others emphasize family involvement in management or generational continuity (Chua et al., 1999; Astrachan, et al., 2002). This definitional ambiguity can affect the comparability and generalizability of findings, as the criteria used to identify family businesses may not be consistent. The interaction between the influence of family firms and its technological capabilities may be more complex, involving factors like family governance structures, succession planning, and the varying degrees of family involvement in day-to-day operations (Chrisman et al., 2005a). These complexities suggest that a one-size-fits-all approach to studying family businesses may overlook important variations and nuances that influence outcomes.

Limitations of measurement are also present in the study. The metrics used to assess technological capabilities and organizational controls might not capture the full extent of these constructs. Self-reported measures could introduce bias, as respondents may provide socially desirable answers or lack complete insight into their firm's technological capabilities and control mechanisms (Cardinal et al., 2004; Podsakoff & Organ, 1986). Additionally, self-reported data can suffer from issues such as common method variance, systematic response distortions, and monomethod bias, which can affect the validity of causal conclusions (Chang et al., 2010). Furthermore, the lack of objective performance data might affect the reliability of the results, as it is challenging to verify the accuracy of self-reported information (Podsakoff et al., 2003). The study also relied on existing scales and frameworks, which might not be perfectly aligned with the specific contexts and nuances of the firms that were studied (Zahra et al., 2007). This misalignment could limit the precision of the conclusions drawn, as the scales may not fully capture the complexity and unique characteristics of different technological environments and organizational structures.

Furthermore, while Prolific provides broad reach and diverse participation, its use for data collection introduces specific challenges. Prolific participants receive compensation for their participation, which may affect their motivation to provide accurate and thoughtful responses. Despite Prolific's measures to ensure data quality through prescreening and monitoring for fraudulent activity, there is still a risk that some participants might prioritize speed over accuracy to complete surveys quickly (Palan & Schitter, 2017). This potential bias necessitates caution in interpreting a study’s results.

For example, in the present study, I had to exclude 81 responses from the initial Prolific data due to insufficient or incomplete answers.

Although the sample's demographic representation was varied, it might still reflect biases inherent in the recruitment methods used. For example, using LinkedIn to target family business networks likely attracted respondents who are more engaged and connected, thus potentially over-representing firms with more resources and better-established networks. The sampling strategy, which combined Prolific with snowball sampling, may have led to homogeneity in the sample due to the social networks of initial respondents (Biernacki & Waldorf, 1981). This approach could overrepresent firms with more established networks and resources, potentially limiting the generalizability of the findings to less connected or resource-constrained firms (Dusek et al., 2015).

Additionally, a reliance on self-reported data can introduce bias, as respondents may provide socially desirable answers or lack complete insight into their firm's technological capabilities and control mechanisms (Cardinal et al., 2004; Goebel & Weißenberger, 2017; Zahra et al., 2007).

Also, the significant reduction in the sample size from 402 to 177 potentially impacted the representativeness of the final sample (Brick & Kalton, 1996; Cummings, 2013). This brings a significant limitation in the handling of missing data, a pervasive issue in survey research. The method chosen to address missing values can introduce bias and affect the validity of the results. According to recent research, various deletion and imputation methods for dealing with missing data can lead to different outcomes and inferences. The choice between these methods is crucial as it impacts the robustness and reliability of the findings (Popovich, 2024). The decision to impute missing values for certain variables, particularly those related to power and experience, while methodologically justified to maintain the integrity of the unique values, might result in bias if these missing data are not completely random (Little & Rubin, 2002). For instance, in the present study, the Power subscale items of Family Board and Family Governance only had 84 and 66 samples, respectively.

In terms of data analysis, the choice of PLS-SEM aligned well with the study's objectives, especially given the non-normal distribution of the data (Hair et al., 2019). However, PLS-SEM's sensitivity to sample size and data quality highlights the importance of the significant reduction in sample size due to missing data. This reduction to 177 samples and the imputing of missing values could have affected the robustness of the model and the reliability of the results.

The low Cronbach's alpha for the Power subscale of the F-PEC scale indicates poor internal consistency, suggesting that this measure might not be entirely reliable in this context (Klein et al., 2005; Rau et al., 2018). Additionally, the exclusion of non-family businesses from the analysis limits the ability to generalize the findings to all types of private firms.

These limitations highlight the need for cautious interpretation of the findings and suggest avenues for future research. Future studies could benefit from a more diverse and comprehensive sampling strategy, the use of more robust data imputation techniques, and the inclusion of additional control variables to capture the full complexity of the relationships between technological capabilities, organizational controls, and family influence. Additionally, employing longitudinal studies could provide valuable insights into how these relationships evolve over time. Longitudinal research would allow for the observation of changes in technological capabilities and organizational controls within family firms across different stages of growth and external environmental shifts. Such an approach could help address temporal constraints by providing a dynamic perspective on how technological advancements and family influence interact and develop, offering a more comprehensive understanding of these complex phenomena.

**Contributions**

The results of this study enriches the current understanding of how formal and clan control systems influence technological capabilities in family firms. It highlights the nuanced roles these controls play in facilitating innovation and thus contributes to the broader discourse on strategic management within unique organizational contexts, underscoring the importance of governance mechanisms in shaping organizational outcomes (Ouchi, 1979; Turner & Makhija, 2006; Sitkin et al., 1994).

The results also illuminate the critical role of family influence in moderating the relationship between a firm's organizational controls and its technological capabilities. Contrary to conventional wisdom that views family influence as primarily imposing constraints on organizational strategy and decision-making, the findings suggest that family characteristics can significantly enhance the effectiveness of both formal and clan controls. This redefined understanding illustrates how familial contexts can foster a culture of innovation and adaptability, resonating with the socioemotional wealth perspective which highlights family firms' distinctive priorities and governance mechanisms (Zahra et al., 2004; Dyer, 1988; Berrone et al., 2010; Gomez-Mejia et al., 2007).

Furthermore, the study integrated strategic management, family business studies, and technology management perspectives, offering a comprehensive view of how these domains intersect and influence each other. The results of the study provide insights that align with the resource-based view, which emphasizes that a firm's unique resources and capabilities drive its competitive advantage. In family businesses, these insights highlight how *familiness*—the unique resources family firms possess—plays a crucial role. Integrating the resource-based view with the socioemotional wealth perspective, which focuses on nonfinancial factors like family control and emotional attachment, provides a comprehensive understanding of how these unique resources contribute to both economic and socioemotional goals in family businesses (Barney, 1991; Habbershon & Williams, 1999).

The tested hypotheses offer nuanced contributions to the existing body of knowledge, particularly regarding the interplay between organizational controls and family dynamics within family firms. The results of the analysis in regard to Hypothesis 1 highlight the positive association of formal controls with a firm’s technological capabilities, demonstrating their role in fostering innovation within the unique context of family firms. The results of Hypothesis 3 suggest that the integration of formal and clan controls enhances a firm's capacity for innovation by leveraging the strengths of both to facilitate a conducive environment for innovation (Carney, 2005; D. Miller, Le Breton-Miller, Lester, & Canella, 2007). However, because Hypothesis 2 did not show significant results, this shows that clan controls alone may not be as influential as formal controls in enhancing a firm’s technological capabilities.

Moreover, the results of Hypotheses 1a and 2a did not show significant interaction effects. This suggests that family characteristics may not alter the effectiveness of these controls in isolation. In contrast, Hypothesis 3a, which explored the interaction between the combined controls and the influence of family firms, showed only a slight significance within the Power scale. This finding underscores the potential for governance synergy within family firms, demonstrating that these enterprises possess unique capabilities to integrate formal and informal controls effectively, albeit with varying degrees of impact (Chrisman et al., 2004; Basco & Rodríguez, 2009).

Collectively, the results of these hypotheses provide empirical evidence supporting the integration of the resource-based view and the socioemotional wealth perspective in understanding family firms. They bridge the gap between strategic management theories and family business literature, offering a more nuanced comprehension of how organizational controls, moderated by family influence, impact a family firm's technological capabilities. This integration is pivotal for advancing both academic theories and practical approaches to managing and studying family businesses.

## Theoretical Implications

The study of organizational controls, family influence, and technology capabilities in family firms greatly enhances various theoretical areas, offering detailed insights into the governance and strategic management of family businesses. The findings of the present study contradict research that has suggested that family ownership has a negative impact on a firm's innovation and the efficacy of its formal controls (Yin et al., 2022; Trebicka, 2023). On the contrary, the findings of the present study demonstrate that family influence can actually improve the efficiency of both formal and clan regulations, thus promoting technological innovation within a family firm. This indicates that family enterprises have a distinct potential to utilize familial characteristics to enhance their governance systems, making significant contributions to the governance theory (Chrisman et al., 2004; Basco & Rodríguez, 2009).

Furthermore, the findings of this study establish a connection between the resource-based view and socioemotional wealth view. It suggests that family-specific resources and endowments may offer strategic benefits in effectively managing its technology capabilities. The results also demonstrate that clan controls, which have sometimes been seen as hindering innovation because of their informal nature (Hu & Hughes, 2020; Yin et al., 2022), can effectively cultivate a culture of innovation and adaptation within family-owned businesses, particularly with a significant level of family involvement. The findings of this study enhance the comprehension of informal control mechanisms and their beneficial influence on promoting adaptive and innovative behaviors in organizational contexts (Zahra et al., 2004; Dyer, 1988).

Additionally, the results of this study emphasize the possibility of achieving a combined effect between formal and informal controls when they are strategically merged. This indicates that when the two types of controls are combined, they can greatly improve a company's ability to innovate (Segarra-Ciprés et al., 2019).

Finally, the results enhance the field of strategic management and organizational theory by demonstrating the influence of family characteristics on the technological capabilities of a family firm and how they interact with organizational controls employed by the firm. These findings thus offer insights into how governance mechanisms can be developed to correspond with both organizational objectives and family dynamics (Wu et al., 2021).

**Practical Implications**

The practical implications of these results extend across various domains, offering valuable insights for family business owners, managers, policymakers, investors, and educational institutions, thereby transforming theoretical insights into actionable strategies.

The findings of the study highlight for family business owners and managers the significance of establishing strong governance techniques in a family firm that successfully combines formal and clan controls with the underlying characteristics of the family. This strategic alignment improves the firm's capacity to efficiently utilize its technology capabilities, promoting its innovation and sustaining its competitive advantage in rapidly changing markets. By strategically incorporating both forms of controls and taking into account their distinct familial implications, company leaders can optimize the efficacy of these governance tools. This method focuses not only on integrating control but also on aligning these controls with the distinctive values and objectives of the family business in order to enhance a firm’s performance and ensure its long-term viability (J. H. Chua, Chrisman, et al., 2012b).

Policymakers and investors can also gain significant advantages from these findings to develop focused plans and make well-informed investment decisions that recognize the distinctive characteristics of family enterprises. These characteristics can influence a family firm’s governance structure and its inclination for innovation. Comprehending these unique attributes can enable the development of laws that promote a favorable atmosphere for family businesses, facilitating their expansion and creativity. Indeed, research has suggested that investors who acknowledge these distinct dynamics are in a more advantageous position to make investment decisions in line with the long-term objectives of family businesses, considering their socioemotional wealth and specific governance requirements (Zellweger, Nason, & Nordqvist, 2012).

Moreover, the implication of the results for instructional programs in business schools is significant. Integrating these discoveries into the curriculum can greatly advantage present and future leaders of family enterprises. Gaining a comprehensive understanding of the intricate relationship between organizational controls, family dynamics, and a firm’s technological capabilities is crucial in order to develop leaders who can effectively navigate the distinct governance environments of family businesses. Acquiring this education is essential for developing a group of leaders who possess both knowledge of the theoretical foundations of family company management and the ability to effectively use these concepts in practical situations to stimulate innovation and strategize for revitalization (Handler, 1994).

**Future Research**

Based on the fundamental knowledge gained from examining organizational controls, family influence, and technological capabilities in family enterprises, there are several potential areas for future research that can enhance and extend the practicality and significance of these discoveries.

