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Exploring the Nexus of Family Businesses Management: Technological Diversification and Exploratory AI Innovation

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ABSTRACT: This extensive research examines the complex relationship that exists among family management, technology diversity, and enterprise-wide exploration of Artificial Intelligence (AI) innovation. Family-managed enterprises, which are motivated by factors other than economic family interests and have a propensity to avoid risk, have characteristics that impede their participation in innovative AI endeavors. Various elements, including extended tenures of leadership, strong emotional ties to current assets, authority in decision-making, and deeply ingrained mental models, together contribute to a conservative stance that is resistive to the revolutionary possibilities that AI advancements provide. The research further emphasizes the crucial significance of technological diversification by defining a crucial differentiation between forms that are connected and those that are unrelated. Diversification into similar technologies may provide synergy possibilities; conversely, diversification into unrelated technologies adds costs, risks, and hinders the organization's capacity to respond to AI exploration. Additionally, the possible loss of control and the resulting need for external skills discourage family-managed enterprises from entering the ever-changing field of artificial intelligence. Amidst the rapid pace of digital development, it is crucial to comprehend the intricacies of technology diversification and family management. The study underscores the need of further inquiries into mitigating elements and exploring approaches that empower family-owned businesses to adapt to the changing requirements of AI innovation while maintaining their fundamental principles and socio-emotional well-being. The enduring success of such enterprises in the digital age will depend on their ability to uncover synergies between family-centric objectives and the ever-evolving potential of artificial intelligence (AI) while maintaining a delicate equilibrium between innovation and tradition.

KEYWORDS: family businesses management, technological diversification, AI, innovation

1. Introduction

Family businesses and, in particular, the management of their information systems have been significantly impacted by the digital transformation of organizations (Casson M. and C. Casson 2015), which is defined as the activities by which a company fundamentally transforms its business strategies, commercial processes, capabilities, products, and services, in addition to its key inter-business relationships in extended commercial networks. Analysts predict that between 2020 and 2023, "direct investment expenditure on

digital transformation [will surpass] $7.4 trillion." This impacts organizations of all sizes and in all industries. Digital technologies enable organizations to generate novel economic opportunities, therefore bolstering their long-term viability (Zellweger Nason, and Nordqvist 2012). Critical differentiating a high-performing organization from one that is less successful is the "effective" and efficient use of information technology. Notwithstanding its intermediate and enduring benefits, digital transformation presents substantial obstacles for organizations, mostly attributable to the need of constructing novel capabilities for the corporation. In an ever more digital world, for the family company to maintain its competitiveness, these obstacles must be effectively resolved.

These obstacles are especially pertinent to family companies, which are often privately owned, small to medium-sized, and managed by a single family or a restricted number of families, on account of their constrained resources. The current state of study on innovation management in family firms remains limited in both theoretical and empirical understanding of their approach to digital transformation and the subsequent creation of new capabilities.

The following research inquiries are prompted by this matter:

1. What is the operational mechanism of the digital transformation process inside family companies, and how can such enterprises use this process to cultivate the necessary capabilities?

2. What barriers and determinants impede or facilitate the digital transformation of family-owned enterprises, and by what means, and rationale do they facilitate or obstruct the building of essential dynamic capabilities?

As research on information systems has shown, the adoption of digital technologies by small and medium-sized enterprises (SMEs) varies from those of bigger companies and necessitates fresh theorization, it is critical to address these problems. A more comprehensive theoretical comprehension of the many phases of the digital transformation process would facilitate the identification of the diverse range of business environments in terms of their present level of digital adoption. To further conceptualize the digital transformation process, a more nuanced understanding of the skills needed along the process is also essential. In addition, it is imperative to ascertain barriers and enablers in the digital transformation process so that general management and information systems research can be integrated to gain a comprehensive understanding of how organizations attempt to implement digital technologies.

2. Embracing Industry: The Emergence of Innovative Technologies and Imperative for Digital Transformation

Industry has seen a diversity of developmental phases throughout the course of history. The most significant industrial revolution took place during the 18th century, when an economy reliant on industry, agriculture, and handicrafts was replaced by mechanized production in enormous factories. Throughout the nineteenth century, the second industrial revolution, sometimes referred to as the period of steam and electricity, persisted. Additionally, the era after World War II was characterized by tremendous development, which continues to this day with important scientific and technical advances (Mohajan 2019).