An important issue for further investigation is the examination of family firms’ governance from cross-cultural and international viewpoints. Examining the effects of cultural and regional disparities on the interplay between organizational controls, family influence, and a firm's technology capabilities may reveal substantial discrepancies. Future research can utilize Hofstede's (1980) framework on cultural dimensions to investigate how these relationships are expressed in other cultures, potentially impacting family enterprises' governance and operational strategies worldwide (House et al., 2005). Conducting such studies would enhance the comprehension of whether the present studies' findings are universally applicable or peculiar to certain contexts and whether it might enable strategic advice to be tailored to different cultural environments.

Longitudinal studies are a powerful method for understanding how family firms' dynamics change over time, particularly during generational changes. Conducting such research would be crucial for monitoring the lasting impacts of family firms' governance decisions and their familial dynamics on their ability to innovate and adapt. These studies could offer a time-based viewpoint, which is sometimes absent in studies, that only analyzes data from a single point in time (De Massis et al., 2015; Basco, 2017). This approach would enable the real-time capturing of the evolving characteristics of family enterprises and their strategies, offering a more dynamic perspective on the growth and transformation of these organizations.

Exploring the function of nonfamily executives in family firms is a promising area for research as well. An analysis of the impact of external management on a firm's governance mechanisms and technology capabilities can provide insights into the difficulties and advantages of incorporating nonfamily executives. Future research might investigate how these specialists manage the distinct environment of family firms and how their presence influences the firm's innovation and strategic renewal (Miller et al., 2015). Gaining insight into these processes could assist family businesses in successfully optimizing their governance frameworks to include outsider opinions.

Given the swift progress of technology, it is essential to examine how family businesses adapt and incorporate disruptive technologies such as artificial intelligence, blockchain, and the Internet of Things. Research could center on analyzing the strategic choices made by family businesses in response to changes in technology and investigate how their governance structures either facilitate or impede these adaptations (Nambisan, 2017). Exploring this line of investigation could yield valuable information about the ability and willingness of family businesses to adopt new technology and provide a clear plan for managing technological changes.

Furthermore, studying the diversity across family businesses could uncover the impact of differences in family participation, generational phases, power allocation, governance, and technological capacities. These future studies could have the potential to find distinct patterns that impact the efficiency of governance systems in various family firm situations. This knowledge can then be used to develop strategies that consider these internal dynamics.

Likewise, it is crucial to analyze potential moderating and mediating factors that impact the effectiveness of governance frameworks in firms in promoting innovation. Industry-specific traits, market dynamism, and technological change intensity are potential factors that could be investigated as moderators influencing the relationship between firms' governance and its innovation (Eddleston & Kellermanns, 2007). This kind of research has the potential to enhance our comprehension of the circumstances in which governance systems in family enterprises effectively facilitate technological progress.

Another promising avenue of research involves investigating the impact of the desire to safeguard socioemotional wealth on risk management choices within family-owned businesses. This encompasses the examination of how enterprises managed by families manage financial risks and make investment decisions, particularly in terms of fostering innovation in their firm and preserving family influence over business operations (Gomez-Mejia et al., 2007; Berrone et al., 2012).

Moreover, the impact of family offices on corporate strategy is an interesting field for investigation. Family offices oversee and handle private wealth and investments and have the potential to greatly influence the strategic decisions of family businesses, particularly in regard to their embracing novel technologies or exploring new markets (Rosplock, 2014).

Finally, research could investigate the factors that either support or impede the integration of new technologies in family businesses, shedding light on how these firms can effectively manage the challenges of digital transformation (Kammerlander & Ganter, 2015). By conducting thorough empirical and theoretical research on these various aspects, future studies can offer a more profound and nuanced understanding of the intricate dynamics that characterize family firms and their strategic management practices. This can enrich academic theories and practical approaches to managing and studying family businesses.

By exploring these diverse aspects through detailed empirical and theoretical research, future researchers can provide deeper and more nuanced insights into the complex dynamics that define family firms and their strategic management practices, enhancing both academic theories and practical approaches to managing and studying family businesses.

## Conclusion

This study embarked on an explorative journey to unravel the complexities of governance within family firms, particularly focusing on the interplay between firms' organizational controls, family influence, and technological capabilities. The synthesis of findings from this study has not only offered a deeper understanding of these intricate relationships but also significantly contributed to addressing the research gap identified in the literature involving a family firm's technological capabilities and family influence on a firm.

A quantitative methodology was employed, utilizing PLS-SEM to analyze the data. The strengths of this methodology lie in its robustness in handling complex model structures and its capacity to generate reliable and valid results.

The study's findings hold substantial relevance in the context of current theories and frameworks, particularly the resource-based view of firms and the socioemotional wealth perspective in family business studies. The positive interaction between organizational controls and the influence of family firms in enhancing their technological capabilities challenges and extends existing theoretical understandings of these relationships. It underscores the unique familiness resources as pivotal in shaping firm outcomes, resonating with the notion that family firms possess distinct capabilities that can serve as sources of competitive advantage.

Key findings of the study highlight the synergy between formal and clan controls when interwoven with a firm's family dynamics, which when used together can significantly enhance its technological capabilities. This alignment between the study's results and the evidence found shows the complex but effective way governance works in family firms. An unexpected yet intriguing finding was the positive role of clan control within family firms, challenging traditional assumptions and suggesting its potential as a strategic asset in fostering innovation and adaptability in firms.

The findings of this study contribute to the existing body of knowledge on family firms' governance. It extends the understanding of the nuanced role of family influence in a firm in relationship to its organizational controls and technological capabilities, offering a new perspective on the interplay between these elements within the unique context of family firms.

The study also presents key recommendations derived from its findings, emphasizing the need for family firms to recognize and leverage the unique attributes of its familial influence along with its governance strategies. These recommendations have significant applicability in real-world contexts, guiding family firms in strategically navigating the complexities of governance to foster its innovation and growth. The practical implications of the findings offer a roadmap for family business owners and managers to develop governance strategies that effectively integrate organizational controls with family dynamics, thereby optimizing their firms' technological capabilities and maintaining a competitive edge.

The alignment of the research questions and the subsequent findings resulting from the hypotheses reinforces the significance of the research conducted. The study not only addressed the gaps in literature related to the influence of family in family firms and a firm's technological capabilities but also illuminated new pathways in understanding the multifaceted nature of governance in family firms.

In conclusion, the findings of this study significantly contribute to the body of knowledge on family firm governance, offering new insights and perspectives that enrich both theoretical understandings and practical applications. The findings pave the way for future research, which can open new avenues to explore and deepen the awareness of the unique dynamics within family firms.

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## Tables

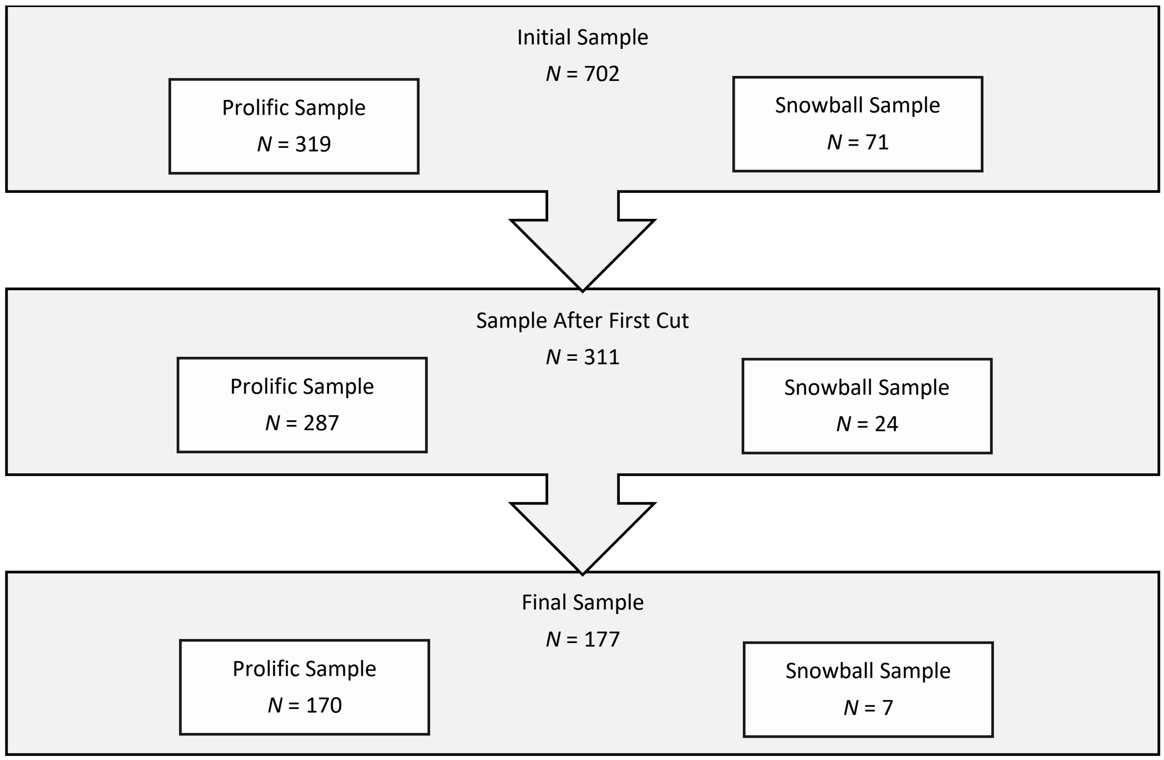
**Table 1**

*Selection Criteria*

| | |
|---|---|
| Inclusion criteria | • 22+<br>• Works in the United States<br>• Has worked for same business since at least December 2019<br>• Job role (At least one is required):<br>• CEO<br>• Senior level<br>• Board member<br>• Actively involved family owner |
| Exclusion criteria | • Reports directly to senior-level employees who are involved with the survey<br>• Not involved with any decision-making or influencing of technological innovation |

**Table 2a**

*Sample Breakdown*




*Note*. Ninety-one responses were removed from the sample after first cut due to the substantial number of items not being completed throughout the survey. One hundred thirty-four responses were removed for the final sample due to a substantial number of items associated with power and experience questions not being completed.

**Table 2b**

*Missing Data*

| Construct | Item | *N* | Missing count | Missing % | Max. total missing |
|---|---|---|---|---|---|
| Technical skills (TS) | TS1 | 177 | 0 | 0.0 | 3 |
| | TS2 | 177 | 0 | 0.0 | |
| | TS3 | 176 | 1 | 0.6 | |
| | TS4 | 177 | 0 | 0.0 | |
| | TS5 | 176 | 1 | 0.6 | |
| | TS6 | 174 | 3 | 1.7 | |
| | TS7* | 175 | 2 | 1.1 | |
| | TS8* | 175 | 2 | 1.1 | |
| | TS9 | 176 | 1 | 0.6 | |
| Technological capabilities (TC) | TC1 | 177 | 0 | 0.0 | 1 |
| | TC2 | 177 | 0 | 0.0 | |
| | TC3 | 177 | 0 | 0.0 | |
| | TC4 | 177 | 0 | 0.0 | |
| | TC5 | 176 | 1 | 0.6 | |
| Formal output controls (FOC) | FOC1 | 177 | 0 | 0.0 | 1 |
| | FOC2 | 176 | 1 | 0.6 | |
| | FOC3 | 177 | 0 | 0.0 | |
| Formal behavioral controls (FBC) | FBC1 | 177 | 0 | 0.0 | 1 |
| | FBC2 | 177 | 0 | 0.0 | |
| | FBC3 | 176 | 1 | 0.6 | |
| | FBC4* | 177 | 0 | 0.0 | |
| Clan control (CC) | CC1* | 176 | 1 | 0.6 | 3 |
| | CC2* | 176 | 1 | 0.6 | |
| | CC3 | 177 | 0 | 0.0 | |
| | CC4 | 177 | 0 | 0.0 | |
| | CC5 | 176 | 1 | 0.6 | |
| | CC6 | 177 | 0 | 0.0 | |
| | P_OwnFam | 133 | 44 | 24.9 | |
| | P_GovFam* | 66 | 11 | 63.8 | |

| Construct | Item | *N* | Missing count | Missing % | Max. total missing |
|---|---|---|---|---|---|
| | P_MangBoard | 84 | 93 | 52.5 | |
| | E_GenOwn | 169 | 8 | 4.5 | |
| | E_GenGov | 170 | 7 | 4.0 | |
| | E_GenMang | 153 | 24 | 13.6 | |
| Culture (Cult) | Cult1_1 | 170 | 7 | 4.0 | 9 |
| | Cult1_2 | 170 | 7 | 4.0 | |
| | Cult1_3 | 170 | 7 | 4.0 | |
| | Cult2_1 | 170 | 7 | 4.0 | |
| | Cult2_2 | 170 | 7 | 4.0 | |
| | Cult2_3 | 170 | 7 | 4.0 | |
| | Cult2_4 | 168 | 9 | 5.1 | |
| | Cult2_5 | 170 | 7 | 4.0 | |
| | Cult2_6 | 170 | 7 | 4.0 | |
| | Cult2_7 | 170 | 7 | 4.0 | |
| | Cult2_8 | 170 | 7 | 4.0 | |
| | Cult2_9 | 170 | 7 | 4.0 | |
| | Cult2_10* | 170 | 7 | 4.0 | |

Note. P_OwnFam = power of family ownership; P_GovFam = power of family governance; P_MangBoard = power of management board; E_GenOwn = experience of generational ownership; E_GenGov = experience of generational governance; E_GenMang = experience of generational management.