Primarily, scientific study has identified three business models in relation to Industry 4.0. The first option is a completely automated firm that prioritizes profit primarily; it is used for mass-produced consumer products across a limited number of product categories. The second model differentiates itself via its emphasis on advanced production customization, which entails the distribution of highly tailored items in limited numbers to meet the precise demands of individual consumers. E-factories represent the third business model, which prioritizes remote operations and individualization while aiming to achieve

cost competitiveness via minimal investment costs (Ibarra 2018). Nonetheless, Industry 4.0 extends beyond manufacturing-level enhancements to include distribution and buying as well. General Electric emphasizes the significance of integrating networked sensors and software with complex physical machinery and systems to improve market and social results (Calabrò, Brogi, and Torchia 2018). As the total of all innovations and implementations in a value chain addressing digitalization (Chen and Su 2023), empowerment, openness, mobility, modularization, network cooperation, and socializing of products and processes, Industry 4.0 may also be extended to the whole supply chain (Calabrò, Brogi, and Torchia 2018).

Industry 4.0 may furthermore include a collection of philosophies and technology designed to streamline the supply chain. The most critical, however, may be summed up as follows, considering documentary research: Examples of cyber-physical systems include the Internet of Things (IoT), smart factories, cyber-physical systems (CPS), and the Internet of Services. Over sixty breakthroughs pertinent to the term have been delineated by Brettel and colleagues; these advancements may be categorized into four groups: data and connections, research and artificial intelligence, human-computer interactions, and automated machinery fleet (Brettel 2014).

At various levels of value creation module aggregation and hierarchy, intelligent digitization is defined by networked production systems and vertical integration, which extend from manufacturing stations to cells, lines, and factories. The use of intelligent digital tools is an integral component of the implementation of an end-to-end solution using integrated information and communication technologies in the cloud.

The implementation of intelligent interaction in a manufacturing system is accomplished via the use of Cyber-Physical Systems (CPS), which function autonomously and without centralization. CPS leverages integrated mechatronic components, including actuator systems for regulating physical processes and sensor systems for gathering data, to establish intelligent connections and continuously exchange data over virtual networks akin to a real-time cloud. The infrastructure for the cloud is included inside the Internet of Things and Services. As an element of a sociotechnical system, CPS engage in human-machine interface interactions with operators.

The Internet of Things (IoT), conversely, is among the most swiftly embraced advancements within the context of Industry 4.0. It pertains to the ability of entities to retain, manipulate, distribute, or swap information via network links, whether explicit or implicit. This technology has the benefit of not being factory-centric; rather, it mostly manifests itself in distribution, including customer service and object use.

From a macro viewpoint, Industry 4.0 represents a more extensive kind of horizontal integration. As it is founded on a product lifecycle perspective, visualization is crucial to the value generation networks of Industry 4.0. From a macro viewpoint, horizontal integration is distinguished by a network of value generating modules. The modules in question symbolize the interplay among various value-generating elements, including goods, gadgets, human capital, operations, and procedures. Throughout the product lifecycle value chain, value production modules are linked; at the greatest level of aggregation, these modules are represented by factories; in neighboring value chains of the product lifecycle, comparable kinds of modules are located. This linkage initiates an intelligent network of value generation modules that span various phases of the product lifecycle and include value chains. The intelligent network now changing conventional business tactics by fostering an atmosphere that is receptive to the development of novel company models. The end-to-end engineering approach, which falls under the same macro view, examines the whole product lifetime, from the procurement of raw materials to the end-of-life phase. It functions as an intermediary between the product, equipment, and actors.

Various entities (customers, staff, suppliers, and so on), products, and manufacturing equipment will be included into a virtual network, where data exchange will take place at every phase of a product's life cycle. The lifespan of a product has many stages: raw material acquisition, production (including product design, production system engineering, and manufacturing), consumption and service, end-of-life (which includes reuse, recycling, recovery, and disposal), and transit between each step. Also included in this phase are transfers between all tiers (Chukalov 2017). These sophisticated data flows will transform industries into so-called "smart factories." Smart factories are powered by intelligent networks and produce intelligent goods. Material flow will be facilitated by intelligent logistics throughout the whole product lifetime and across adjacent lifecycle phases. The intelligent data flow between various components of Industry 4.0 value network systems is sent over the cloud.