* Indicates removed items from final analysis.

**Table 2c**

*Demographics*

| Age | Count | % |
|---|---|---|
| 20-29 | 16 | 9.04% |
| 30-39 | 56 | 31.64% |
| 40-49 | 47 | 26.55% |
| 50-59 | 35 | 19.77% |
| 60-70 | 23 | 12.99% |

| Gender | Count | % |
|---|---|---|
| Male | 104 | 58.76% |
| Female | 71 | 40.11% |
| Prefer not to say | 1 | 0.56% |
| Non-Binary | 1 | 0.56% |

| Race | Count | % |
|---|---|---|
| Caucasian | 141 | 79.66% |
| African American | 16 | 9.04% |
| Other | 13 | 7.34% |
| Asian | 5 | 2.82% |
| Caucasian,Asian | 1 | 0.56% |
| Native American | 1 | 0.56% |

| Education | Count | % |
|---|---|---|
| Bachelor's degree | 76 | 42.94% |
| Graduate or professional degree | 47 | 26.55% |
| Some college, but no degree | 28 | 15.82% |
| Associates or technical degree | 14 | 7.91% |
| High school diploma or GED | 10 | 5.65% |
| Prefer not to say | 1 | 0.56% |
| Some high school or less | 1 | 0.56% |

| Year Founded | Count | % |
|---|---|---|
| Before 1919 | 3 | 1.69% |
| 1920-1929 | 6 | 3.39% |
| 1930-1939 | 1 | 0.56% |
| 1940-1949 | 7 | 3.95% |
| 1950-1959 | 6 | 3.39% |
| 1960-1969 | 5 | 2.82% |
| 1970-1979 | 11 | 6.21% |
| 1980-1989 | 18 | 10.17% |
| 1990-1999 | 27 | 15.25% |
| 2000-2009 | 38 | 21.47% |
| 2010-Present | 48 | 27.12% |

| Roles Held | Count | % |
|---|---|---|
| Director/ Associate Director/ Senior Manager | 61 | 34.46% |
| Manager/supervisor | 50 | 28.25% |
| CEO | 38 | 21.47% |
| Senior Level (C-Suite, Senior Leader) | 20 | 11.30% |
| Employee | 4 | 2.26% |
| Member of board of directors | 3 | 1.69% |

| Primary Business | Count | % |
|---|---|---|
| Technology | 29 | 16.38% |
| Retail and Consumer Products | 25 | 14.12% |
| Distribution and Manufacturing | 24 | 13.56% |
| Media, Arts and Entertainment | 20 | 11.30% |
| Other | 16 | 9.04% |
| Real Estate and Construction | 14 | 7.91% |
| Services | 14 | 7.91% |
| Health Care Services | 13 | 7.34% |
| Financial Services | 11 | 6.21% |
| Hospitality and Leisure | 4 | 2.26% |
| Automotive | 2 | 1.13% |
| Oil and Gas, Power and Utilities | 2 | 1.13% |
| Telecommunications | 1 | 0.56% |
| Mining and Metals | 1 | 0.56% |

| Occupation | Count | % |
|---|---|---|
| Senior Management | 68 | 38.42% |
| Operations | 40 | 22.60% |
| Information Technology | 26 | 14.69% |
| Sales and Service | 16 | 9.04% |
| Finance and Accounting | 10 | 5.65% |
| Marketing and Merchandising | 10 | 5.65% |
| Logistics and Supply Chain | 4 | 2.26% |
| Retired | 1 | 0.56% |

| Employment Growth | Frequency | % |
|---|---|---|
| Decreased | 39 | 22.03% |
| <2% | 31 | 17.51% |
| 2-3.99% | 37 | 20.90% |
| 4-5.99% | 32 | 18.08% |
| 6-7.99% | 15 | 8.47% |
| 8-9.99% | 7 | 3.95% |
| >10% | 16 | 9.04% |

| Years Worked | Count | % |
|---|---|---|
| 0-4 Years | 53 | 29.94% |
| 5-9 Years | 51 | 28.81% |
| 10-14 Years | 30 | 16.95% |
| 15-19 Years | 17 | 9.60% |
| 20-24 Years | 10 | 5.65% |
| 25-29 Years | 6 | 3.39% |
| 30-34 Years | 6 | 3.39% |
| 35-40 Years | 1 | 0.56% |
| 45+ Years | 1 | 0.56% |

| Family Business | Count | % |
|---|---|---|
| Yes | 93 | 52.54% |
| No | 83 | 46.89% |

**Table 3**

*Descriptive Statistics*

| Variables | *N* | Range | *M* | Min. | Max. | *SD* | Variance | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|
| *Age* | *177* | *49* | *45.03* | *43* | *21* | *70* | *11.632* | *0.2755* | *−0.9234* |
| *Gender Identity* | *177* | *2* | *1.38* | *1* | *1* | *3* | *0.509* | *0.7648* | *−0.8204* |
| *Education* | *177* | *5* | *4.74* | *5* | *1* | *6* | *1.168* | *−1.0381* | *0.3575* |
| *Tenure at firm* | *177* | *64* | *11.81* | *9* | *1* | *65* | *9.535* | *2.0906* | *6.8974* |
| *Year firm founded* | *177* | *145* | *1989.3* | *2000* | *1875* | *2020* | *32.504* | *−1.6688* | *2.3838* |
| *Firm's age* | *177* | *145* | *34.73* | *24* | *4* | *149* | *32.504* | *1.6688* | *2.3838* |
| *Family business/not* | *177* | *1* | *1.51* | *2* | *1* | *2* | *0.501* | *−0.0342* | *−2.0218* |
| *Employment growth* | *177* | *8* | *4.77* | *5* | *1* | *9* | *2.451* | *−0.1731* | *−0.7331* |
| TS | 177 | 92.56 | 57.51 | 61 | 0 | 92.56 | 20.565 | −0.6908 | 0.1239 |
| TC | 176 | 100 | 62.25 | 66.1 | 0 | 100 | 22.863 | −0.663 | −0.0117 |
| Combined controls | 177 | 4.69 | 5.12 | 5.31 | 1.88 | 6.56 | 0.831 | −1.2067 | 1.7098 |
| Formal controls | 177 | 4.88 | 4.78 | 5 | 1.25 | 6.13 | 0.868 | −1.2776 | 2.6352 |
| Formal behavior | 176 | 5.25 | 5.43 | 5.75 | 1.75 | 7 | 1.08 | −1.1102 | 1.3247 |
| Formal outcome | 177 | 6 | 5.52 | 5.67 | 1 | 7 | 1.05 | −1.5066 | 3.9992 |
| Clan control | 177 | 6 | 5.45 | 5.67 | 1 | 7 | 1.087 | −1.2565 | 2.2473 |
| Power | 134 | 100 | 58.95 | 58.92 | 0 | 100 | 30.908 | −0.1439 | −1.1274 |
| Experience | 174 | 5 | 1.78 | 1.33 | 0 | 5 | 1.183 | 1.4693 | 1.3843 |
| Culture | 170 | 5.85 | 5.1 | 5.54 | 1 | 6.85 | 1.636 | −1.2125 | 0.8217 |

*Note*. TS = technological skills; TC = technological capabilities.

## Table 4

*Correlation Matrix*

| Variable | Age | Gender identity | Education | Tenure at firm | Year firm founded | Firm's age | Family business /not | Employment growth | TS | TC | Combined controls | Formal controls | Formal behavior | Formal outcome | Clan control | Power | Experience | Culture |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Age* | — | | | | | | | | | | | | | | | | | |
| *Gender identity* | −0.013 | — | | | | | | | | | | | | | | | | |
| *Education* | 0.140 | −0.015 | — | | | | | | | | | | | | | | | |
| *Tenure at firm* | 0.418*** | 0.109 | 0.154* | — | | | | | | | | | | | | | | |
| *Year firm founded* | −0.216** | 0.042 | −0.201** | −0.159* | — | | | | | | | | | | | | | |
| *Firm's age* | 0.216** | −0.042 | 0.201** | 0.159* | −0.100*** | — | | | | | | | | | | | | |
| *Family business/not* | −0.233** | 0.021 | 0.043 | −0.037 | −0.115 | 0.115 | — | | | | | | | | | | | |
| *Employment growth* | −0.170* | −0.127 | −0.023 | −0.040 | −0.032 | 0.032 | 0.182* | — | | | | | | | | | | |
| TS | −0.087 | −0.087 | −0.093 | 0.018 | 0.021 | −0.021 | 0.088 | 0.186* | — | | | | | | | | | |
| TC | −0.125 | −0.082 | −0.053 | −0.016 | 0.062 | −0.062 | 0.034 | 0.273*** | 0.695*** | — | | | | | | | | |
| Combined controls | 0.033 | 0.007 | −0.102 | 0.062 | −0.068 | 0.068 | −0.031 | 0.109 | 0.462*** | 0.466*** | — | | | | | | | |
| Formal controls | −0.034 | −0.065 | −0.091 | −0.058 | −0.012 | 0.012 | −0.060 | 0.094 | 0.486*** | 0.502*** | 0.808*** | — | | | | | | |
| Formal behavior | −0.011 | −0.019 | −0.016 | −0.027 | 0.030 | −0.030 | −0.124 | 0.045 | 0.426*** | 0.429*** | 0.745*** | 0.903*** | — | | | | | |
| Formal outcome | −0.048 | −0.094 | −0.130 | −0.078 | −0.055 | 0.055 | −0.002 | 0.121 | 0.474*** | 0.497*** | 0.757*** | 0.950*** | 0.724*** | — | | | | |
| Clan control | 0.078 | 0.062 | −0.084 | 0.141 | −0.095 | 0.095 | 0.001 | 0.091 | 0.319*** | 0.311*** | 0.883*** | 0.436*** | 0.417*** | 0.399*** | — | | | |
| Power | 0.168 | 0.151 | 0.018 | 0.126 | 0.073 | −0.073 | −0.516* | −0.446*** | −0.207* | −0.166 | −0.062 | −0.040 | 0.015 | −0.074 | −0.059 | — | | |
| Experience | 0.022 | −0.051 | −0.167* | 0.110 | −0.469*** | 0.469*** | 0.217** | 0.081 | −0.011 | −0.035 | 0.004 | −0.047 | −0.109 | 0.000 | 0.044 | −0.217* | — | |
| Culture | 0.013 | −0.080 | −0.097 | −0.030 | 0.167* | −0.167* | 0.520*** | −0.086 | 0.220** | 0.254*** | 0.343*** | 0.255*** | 0.275*** | 0.209** | 0.318*** | 0.265** | −0.162* | — |

*Note*. TS = technological skills; TC = technological capabilities.

*p < .05. **p < .01. ***p < .001.

**Table 5**

*Confirmatory Composite Analysis Factor Loadings*

| CCA measurement items | Model 1 | Model 2 |
|---|---|---|
| Formal control (on a scale from 1–7) | | |
| Formal behavior control | | |
| (1) Top management monitored the extent to which growth intiatives follwed establsihed proceedures. | 0.826 | 0.734 |
| (2) Top management evaluated the procedures and growth initiatives used to accomplish a given task. | 0.824 | 0.734 |
| (3) Top management modified the growth iniatives' proceedures when desired results were not obtained. | 0.841 | 0.739 |
| Formal outcome control | | |
| (1) Specific dates were establlished and monitored for growth iniatatives milestones. | 0.835 | 0.767 |
| (2) Specific performance goals were establsihed and monitored for growth iniatives. | 0.839 | 0.77 |
| (3) Critical growth iniatives' cost budgets were establsiehd and monitored. | 0.772 | 0.727 |
| Clan control (CC; on a scale from 1–7) | | |
| CC_3. Our mission statement conveys the organization's core values to our employees. | 0.906 | 0.765 |
| CC_4. Top managers communicate the organization's core values to employees. | 0.898 | 0.745 |
| CC_5. Our employees are aware of the organization's core values. | 0.933 | 0.786 |
| CC_6. Our employees perceive the values codified in our mission statement to be motivating. | 0.875 | 0.663 |
| Technology capabilties (on a scale from 0–100) | | |
| *Please rate your company's skills in the following areas relative to your major competitor using the scale below. In rating your company's skills, please focus on the past 3 years.* | | |
| Technological skills | | |
| Skill in conducting applied R & D | 0.758 | 0.757 |
| Ability to transform R & D results to products | 0.802 | 0.802 |
| Skill to develop new products | 0.782 | 0.78 |
| Ability to upgrade existing products | 0.779 | 0.777 |
| Speed of new product/service development | 0.768 | 0.766 |
| Efficiency in developing new products/services | 0.792 | 0.79 |
| Overall technological skills | 0.82 | 0.819 |
| Technological capabilities | | |
| *Please indicate the level of your company's capabilities in the following areas:* | | |

| CCA measurement items | Model 1 | Model 2 |
|---|---|---|
| Acquiring important digital opportunities | 0.833 | 0.835 |
| Identifying new digital opportunities | 0.82 | 0.822 |
| Responding to digital transformation | 0.838 | 0.84 |
| Mastering the state-of-the-art digital techologies | 0.885 | 0.887 |
| Developing innovaite products/service/processes using digital technology | 0.872 | 0.873 |
| F-PEC | | |
| Power | | |
| Main company owned by (percentage of family) | 0.721 | 0.721 |
| How many management board members are family? | 0.919 | 0.919 |
| Experience | | |
| Which generation owns the company? | 0.933 | 0.86 |
| Which generation(s) manage(s) the company? | 0.952 | 0.949 |
| What generation is active on the governance board? | 0.861 | 0.933 |
| Culture | | |
| *Please rate the extent to which: 1* = Not at all *to 5* = A large extent | | |
| 1. The family has influenced your business. | 0.807 | 0.807 |
| 2. The family members share similar values. | 0.839 | 0.839 |
| 3. The family and business share similar values. | 0.913 | 0.913 |
| *Please rate the extent to which you agree with the following statements:* | | |
| 4. Our family members are willing to put in a great deal of effort beyond that normally expected to help the family business be succcesful. | 0.897 | 0.897 |
| 5. We suport the family business in discussions with friends, employees, and other family members. | 0.94 | 0.94 |
| 6. We feel loyalty to the family business. | 0.928 | 0.928 |
| 7. We find that our values are compatible with those of the business. | 0.953 | 0.953 |
| 8. We are proud to tell others that we are part of the faimly business. | 0.926 | 0.926 |
| 9. There is so much to be gained by participating with the family busienss on a long-term basis. | 0.956 | 0.956 |
| 10. We agree with the family business's goals, plans, and policies. | 0.95 | 0.95 |
| 11. We really care about the fate of the family business. | 0.923 | 0.923 |
| 12. Deciding to be involved with the faimly business has a positive influence on my life. | 0.941 | 0.941 |

*Note*. CCA = confirmatory composite analysis; F-PEC = family influence on power, experience, and culture.

**Table 6a**

*Construct Reliability and Validity—Formal and Clan Control—Model 1*

| | | Construct reliability | | |
|---|---|---|---|---|
| Construct | Cronbach's $\alpha$ | rho_a | rho_c | AVE |
| Clan control | 0.924 | 0.925 | 0.946 | 0.815 |
| Culture | 0.982 | 0.985 | 0.984 | 0.838 |
| Experience | 0.913 | 0.985 | 0.940 | 0.838 |
| Formal control | 0.905 | 0.908 | 0.927 | 0.678 |
| Power | 0.560* | 0.677* | 0.809 | 0.682 |
| TC | 0.953 | 0.955 | 0.959 | 0.661 |

*Note*: TC = technological capabilities; AVE = average value explained.

* Indicate poor reliability values.

**Table 6b**

*Construct Reliability and Validity—Combined Control—Model 2*

| Construct | Cronbach's $\alpha$ | Construct reliability | | AVE |
|---|---|---|---|---|
| | | rho_a | rho_c | |
| Clan control | 0.905 | 0.905 | 0.927 | 0.678 |
| Culture | 0.924 | 0.929 | 0.946 | 0.816 |
| Experience | 0.910 | 0.911 | 0.925 | 0.553 |
| Formal control | 0.982 | 0.985 | 0.984 | 0.838 |
| Power | 0.913 | 0.987 | 0.940 | 0.839 |
| TC | 0.560 | 0.677 | 0.812 | 0.686 |

*Note*: TC = technological capabilities; AVE = average value explained.

[*] Indicate poor reliability values.

**Table 7a**

*Discriminant Validity—Formal and Clan Control—Model 1*

| HTMT | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Clan control | — | | | | | |
| Culture | 0.350 | — | | | | |
| Experience | 0.049 | 0.165 | — | | | |
| Formal control | 0.545 | 0.276 | 0.077 | — | | |
| Power | 0.097 | 0.250 | 0.182 | 0.145 | — | |
| TC | 0.426 | 0.268 | 0.055 | 0.575 | 0.303 | — |
| Fornell-Larker criterion | | | | | | |
| Clan control | **0.903** | | | | | |
| Culture | 0.336 | **0.916** | | | | |
| Experience | 0.049 | −0.134 | **0.916** | | | |
| Formal control | 0.495 | 0.260 | −0.044 | **0.823** | | |
| Power | −0.065 | 0.161 | −0.081 | −0.081 | **0.828** | |
| TC | 0.403 | 0.267 | −0.042 | 0.538 | −0.231 | **0.791** |

*Note*: TC = technological capabilities; HTMT = heterotrait-monotrait ration of correlations.

**Table 7b**

*Discriminant Validity—Combined Control—Model 2*

| HTMT | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Clan control | — | | | | | | |
| Combined | 0.891 | — | | | | | |
| Culture | 0.350 | 0.355 | — | | | | |
| Experience | 0.049 | 0.075 | 0.165 | — | | | |
| Formal control | 0.545 | 0.999 | 0.276 | 0.077 | — | | |
| Power | 0.097 | 0.144 | 0.250 | 0.182 | 0.145 | — | |
| TC | 0.426 | 0.590 | 0.268 | 0.055 | 0.575 | 0.303 | — |
| Fornell-Larker criterion | | | | | | | |
| Clan control | **0.903** | | | | | | |
| Combined | 0.821 | **0.744** | | | | | |
| Culture | 0.333 | 0.337 | **0.916** | | | | |
| Experience | 0.051 | −0.005 | −0.134 | **0.915** | | | |
| Formal control | 0.501 | 0.905 | 0.263 | −0.046 | **0.823** | | |
| Power | −0.067 | −0.084 | 0.161 | −0.080 | −0.077 | **0.828** | |
| TC | 0.401 | 0.551 | 0.267 | −0.042 | 0.536 | −0.231 | **0.791** |

*Note*: TC = technological capabilities; HTMT = heterotrait-monotrait ration of correlations.

**Table 8a**

*Collinearity Statistics—Model 1*

| | VIF |
|---|---|
| Clan control -> TC | 1.850 |
| Culture -> TC | 1.828 |
| Experience -> TC | 1.478 |
| Formal control -> TC | 1.810 |
| Power -> TC | 1.297 |
| Culture x clan control -> TC | 2.080 |
| Power x clan control -> TC | 1.748 |
| Power x formal control -> TC | 1.644 |
| Culture x formal control -> TC | 2.268 |
| Experience x clan control -> TC | 1.462 |
| Experience x formal control -> TC | 1.598 |

*Note*. TC = technological capabilities; VIF = variation inflation factor; -> = relationship between variables; x = moderated relationship.

**Table 8b**

*Collinearity Statistics—Model 2*

| | VIF |
|---|---|
| Combined -> TC | 1.539 |
| Culture -> TC | 1.642 |
| Experience -> TC | 1.450 |
| Power -> TC | 1.289 |
| Culture x combined -> TC | 1.319 |
| Power x combined -> TC | 1.108 |
| Experience x combined -> TC | 1.160 |

*Note*. TC = technological capabilities; VIF = variation inflation factor; -> = relationship between variables; x = moderated relationship.

**Table 9a**

*Path Analysis—Formal and Clan Controls—Model 1*

| Control | *b* | *M* | STDV | *t* | *p* | $f^2$ | Bias | 2.50% | 97.50% |
|---|---|---|---|---|---|---|---|---|---|
| Variable | | | | | | | | | |
| Age -> TC | −0.055 | −0.046 | 0.066 | 0.831 | 0.406 | 0.004 | 0.009 | −0.194 | 0.062 |
| Gender identity -> TC | −0.060 | −0.048 | 0.067 | 0.891 | 0.373 | 0.006 | 0.011 | −0.200 | 0.061 |
| Employment growth -> TC | **0.160** | **0.160** | **0.068** | **2.348** | **0.019** | **0.039** | **0.000** | **0.022** | **0.292** |
| Tenure at firm -> TC | 0.070 | 0.066 | 0.067 | 1.041 | 0.298 | 0.007 | −0.004 | −0.072 | 0.193 |
| Firm's age -> TC | −0.015 | −0.018 | 0.072 | 0.206 | 0.837 | 0.000 | −0.003 | −0.166 | 0.117 |
| Family business/not -> TC | 0.245 | 0.230 | 0.161 | 1.523 | 0.128 | 0.014 | −0.015 | −0.060 | 0.581 |
| Model path | | | | | | | | | |
| H1: FC -> TC | **0.422** | **0.427** | **0.079** | **5.349** | **0.000** | **0.177** | **0.005** | **0.261** | **0.569** |
| H2: CC -> TC | 0.053 | 0.057 | 0.089 | 0.596 | 0.551 | 0.003 | 0.004 | −0.119 | 0.232 |
| Power -> TC | **−0.143** | **−0.146** | **0.062** | **2.313** | **0.021** | **0.028** | **−0.004** | **−0.255** | **−0.015** |
| Experience -> TC | −0.057 | −0.044 | 0.087 | 0.651 | 0.515 | 0.004 | 0.013 | −0.218 | 0.117 |
| Culture -> TC | **0.217** | **0.207** | **0.103** | **2.104** | **0.035** | **0.046** | **−0.010** | **0.014** | **0.415** |
| Moderation | | | | | | | | | |
| H1a: Power x FC -> TC | 0.087 | 0.077 | 0.096 | 0.906 | 0.365 | 0.005 | −0.010 | −0.106 | 0.274 |
| H2a: Power x CC -> TC | 0.152 | 0.135 | 0.098 | 1.554 | 0.120 | 0.015 | −0.018 | −0.019 | 0.372 |
| H1a: Experience x FC -> TC | −0.011 | −0.017 | 0.082 | 0.129 | 0.897 | 0.000 | −0.006 | −0.178 | 0.141 |
| H2a: Experience x CC -> TC | −0.038 | −0.032 | 0.077 | 0.487 | 0.626 | 0.002 | 0.006 | −0.199 | 0.108 |
| H1a: Culture x FC -> TC | 0.062 | 0.067 | 0.078 | 0.789 | 0.430 | 0.006 | 0.006 | −0.112 | 0.198 |
| H2a: Culture x CC -> TC | −0.065 | −0.050 | 0.098 | 0.661 | 0.509 | 0.004 | 0.014 | -0.268 | 0.118 |

*Note*: TC = technological capabilities; STDV = standard deviation; FC = formal control; H = hypothesis; CC = clan control.

Significant paths are in bold.