Smart data is produced by the intelligent structure of Big Data information, which is then used to enhance knowledge and make decisions throughout the product lifetime (Chirico and Salvato 2008). Smart factories use integrated cyber-physical systems to generate value (CPS). This allows the intelligent producer to decentralize and distribute critical production processes around the plant via the exchange of intelligent data with CPS. The intelligent product is equipped with data pertaining to its production process and equipment requirements. CPS is used by intelligent logistics to oversee the movement of materials inside and between the manufacturer, the customer, and other stakeholders. In addition, they are decentralized according to product specifications, with a smart network tailoring manufacturing from suppliers to end-users in real time. Conversely, the micro viewpoint of Industry 4.0 pertains primarily to the horizontal and vertical integration of intelligent manufacturing facilities, while also being an element of comprehensive engineering. As a value creation module, the smart factory at the highest aggregation level comprises many value creation modules situated at lower aggregation levels, including production lines, manufacturing cells, and production stations. The intelligent network and management system of the smart factory must adapt to changing production and supply requirements.

Horizontally connected with value creation modules throughout the material flow of the intelligent factory, which also incorporates intelligent logistics, is the micro view. As part of intelligent logistics, incoming and departing commercial logistics will be distinguished by transport equipment that can operate independently between the point of origin and destination and react quickly to unanticipated occurrences, such as traffic or weather conditions. In pursuit of internal transit throughout the material flow, automated guided vehicles and other forms of autonomous transport equipment will be implemented. To enable decentralized coordination of goods and supplies from transport networks, value creation modules are used by every transport equipment to share intelligent data. Products and supplies are equipped with identifying technologies, such as RFID chips or QR codes, for this purpose. This enables monitoring and wireless identification of all materials across the value chain. Vertical integration and networked manufacturing systems refer to the intelligent articulation of value factors, equipment, human resources, and products, as well as the various aggregation levels of value generating modules between production stations and the smart factory. Cross-articulation of value creation modules with diverse value chain activities entails interconnections across several aggregation levels, such as marketing, sales, service, and procurement, among others.

3. Revolutionizing Family Businesses: Digital Transformation Across Industries

Continuous renewal via innovation may drive the performance and expansion of firms, according to experts. However, the competencies that businesses need to innovate

successfully during times of technological transition and how these qualities might be cultivated remain a matter of controversy (Chen and Su 2023). Scholars investigating business innovation capabilities (Chen and Su 2023) during such periods place significant emphasis on the criticality of organizational resources, the necessity to confront the disruptive characteristics of technology, and the capacity to adapt effectively to technological advancements while preserving fundamental operations. The pervasive impact of technology on companies and innovation specifically makes this discourse especially pertinent in the context of digital technologies (Steininger 2019).

Commencing digital transformation via the use of digital technologies—comprising binary-number-based approaches, competencies, and procedures—promises benefits to enterprises while concurrently introducing obstacles. Organizations have the potential to grow income and decrease expenses via the use of digital technology, generate value for the company through the introduction of novel business models, and attain a competitive edge. Conversely, implementing digital technology is a protracted and expensive endeavor, accompanied with indeterminate results that need some time to manifest.

A comprehensive comprehension of digital transformation is especially vital for family companies, given their substantial economic impact as well as the unique resource limits and peculiarities that may impede the process. The existing body of research has highlighted the distinctions between family firms and their non-family equivalents, with particular emphasis on the owner-position manager's and the resources at their disposal. This may lead to variations in the way family companies undergo digital transformation. One encouraging aspect is that a recent meta-analysis.

Family businesses exhibit greater efficacy in their innovation endeavors compared to non-family enterprises (Casson 2015). This superiority can be attributed to several factors, including the personal investment and dedication of their owners and managers, their long-term focus (Zellweger, Nason, and Nordqvist 2012), minimal bureaucratic procedures, tacit expertise, and a devoted community comprising employees, suppliers, and customers. Nevertheless, scholars underscore the fact that although family-owned enterprises could flourish in incremental innovation, they have difficulties when faced with more revolutionary forms of innovation, such as digital transformation. The aforementioned obstacles are attributable to their particular risk-taking conduct, which consists of a preference for self-financing and an aversion to the loss of socio-emotional wealth (Berrone, Cruz, and Gomez-Mejia 2012); these behaviors restrict the resources that these companies may allocate towards innovation (Chua, Chrisman, and Sharma 1999).