**Table 9b**

*Path Analysis—Combined Controls—Model 2*

| Control | *b* | *M* | STDV | *t* | *p* | $f^2$ | Bias | 2.50% | 97.50% |
|---|---|---|---|---|---|---|---|---|---|
| Variable | | | | | | | | | |
| Age -> TC | −0.060 | −0.052 | 0.065 | 0.916 | 0.360 | 0.004 | 0.007 | −0.194 | 0.060 |
| Gender identity -> TC | −0.081 | −0.071 | 0.066 | 1.225 | 0.221 | 0.010 | 0.01 | −0.218 | 0.039 |
| Employment growth -> TC | **0.162** | **0.165** | **0.069** | **2.337** | **0.019** | **0.040** | **0.003** | **0.020** | **0.294** |
| Tenure at firm -> TC | 0.051 | 0.051 | 0.062 | 0.819 | 0.413 | 0.003 | 0.000 | −0.085 | 0.160 |
| Firm's age -> TC | −0.015 | −0.018 | 0.071 | 0.211 | 0.833 | 0.000 | −0.003 | −0.163 | 0.114 |
| Family business/not -> TC | 0.199 | 0.190 | 0.145 | 1.370 | 0.171 | 0.010 | −0.009 | −0.074 | 0.499 |
| Model path | | | | | | | | | |
| H3: CC -> TC | **0.422** | **0.425** | **0.075** | **5.659** | **0.000** | **0.196** | **0.003** | **0.277** | **0.572** |
| Power -> TC | **−0.145** | **−0.150** | **0.062** | **2.339** | **0.019** | **0.028** | **−0.006** | **−0.257** | **−0.015** |
| Experience -> TC | −0.070 | −0.054 | 0.086 | 0.809 | 0.418 | 0.006 | 0.016 | −0.219 | 0.106 |
| Culture -> TC | **0.191** | **0.188** | **0.093** | **2.056** | **0.040** | **0.038** | **−0.003** | **0.004** | **0.373** |
| Moderation | | | | | | | | | |
| H3a: Power x CC-> TC | 0.199 | 0.178 | 0.094 | 2.130 | 0.033 | 0.039 | −0.022 | 0.026 | 0.387 |
| H3a: Experience x CC-> TC | −0.049 | −0.047 | 0.069 | 0.722 | 0.471 | 0.004 | 0.002 | −0.203 | 0.071 |
| H3a: Culture x CC -> TC | 0.000 | 0.014 | 0.058 | 0.004 | 0.997 | 0.000 | 0.015 | −0.102 | 0.116 |

*Note*: *N* = 177. STDV = standard deviation; TC = technological capabilities; H = hypothesis; CC = combined controls.

Significant paths are in bold.

**Table 10**

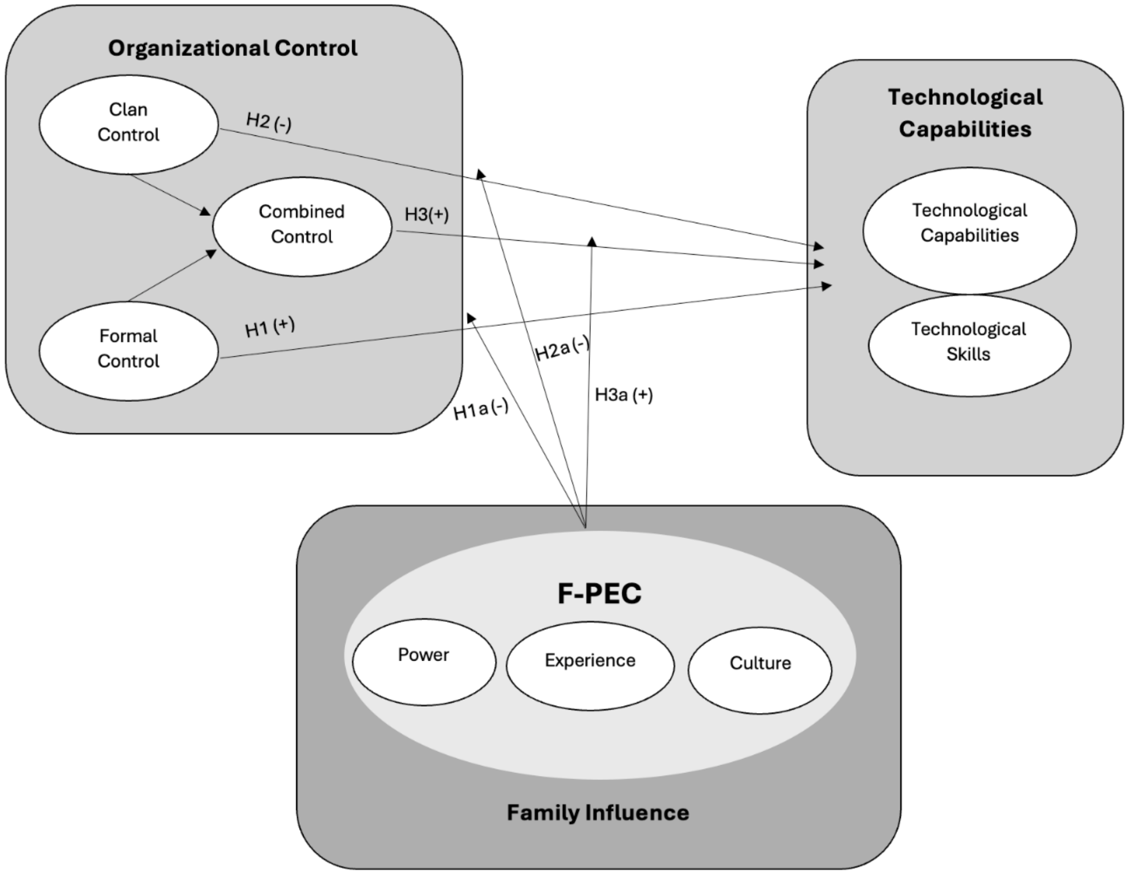
*Hypothesis Results*

| Hypothesis | Result | Rationale |
|---|---|---|
| 1. The level of formal behavioral and outcome controls are positively associated with the strength of a firm's technological capabilities. | Accepted | Path analysis for formal controls is significant. |
| 1a. The influence of family firms weakens the positive relationship between formal control and its technology capabilities. | Rejected | Moderator has nonsignificant effect on the overall relationship. |
| 2. The level of clan control is negatively associated with the strength of a firm's technological capabilities. | Rejected | Path analysis for clan controls is nonsignificant. |
| 2a. The influence of family firms weakens the negative relationship between clan control and its technology capabilities. | Rejected | Moderator has nonsignificant effect on the overall relationship. |
| 3. The levels of formal and clan controls interacts to positively impact the strength of a firm's technological capabilities. | Accepted | Path analysis for combined controls is significant. |
| 3a. The influence of family firms strengthens the positive relationship between the combined integration of formal controls with clan controls and its technology capabilities. | Partially accepted | Moderator has partial significant effect within the power construct on the overall relationship. |

# Figures

## Figure 1

*Hypothesized Model*




*Note*. F-PEC = family influence on power, experience, and culture; H = hypothesis.