With respect to the consequences of digital technology implementation in small and medium-sized firms (SMEs), previous studies have shown that digitization may facilitate complementarity within innovation networks (Chen and Su 2023) and that cloud technologies can inspire an entrepreneurial mindset among SMEs. Additionally, prior studies have shown findings that support the notion that manufacturing SME adoption of digital technology might provide significant advantages. In brief, study results are almost uniform in their agreement that family companies may benefit from the use of digital technology. It is worth mentioning that most of the research have isolatedly concentrated on certain facets (such as particular drivers, results, or digital technology) of the digital transformation process. Consequently, the most research designs discovered have been cross-sectional in nature. As a result, we were unable to locate a study that provided a full examination of the digital transformation process inside family companies. In the realm of theorization, a substantial body of peer-reviewed literature has been devoted to the application of theoretical frameworks connected with (dynamic) capabilities and ideas that are intricately linked, such resource-based view and adaptability. More specifically, these publications contend that to effectively use digital technology, organizations must first reconfigure their resources and enhance their competencies.

Dynamic capabilities, which are based on the evolutionary theory of the firm, have the potential to accurately mirror and direct the digital transformation endeavors of organizations. Operational capabilities refer to the functional capacities necessary for conducting daily routine tasks. On the other hand, dynamic capabilities comprise a collection of distinct and processes or routines that demonstrate "possible adaptations to external environments marked by abrupt or sudden changes." These capabilities include strategic decision-making (Sharma, Chrisman, and Chua 1997), learning routines, and alliances. Capabilities can be broadly categorized into three activities: detection, seizing, and transforming. Detection pertains to the identification and development of technological opportunities; seizing concerns the mobilization of an organization's resources to capitalize on these opportunities; and transforming concerns the ongoing renewal of the organization.

Particularly for family enterprises and SMBs, size restrictions may need distinctive (dynamic) capabilities (De-Massis 2016). Family businesses have unique dynamic capabilities, such as the ability to "internalize and reinterpret past knowledge" and the veto power in decision-making processes. Dynamic capabilities known as "fraternizing" and "imbuing" can aid family businesses in acquiring and transferring knowledge with business partners in a collaborative setting (Chirico and Salvato 2008; Casson 2015). In contrast, inflexible mental models and emotional attachments to current assets may impede the growth of (dynamic) capacities connected with the transformation of existing assets in family enterprises. Moreover, the hesitancy of family-owned enterprises to embrace technology developed outside suggests challenges in cultivating dynamic competencies linked to strategic cooperation and operation. Typically, the limited availability of resources inside family-owned enterprises might hinder the growth and progress of substantial dynamic capacities (Sharma, Chrisman, and Chua 1997).

Within the framework of digital transformation, information technology capabilities—which are defined as the "capacity to mobilize and deploy IT resources"—along with other capabilities—improve the cost-effectiveness and overall performance of organizations, particularly when the company possesses the requisite dynamic capabilities to effectively leverage them. Put simply, dynamic skills have the potential to assist organizations in initiating "a wide range of competitive activities," which are thereafter a "substantial predictor of firm success."

Nonetheless, the conventional assessment of (dynamic) capabilities is merely a momentary glimpse that fails to unveil a comprehensive comprehension of the precise capabilities required, the way these capabilities evolve during the digital transformation endeavor, or their interplay with both internal and external influencing factors. Additionally, the catalysts and impediments to the development of this skill are yet largely unknown. Moreover, there exists a dearth of understanding about the precise high-level skills that are pertinent to digital transformation, although the widespread agreement that dynamic capabilities constitute a substantial determinant in the process of corporate digital transformation.

4. AI as the Core of the Digital Transformation Era

Artificial intelligence (AI) is a swiftly advancing and disruptive technology advancement that broadens the domain of traditional intelligence by facilitating information processing and inter-intelligent system communication. As a result, AI is seen as a fundamental element and catalyst of the ongoing digital revolution in the business sector. AI serves as the driving force behind the fourth industrial revolution (Industry 4.0), facilitating transformations in the characteristics of systems and information that provide fresh opportunities to reassess foundational business paradigms (Chen and Su 2023). Prominent instances include the capacity to promote intelligent and interconnected solutions, enhance

the synchronization of processes centered on supply and demand, and incorporate digital services into operational company operations. In addition, it is anticipated that artificial intelligence will erode the distinctions between technology and non-technology enterprises, creating prospects and challenges for established and emerging firms alike, thereby transforming the worldwide competitive environment.

Despite these forecasts and anticipations, substantial investments in AI are dangerous and, as such, have not yet been completely implemented. This is especially true when the objective of these investments is to develop innovative AI solutions, in which monitoring, control, and optimization are marketed as novel product attributes that potentially coincide with innovation (Chen and Su 2023). Undoubtedly, the task of designing organizations that specialize in delivering AI solutions is exceptionally intricate. This is primarily due to the potential diversity and variety of data types, the lack of substantial interface standardization, and the challenge of forecasting the innovative company's integration into the ever-evolving AI and Industry 4.0 ecosystem (Westerlund 2014). As a result, managers have difficulties in staying abreast of the rapid technical advancements in AI products and in strategizing the corresponding investments in R&D.