**Figure 2a**

*Formal Controls—Boxplot Showing Outliers*

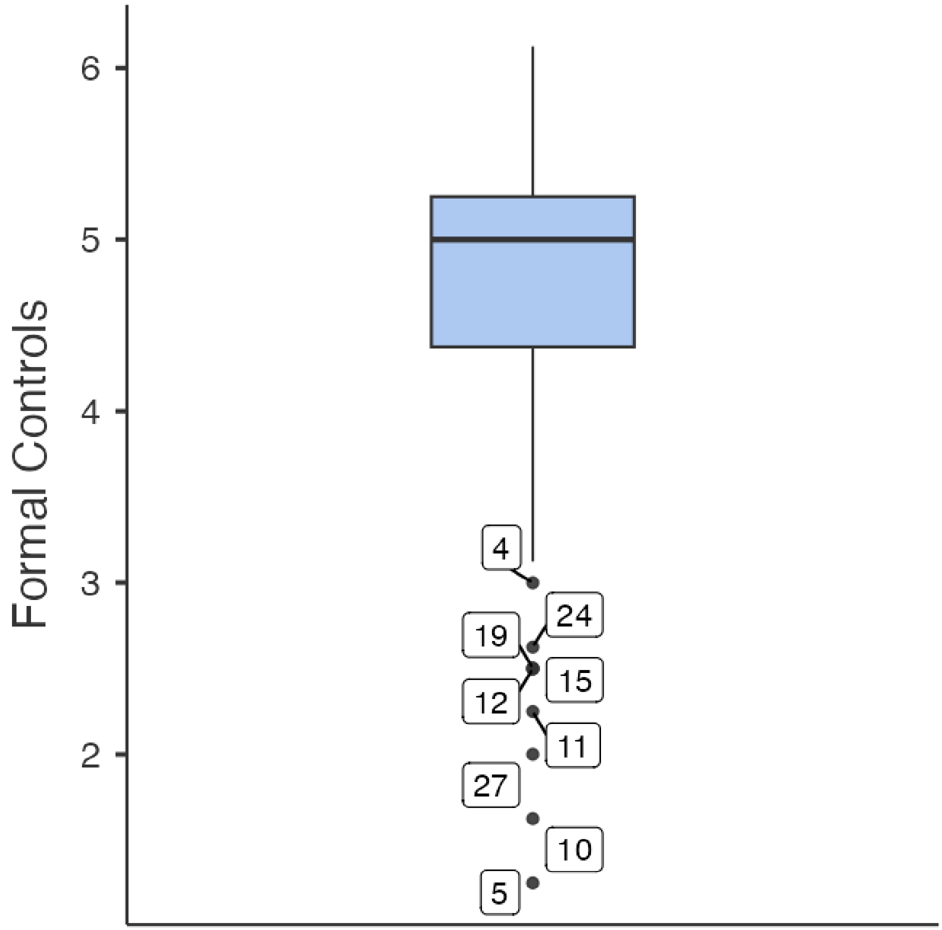


**Figure 2b**

*Formal Controls—Histogram*

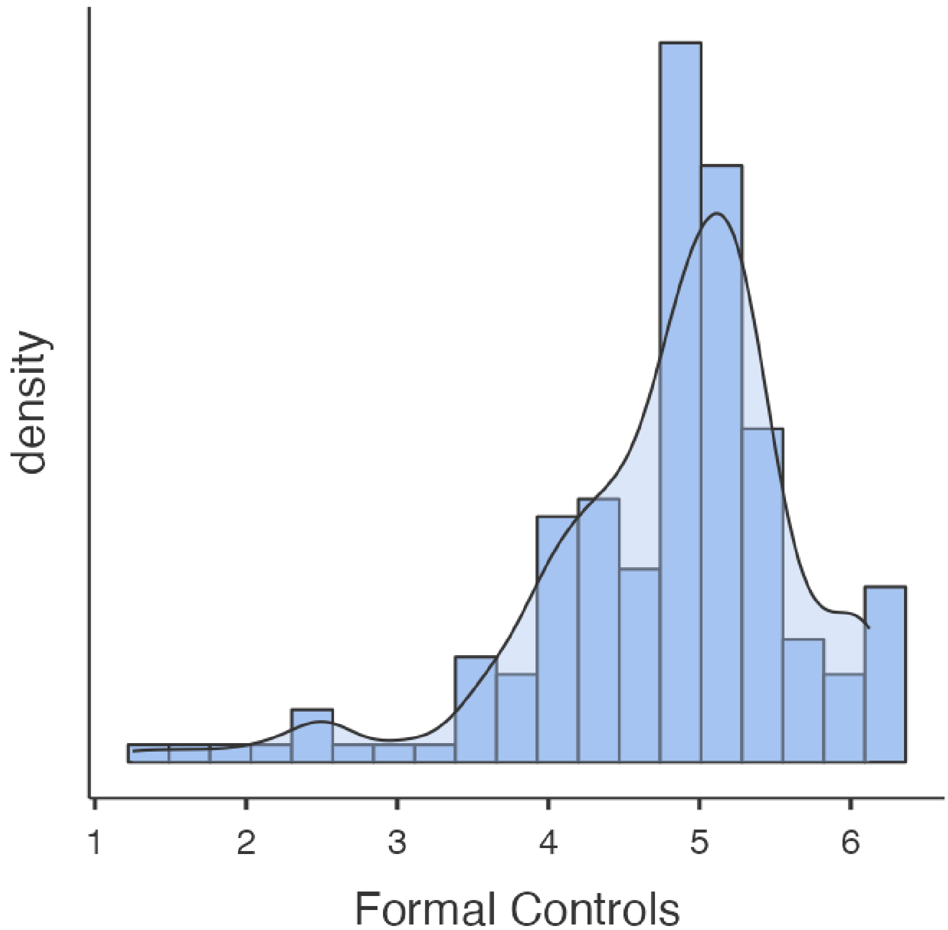


**Figure 3a**

*Clan Controls—Boxplot Showing Outliers*

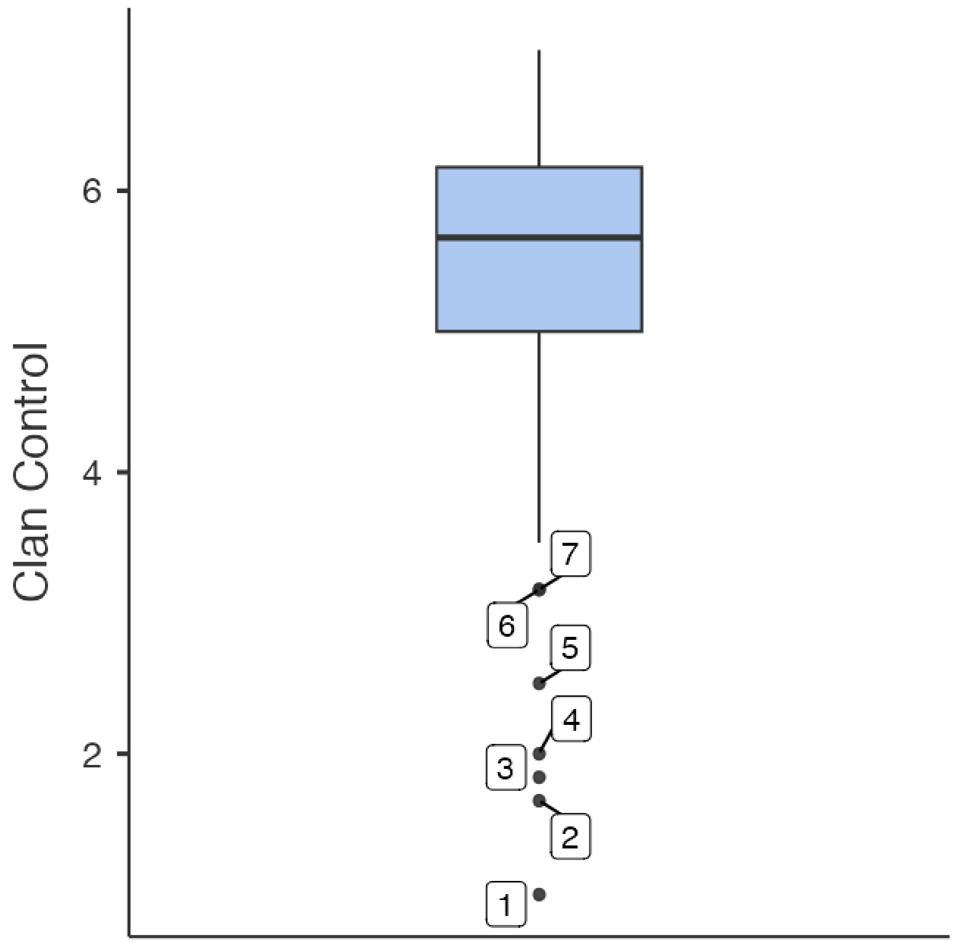


**Figure 3b**

*Clan Controls—Histogram*

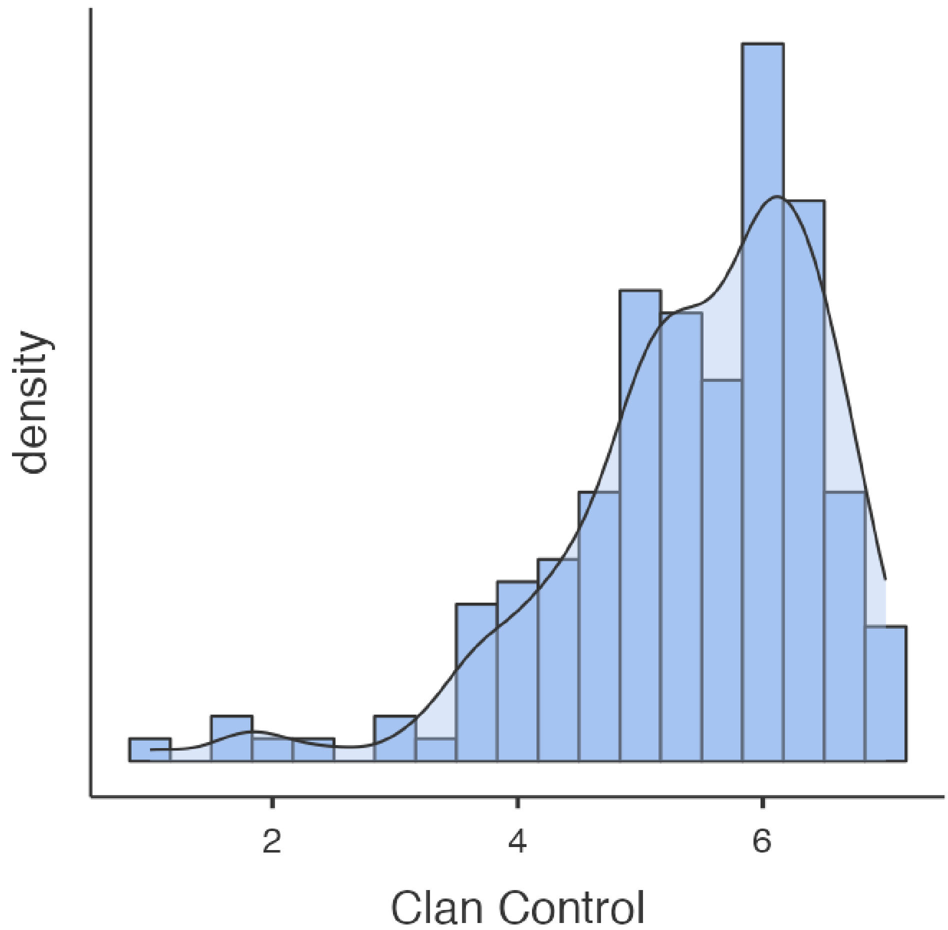


**Figure 4a**

*Technological Capabilities—Boxplot Showing Outliers*

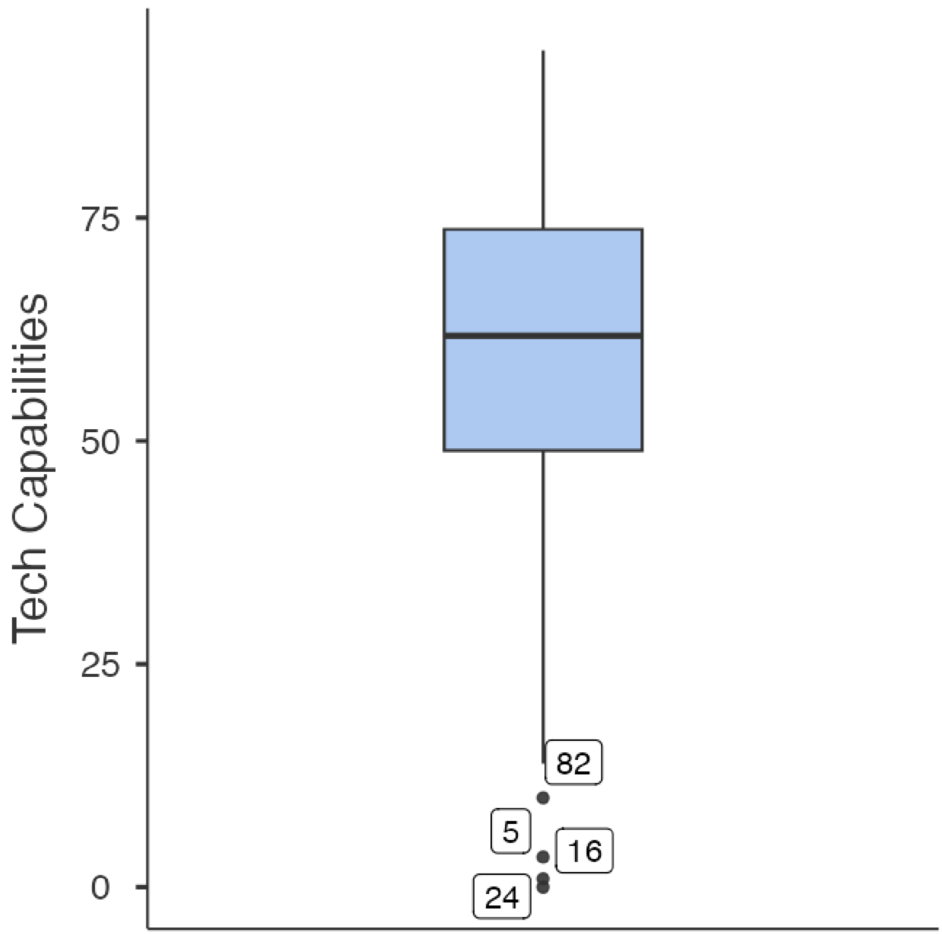


**Figure 4b**

*Technological Capabilities—Histogram*

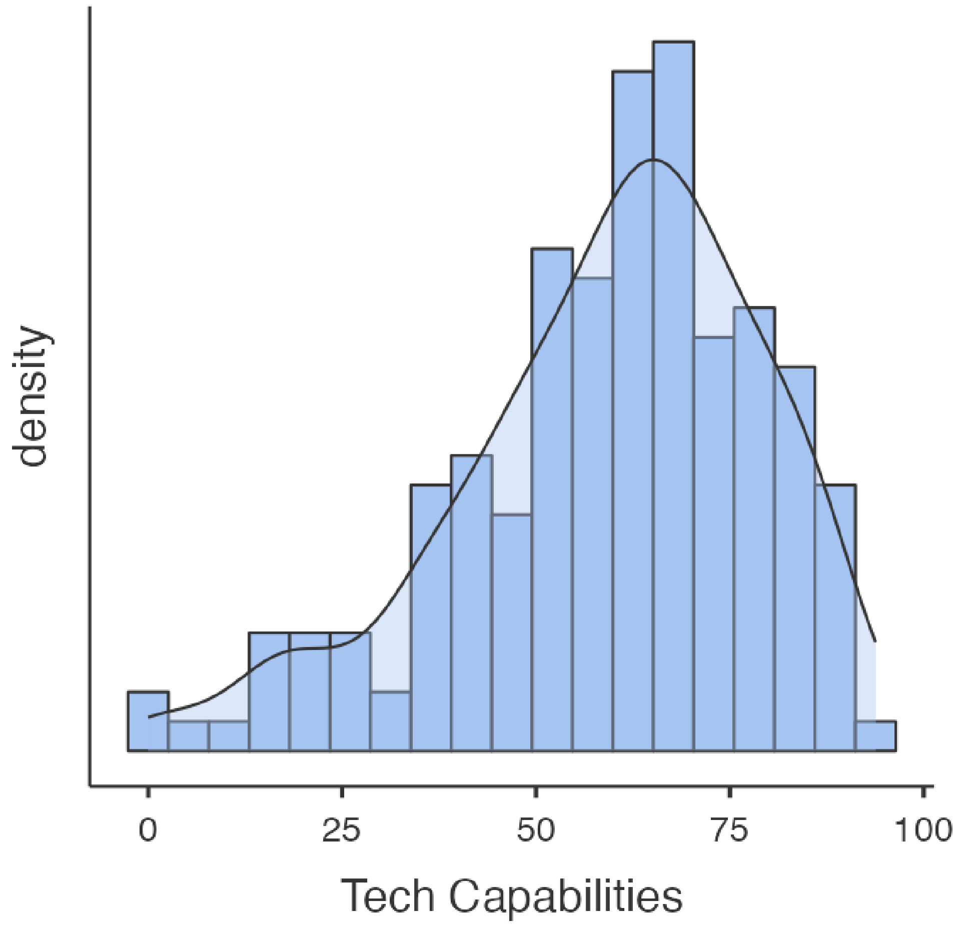
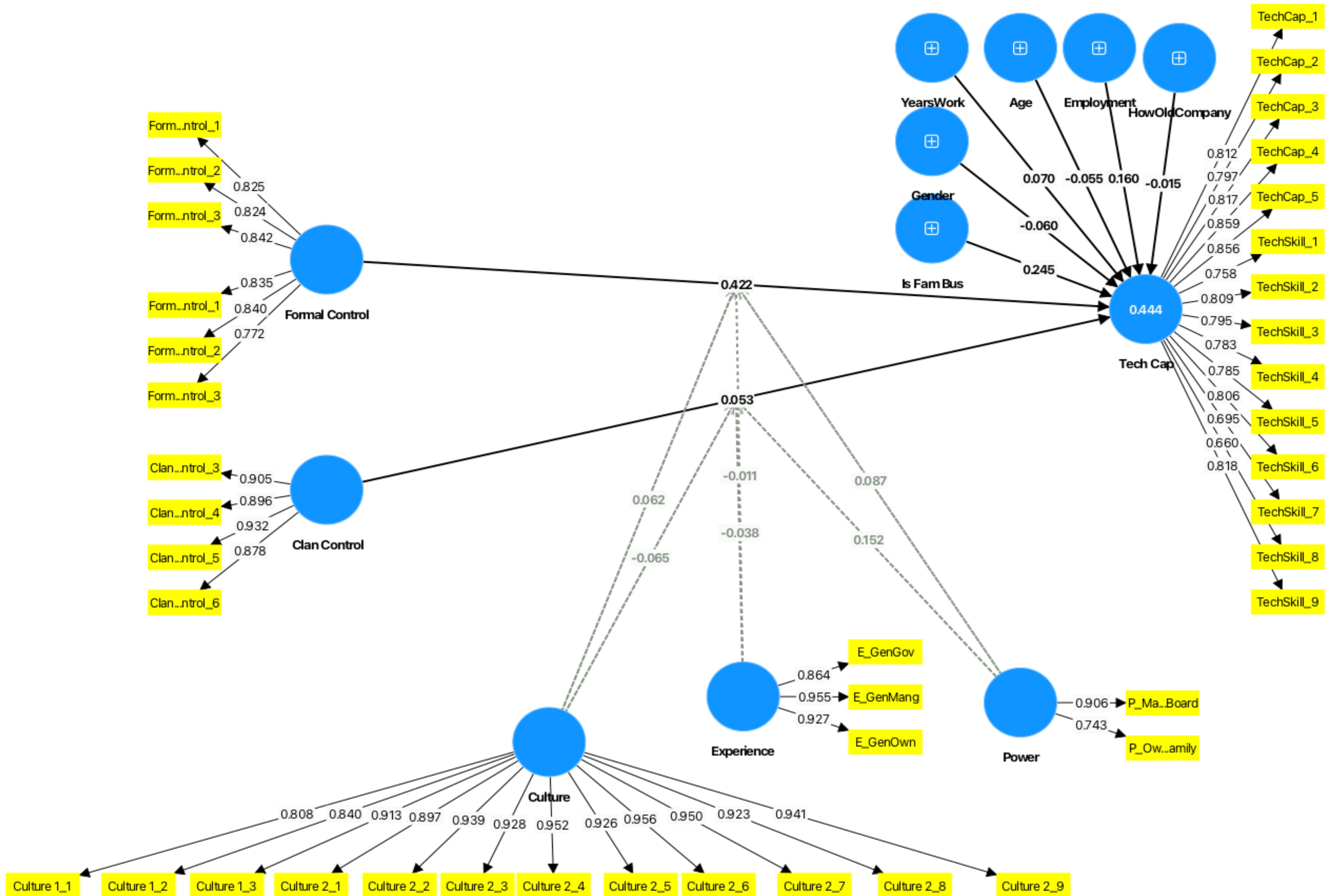


**Figure 5a**

*Formal and Clan Controls PLS-SEM Output–Model 1*



## Figure 5b

*Combined Controls PLS-SEM Output—Model 2*

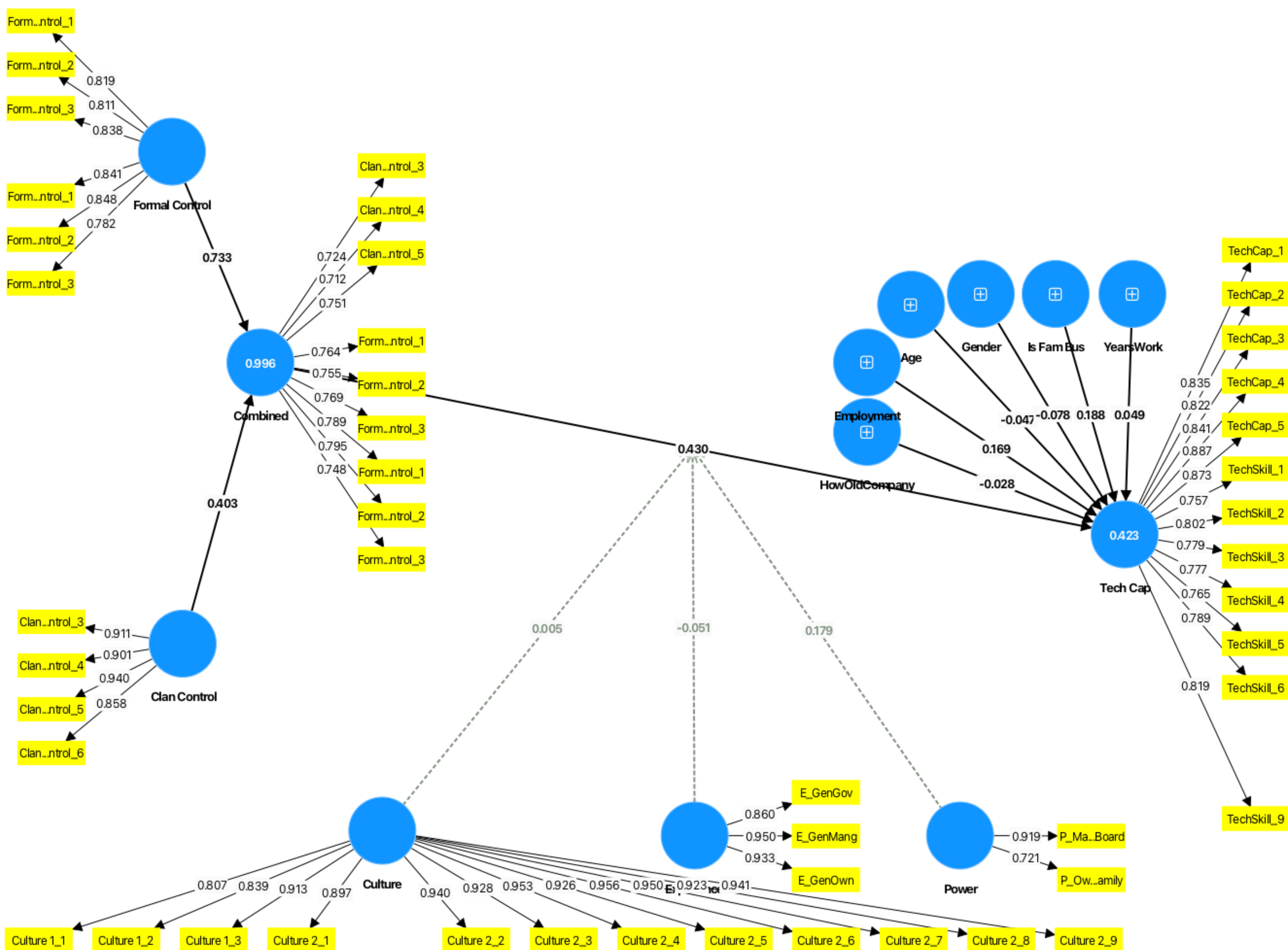
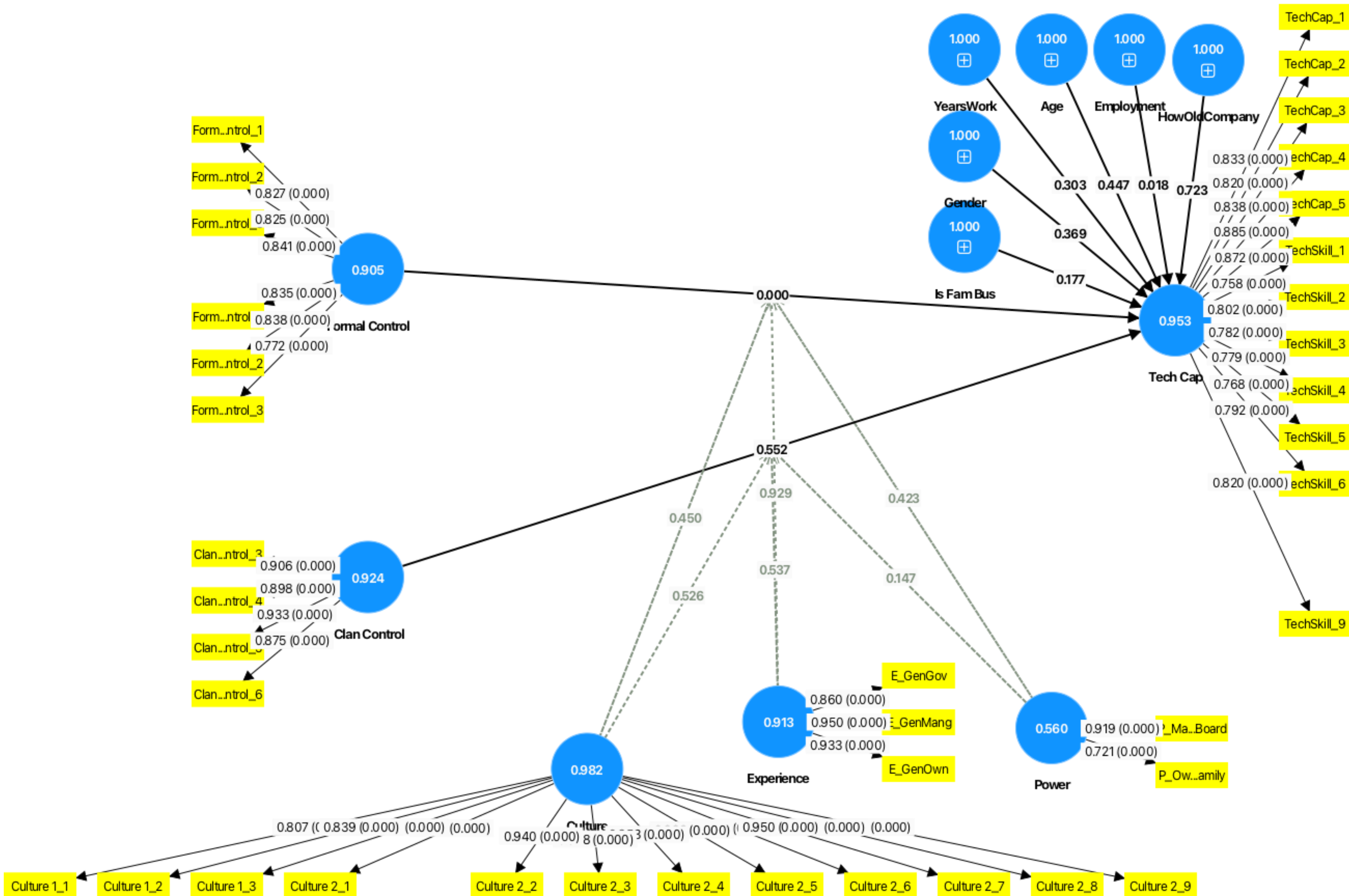