This difficulty is further compounded by the fact that organizations frequently encounter the subsequent paradox: integrating offerings of products and services or developing entirely new purposes for existing products (e.g., disruptive business models replacing the traditional product purpose) while simultaneously incorporating additional features into existing products via exploitation innovation activities (e.g., operational innovation activities). The paradox at hand pertains to the correlation between AI innovations and a company's understanding of its current products (Doe and Hinson 2023). To the degree that organizations are compelled to augment established core competencies with novel technological proficiencies to generate value through AI investments while mitigating risks and shortening time to market. Understanding the factors that can effectively facilitate or impede a company's development of AI solutions is crucial and urgent, especially given the potential for tensions to arise when a company invests in and commits to AI innovation development and must choose between deviating from its current knowledge base and continuing along current R&D trajectories (Chen and Su 2023).

In conclusion, it is crucial to acknowledge the significance of understanding technologies that complement artificial intelligence and are vital in creating the industry 4.0 movement (e.g., the Internet of Things, cloud computing, robots, big data structures, etc.). Increasingly, it is recognized that AI innovations necessitate the concurrent management of various complementary technological domains, many of which are of a general nature (e.g., IoT and cloud computing) and not always well-established in mature markets (Doe and Hinson 2023; Lannon, Lyons, and O'Connor 2023). Therefore, a company's technological diversification gains greater explanatory power when tensions between deviating from the company's existing knowledge base and maintaining continuity with current R&D trajectories are analyzed (Chirico and Salvato 2008). This enables one to determine whether the top management team facilitates or hinders the emphasis on exploratory/explanatory innovation activities in the AI domain (TMT). Technological diversification pertains to the company's capacity to effectively manage a wide range of technological expertise, as it signifies the extent of its technological foundation. However, it may have drawbacks that impede the management team's goal to participate in innovation activities rather than encourage them (Chen and Su 2023).

5. Pioneering AI: Innovation and Family-Driven Management

Family enterprises, which are defined as organizations in which a family member has discretionary authority to manage, allocate, add, or dispose of the company's resources in

strategic projects based on the family, are pervasive in the global economy. These companies are now at the center of academic and policy discussions due to their significance, with a special focus on the intricate and well-defined impacts that family-specific elements have on innovative endeavors (Chrisman 2006). In fact, familial participation in organizations having family participation in management, governance (Le Breton-Miller and Miller 2006), and ownership exhibit unique patterns of innovative behavior in comparison to those that do not (Chua, Chrisman, and Sharma 1999). The top management team (TMT) symbolizes the highest levels of a family business. Their pivotal position in the family business literature is indisputable, as they represent the "most significant intersection between family and business." As a result, differentiations are drawn between companies that incorporate family members into the TMT (i.e., family management) and those that do not, specifically about innovation performance, albeit yielding inconsistent outcomes (Chen and Su 2023).

One perspective posits that family participation in the TMT grants companies access to scarce and distinctive resources, which, when coupled with a more steadfast commitment to the long term (Zellweger, Nason, and Nordqvist 2012), intensified personal investment, and enhanced managerial oversight, may ultimately augment the organization's capacity to adapt to technological advancements and, ultimately, foster innovation (Chen and Su 2023).

Family managers, by virtue of their extensive tenure with the organization, consider the business to be an intrinsic component of themselves. Consequently, managerial focus is directed towards non-economic goals that revolve around the family. This orientation towards the family results in a tendency to safeguard the socio-emotional wealth of the family (Gomez-Mejía 2001; Berrone, Cruz, and Gomez-Mejia 2012). As a result, family managers adhere to conservative strategic behaviors to protect their socio-emotional wealth (Chua, Chrisman, and Sharma 1999; Sharma, Chrisman, and Chua 1997). These behaviors involve avoiding risky innovation projects that may jeopardize their socio-emotional wealth priorities, such as preserving family control, even when potential economic benefits are present (Chen and Su 2023). Nevertheless, most of these explanations fail to account for the diversity of innovation that family-managed enterprises foster; hence, further study on the relationship between family management and innovation performance is required (Berrone, Cruz, and Gomez-Mejia 2012).

In particular, the digitalization megatrend, which may be an additional source of disruption for family-managed enterprises, has heightened tensions and uncertainty over choices to conduct exploratory/explanatory innovation efforts. The attributes of senior executives that influence the development of exploratory or explanatory AI technologies remain unexplored in this setting. As a result, the link between family management and AI innovation is investigated in this research.

Several attributes of TMT-affiliated family-owned businesses impact the organization's determination to create AI advancements. Initially, family managers often prioritize non-economic objectives that revolve around the family, such as family social standing and harmony (Calabrò, Brogi, and Torchia 2018), which are comparatively less linked to a propensity for taking risks. When combined with a concentrated ownership and decision-making process, this characteristic leads to an increased aversion to risk. Thus, family managers are likely to exercise more prudence and conservatism in their investment selections compared to managers of publicly traded companies. AI is distinguished by its extensive technical intricacy, which encompasses a wide range of protocols and technologies, a broad selection of devices, compatibility with several general-purpose digital technologies, and the participation of numerous players that need coordination. Developing defined R&D strategies or digital business models and assessing the state of the art in AI advancements are difficult tasks due to this complexity. As a result, the advancement of artificial intelligence advances could entail notably elevated levels of

danger. Family leaders, by nature, prioritize non-economic objectives that revolve on the family. Consequently, they often exhibit a heightened sensitivity to risk and favor exploitation over exploration, given that the rewards of exploitation are more immediate, assured, and convenient. Furthermore, family-affiliated executives often serve on the board for longer terms (Zellweger, Nason, and Nordqvist 2012), which ensures a more consistent progression of the company's innovative endeavors. This continuity may inhibit AI research in organizations whose family members have held TMT positions for an extended period, since it necessitates the investigation of novel innovation paths, which eventually disrupts existing innovation routines (Chen and Su 2023). Furthermore, family members exhibit more profound emotional attachments to established assets, since family leaders have a heightened sense of emotional connection to the business's environs and its current resources. These linkages to current assets impede family-owned enterprises' exploratory efforts. Certain organizations, such as software technology businesses, may see the development of AI advancements as exploitative. However, it is worth noting that for those not working in the software industry, pursuing AI advances may be considered an experimental undertaking.

To sell AI advancements, businesses may be required to develop new business models and digital ecosystems; this may make old assets useless. Therefore, it is imperative that they reassess "virtually every aspect of their operations, including sourcing, manufacturing, conceptualizing, designing, and constructing products, as well as operating, maintaining, and establishing the requisite IT infrastructure." This raises the following query: "Where am I focused my efforts?" Consequently, the emotional attachments of a family leader to established ecosystems and tangible and intangible assets will hinder their inclination to innovate concerning exploratory AI. Therefore, it is anticipated that an increased quantity of family members in the TMT will be linked to more inflexible cognitive frameworks and regional inquiry, impeding the progress of AI innovations that shrewdly diverge from established product concepts and business models (Doe and Hinson 2023). Organizations with more substantial family ownership are less receptive to the input of external stakeholders in the decision-making process. Nevertheless, participation in artificial intelligence innovation endeavors frequently alters the allocation of decision-making authority (Chen and Su 2023).

Family members in TMTs are distinguished by their emphasis on non-economic family-oriented objectives, longevity (Zellweger, Nason, and Nordqvist 2012), emotional attachment to current assets, decision-making authority, and inflexible mental frameworks. These attributes may discourage companies from embracing innovations that are too far removed from the organization's current technological foundation. Our contention is that these attributes are especially pertinent when considering IoT innovations, given the unique challenges they present (Chen and Su 2023).

To begin with, artificial intelligence (AI) possesses the capacity to fundamentally alter the process of product design, thereby presenting novel avenues for value creation, delivery, and capture. As previously stated, AI engenders more intricate ecosystems due to the substantial volume of data exchanged among numerous actors and stakeholders engaged in value creation endeavors. In general, emerging AI ecosystems are disorderly, chaotic, and complex, necessitating the establishment of novel relationships, coordination of participants, and definition of positions within the ecosystem.

Furthermore, analogous to digital technologies, artificial intelligence (AI) exhibits an exponential growth trajectory. Moreover, in its capacity as a swiftly expanding industry, AI provides unparalleled and "virtually infinite" methods of integrating data to improve the process of decision-making. In a realm where combinatorial possibilities are exponentially multiplying, the task is to identify genuinely intriguing prospects, and expeditiously

managing options becomes the most significant limitation. These two developments underscore the critical nature of adoption speed.