**Figure 6a**

*Formal and Clan Controls Bootstrapping Output—Model 1*



## Figure 6b

*Combined Controls Bootstrapping Output—Model 2*

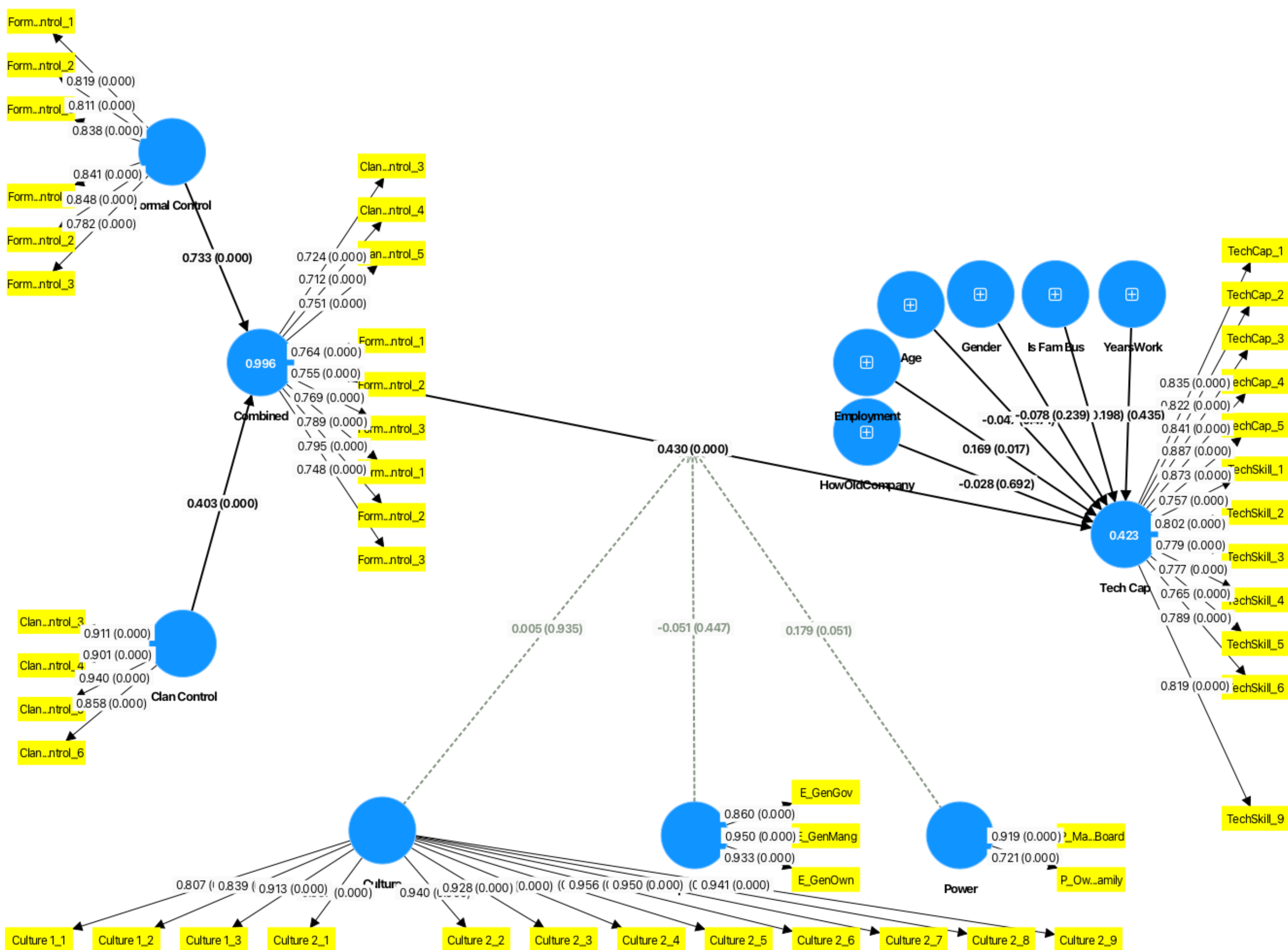
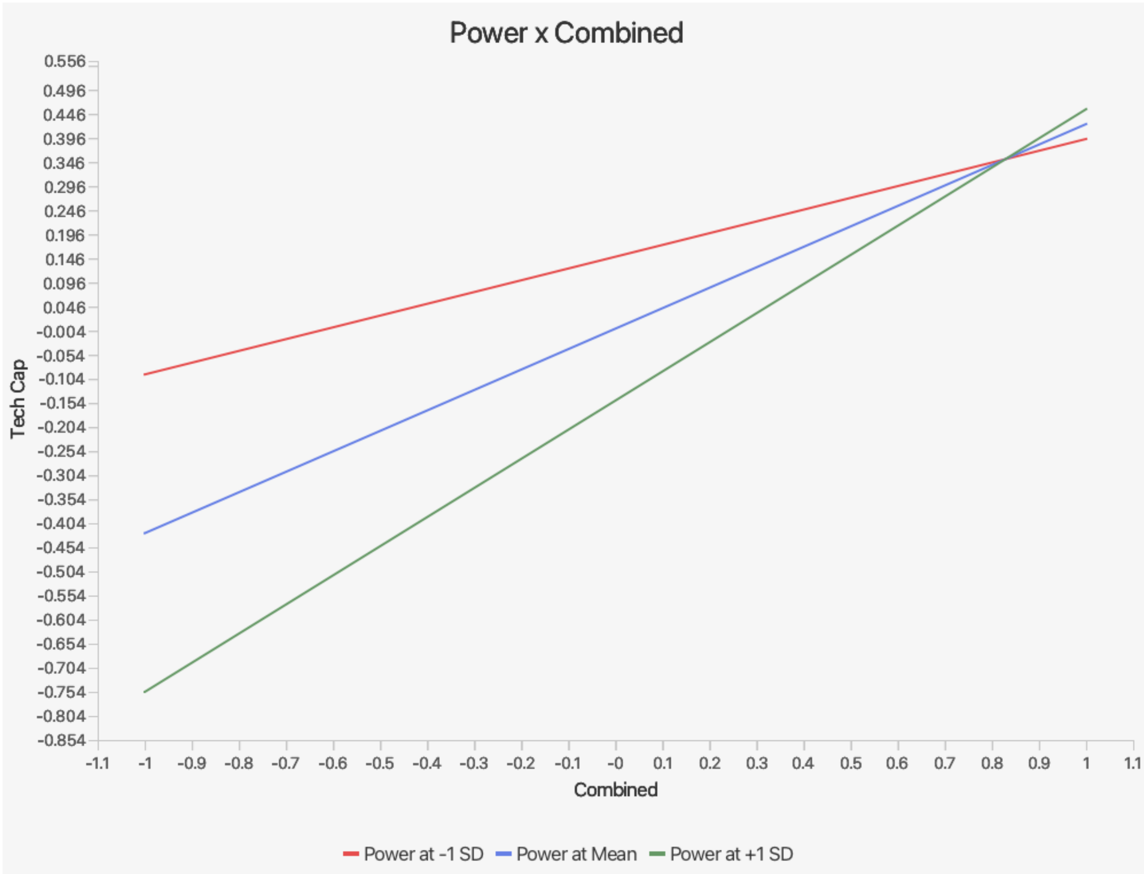


**Figure 7**

*Simple Slope Analysis: Power x Combined Controls—Hypothesis 3a*



## Appendix

**Formal control (Kreutzer et al., 2016)**

**Formal control combined ( α = 0.84)**

**Formal behavior control ( α = 0.77)**

(1) Top management monitored the extent to which growth initiatives followed established procedures.

(2) Top management evaluated the procedures and growth initiatives used to accomplish a given task.

(3) Top management modified the growth initiatives' procedures when desired results are not obtained.

**Formal outcome control ( α = 0.86)**

(1) Specific dates are established and monitored for growth initiative milestones.

(2) Specific performance goals are established and monitored for growth initiatives.

(3) Critical growth initiatives' cost budgets are established and monitored.

(4) Performance evaluations placed primary weight on results.

**Clan control (Goebel and Weißenberger, 2017)**

**Cultural controls ( α =.90)**

CC_1. Traditions, values, and norms play a significant role in our organization.

CC_2. In our organization, high emphasis is placed on sharing informal codes of conduct with employees.

CC_3. Our mission statement conveys the organization's core values to our employees.

CC_4. Top managers communicate the organization's core values to employees.

CC_5. Our employees are aware of the organization's core values.

CC_6. Our employees perceive the values codified in our mission statement to be motivating.

**Family Influence on Power, Experience, and Culture (F-PEC) scale (Astrachan et al. 2002)**

***Part 1: The Power subscale***

1. Please indicate the proportion of share ownership held by family and nonfamily members:

(a) Family ________________ %

(b) Nonfamily ________________ %

2. are shares held in a holding company or similar entity (e.g., trust)? 1.Yes If YES, please indicate the proportion of ownership:

2.No

(a) Main company owned by: (i)

(ii) direct

nonfamily:_____%ownership:_______%

(iii) holding company:_______%

(b) Holding company owned by: (i)

(ii) nonfamily ownership:__%

(iii) 2nd holding company:__%

(c) 2nd holding company owned by: (i)

3. Does the business have a governance board?

If YES:

(a) How many board members does it comprise?

(b) How many board members are family?

(c) How many nonfamily (external) members

direct family ownership: _____%

family ownership:______%

______ family ownership:_____%

1.Yes 2.No

______________ *members* _________ *family members nominated* by the family are on the board?

4. Does the business have a management board?

If YES:

(a) How many persons does it comprise?

(b) How many management board members are family?

(c) How many nonfamily board members are chosen through them?

______ *nonfamily members* 1.Yes 2.No

_______________ *members family members*

_______ *nonfamily member*

***Part 2: The Experience Subscale***

• The founding generation is viewed as the first generation.

• Active family members are those who contribute substantially to the business. These individuals might hold official positions in the business as shareholder, board member, or employee.

1. Which generation(s) of the family owns the company?

2. Which generation(s) manage(s) the company?

3. What generation(s) is active on the governance board?

4. How many family members participate actively in the business?

5. How many family members do not participate actively in the business but are interested in the business?

6. How many family members are not at all interested (yet)?

_____________ generation ____________generation _____________ generation

_____________ members______________members ______________members

***Part 3: The Culture Subscale***

Please rate the extent to which: 1 = *Not at all* to 5 = *A large extent*.

1. Your family has influence on your business.

2. Your family members share similar values.

3. Your family and business share similar values.

Please rate the extent to which you agree with the following statements:

4. Our family members are willing to put in a great deal of effort beyond that normally expected to help the family business be successful.

5. We support the family business in discussions with friends, employees, and other family members.

6. We feel loyalty to the family business.

7. We find that our values are compatible with those of the business.

8. We are proud to tell others that we are part of the family business.

9. There is so much to be gained by participating with the family business on a long-term basis.

10. We agree with the family business's goals, plans, and policies.

11. We really care about the fate of the family business.

12. Deciding to be involved with the family business has a positive influence on my life.

13. I understand and support my family´s decisions regarding the future of the family business.

**Technological skills (Adapted from Zahra et al., 2007; α = .81):**

Please rate your company's skills in the following areas relative to your major competitor using the scale below. In rating your company's skills, please focus on the past 3 years.

- Skill in conducting applied R & D
- Ability to transform R & D results to products
- Skill to develop new products
- Ability to upgrade existing products
- Speed of new product/service development
- Efficiency in developing new products/services
- Efficiency in manufacturing your products/service
- Skill in manufacturing
- Overall technological skills

**Technological Capabilities (Adapted from Khin & Ho, 2019):**

Please indicate the level of your company's capabilities in the following areas:

- Acquiring important digital technologies
- Identifying new digital opportunities
- Responding to digital transformation
- Mastering the state-of-the-art digital technologies
- Developing innovative products/service/processes using digital technology

**Control scale (Adapted from Kellermanns et al., 2012; α = .90):**

For each item, compare your firm's performance to that of its competitors.

Firm performance

- Growth in sales
- Growth in market share
- Growth in the number of employees
- Growth in profitability
- Return on equity
- Return on total assets
- Profit margin on sales
- Ability to fund growth from profits

Financial performance

- < $1,000,000
- $1,000,001–$10,000,000
- $10,000,001–$50,000,000
- $50,000,001–$100,000,000
- $100,000,001–$500,000,000
- $500,000,001–$1,000,000,000
- > $1,000,000,000

Growth in employment for the firm over the past three years

- Zero or decreased
- < 2%
- 2%–3.99%

- 4%–5.99%
- 6%–7.99%
- 8%–9.99%
- > 10%