Furthermore, artificial intelligence (AI) is a swiftly advancing technology, which implies that even outdated AI solutions may be enhanced. Data obtained from various sources frequently possesses distinct technical characteristics and specifications. Investments in AI innovations are arduous and risky due to the absence of interoperability and apprehensions regarding security and privacy. Family-managed businesses are prone to a greater aversion to risk, which ought to discourage them from engaging in exploratory AI initiatives (Doe and Hinson 2023; Lannon, Lyons, and O'Connor 2023).

Prior studies have also emphasized the substantial influence that a firm's degree of technological diversification has on its exploration and exploitation endeavors. An organization's inclination to discover novel solutions is influenced by its access to and exposure to a variety of alternative technological knowledge domains (Chirico and Salvato, 2008). Furthermore, technological diversification results in reduced exploration expenses compared to a specialization strategy and expedites the identification of fresh research and development prospects. Consequently, its effect on exploration is substantial. However, in organizations where the family has a significant stake in the TMT, an excessive degree of technology variety might impede exploratory innovation endeavors (Chen and Su 2023), including those related to artificial intelligence (Allioui 2022).

To begin with, the implementation of technological diversification necessitates an escalation in research and development expenses that the family may not be able to entirely finance. Consequently, family leaders are compelled to pursue external capital against their will (e.g., by going public or assuming bank debt), thereby jeopardizing the company's control over shareholders and banks.\furthermore, an extensive technological diversification mandates a restructuring of the operations and routines of family-managed businesses, which may incite reluctance among family members.

As the R&D costs of increased technological diversification add to the costs of entering the AI domain, these issues of (enforced) diversification are likely to be especially pertinent when exploratory AI development is undertaken. The necessity to reshape the company because of technological diversification exacerbates the radical changes that result from digital transformation, and the challenge of prioritizing R&D activities and selecting the best ideas is further compounded.

Diversification risks associated with technological diversification are likely to be especially detrimental to family-managed businesses, which tend to protect the socio-emotional wealth of the family and concentrate on their core business. As a result, these businesses innovate "in technological areas adjacent to their existing technological platforms." Consequently, family businesses' inclination to maintain control within the family will outweigh their inclination to engage in riskier innovations (Berrone, Cruz, and Gomez-Mejia 2012; Allioui 2022).

6. Navigating the Influence of Technological Diversity: Exploring Related and Unrelated Moderating Effects

The risk mechanisms linked to technological diversification that bolster the adverse impact of family management on the development of remote AI innovations (Doe and Hinson 2023) were identified in the preceding section. Nevertheless, prior research has indicated that a more nuanced approach may be necessary to comprehend these mechanisms that contribute to the consequences of technological diversification. In line with early investigations into the extent of a firm's operations, scholarly discourse on technological diversification has evolved (Chen and Su 2023).

Despite the limited empirical research that presently exists on the subject, the subsequent attributes of related and unrelated technological diversification have been discerned. Research has demonstrated that technological advancements that gravitate towards non-related forms of technological diversification are especially perilous, given the high degree of technological uncertainty associated with such a strategy.

These arguments posit that the adverse impact of technological diversification on the correlation between family management and investments in exploratory AI innovations is attributable to unrelated technological diversification. The inclination to conceive entirely new AI products is diminished, specifically in relation to the heightened risk associated with unrelated technological diversification. Organizations whose family leaders initiate the process of diversifying their underlying technologies are more likely to experience this negative effect.

Furthermore, the organization faces the potential peril of relinquishing control over its strategy to safeguard the family legacy due to the heightened requirement for fresh personnel resulting from unrelated technological diversification. These considerations, in conjunction with the organization's inclination to evade (technological) uncertainty, which is a significant component of unrelated technological diversification, indicate that unrelated technological diversification adversely impacts development.

7. Conclusion

In summary, the comprehensive examination underscores the complex correlation among technological diversification, family management, and the endeavor to pioneer exploratory AI in the business sector. Family-owned enterprises, motivated by a preference for risk aversion and a preoccupation with socio-emotional wealth (Berrone, Cruz, and Gomez-Mejia 2012), demonstrate inclinations that impede involvement in exploratory AI undertakings. Factors such as the tenure of family leaders, emotional attachments to current assets, decision-making authority, and inflexible technological horizons.

Moreover, the influence of technological diversification, particularly when it comes to unrelated forms, becomes a crucial moderating element. Although synergy opportunities may arise from related technological diversification, unrelated technological diversification escalates risks, costs, and hinders the organization's capacity to adopt AI exploration. Additionally, family-managed businesses are deterred further by the associated requirement for external talent and the potential loss of control.

Considering the swift digital transformation occurring in the business environment, it is critical to comprehend the intricacies of family management and technological diversification. Subsequent investigations should further examine factors that mitigate the challenges and devise approaches for family-managed enterprises to effectively navigate the evolving requirements of AI innovation while safeguarding their fundamental values and socio-emotional well-being. Striking a balance between innovation and tradition continues to be a significant obstacle.

References

Berrone, Pascual, Cristina Cruz, and Luis R. Gomez-Mejia. 2012. “Socioemotional wealth in family firms: Theoretical dimensions, assessment approaches, and agenda for future research.” *Family Business Review* 25(3): 258-279.

Brettel, Malte, Niklas Friederichsen, Michael Keller, and Marius Rosenberg. 2014. “How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 Perspective.” *International Journal of Information and Communication Engineering* 8(1): 37-44.

Calabrò, Andrea, Brogi, M., and Torchia, Mariateresa. 2018. “Socioemotional wealth, family commitment, and the family firm's engagement in corporate social responsibility.” *Journal of Business Ethics* 148(3): 567-585.

Casson, Mark, and Catherine Casson. 2015. "The family business in history." *Business History* 57(1): 1-22.
Chen, Hui, and Wangshu Su. 2023. "Innovation and application of enterprise's supply chain management mode under the background of Industry 4.0." *International Journal of Technology Management* 91(1-2): 19-38.
Chirico, Francesco, and Carlo Salvato. 2008. "Knowledge integration and dynamic organizational adaptation in family firms." *Family Business Review* 21(2): 169-181.
Chrisman, James J., Lloyd P. Steier, and Jess H. Chua. 2006. "Personalism, particularism, and the competitive behaviors and advantages of family firms: An introduction." *Entrepreneurship Theory and Practice* 30(6): 719-729.
Chua, Jess H., James J. Chrisman, and Pramodita Sharma. 1999. "Defining the family business by behavior." *Entrepreneurship Theory and Practice* 23(4): 19-39.
Chukalov, Konstantin. 2017. "Horizontal and vertical integration, as a requirement for cyber-physical systems in the context of industry 4.0." *Industry 4.0* 2(4): 155-157.
De Massis, Alfredo, Philipp Sieger, Jess H. Chua, and Silvio Vismara. 2016. "Incumbents' attitude toward intrafamily succession: An investigation of its antecedents." *Family Business Review* 29(3): 278-300.
Doe, Joshua Kofi, and Robert E. Hinson. 2023. "AI-driven sustainability brand activism for family businesses: a future-proofing perspective article." *Journal of Family Business Management.*
Gomez-Mejia, Luis R., Manuel Nunez-Nickel, and Isabel Gutierrez. 2001. "The role of family ties in agency contracts." *Academy of Management Journal* 44(1): 81-95.
Ibarra, Dorleta, Jaione Ganzarain, and Juan Ignacio Igartua. 2018. "Business model innovation through Industry 4.0: A review." *Procedia Manufacturing* 22: 4-10.
Lannon, Finn, Roisin Lyons, and Christina O'Connor. 2023. "Generation AI and family business: a perspective article." *Journal of Family Business Management.*
Le Breton–Miller, Isabelle, and Danny Miller. 2006. "Why do some family businesses out-compete? Governance, long-term orientations, and sustainable capability." Entrepreneurship Theory and Practice 30(6): 731-746.
Miller, Danny, and Isabelle Le Breton-Miller. 2006. "Family governance and firm performance: Agency, stewardship, and capabilities." *Family Business Review* 19(1): 73-87.
Mohajan, Haradhan Kumar. 2019. "Knowledge sharing among employees in organizations." *Journal of Economic Development, Environment and People* 8(1): 52-61.
Sharma, Pramodita, James J. Chrisman, and Jess H. Chua. 1997. "Strategic management of the family business: Past research and future challenges." *Family Business Review* 10(1): 1-35.
Steininger, Dennis M. 2019. "Linking information systems and entrepreneurship: A review and agenda for IT-associated and digital entrepreneurship research." Information Systems Journal 29(2): 363-407.
Westerlund, Mika, Seppo Leminen, and Mervi Rajahonka. 2014. "Designing business models for the internet of things." *Technology Innovation Management Review* 4(7): 5–14.
Zellweger Thomas Markus, Robert S. Nason, and Mattias Nordqvist. 2012. "From long-term aspired to transitory goals: The role of human capital in family business." *Journal of Family Business Strategy* 3(4): 239-250.