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Inertia or Adaptability? The Effects of Outside Director Incumbency Capital on Incumbent Firms' Adoption of Discontinuous Technologies

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ABSTRACT

We fuse research on incumbents' adaptation to discontinuous technologies with board capital theory to investigate how heterogeneity in incumbent firms' adoption of discontinuous technologies may be affected by what we label as outside director incumbency capital—the specific subset of social capital and human capital that outside directors possess due to their educational, professional, and social exposure to and entrenchment in the established technological paradigm. We predict two opposing effects: Outside director incumbency social capital will be positively associated and outside director incumbency human capital will be negatively associated with the speed and aggressiveness of discontinuous technology adoption. We further hypothesize that the two types of outside director incumbency capital interactively affect adoption speed and aggressiveness. We find support for most of our hypotheses in 1111 firm-year observations of 75 incumbent US retail firms and their adoption of e-commerce between 1995 and 2019. Our research offers partially counterintuitive insights into how outside directors' human and social capital differentially affect discontinuous technology adoption. Thereby, we add new facets to the research on incumbent heterogeneity and the emerging nuanced view of board capital, innovation, and firm adaptability. Altogether, bridging the strategic leadership perspective on incumbent heterogeneity and existing board-level research innovation, our study connects two important but previously disconnected conversations at the nexus of strategic leadership, governance, and innovation.

1 | Introduction

Research on innovation management and organizational adaptation has long been captivated by "incumbent heterogeneity" (Eggers and Park 2018, 359)—the phenomenon that established firms respond differently to emergent discontinuous technologies. Discontinuous technologies are "novel, path-divergent, paradigm-challenging concepts of value creation and value capture" (Graf-Vlachy et al. 2023, 3). Although incumbents—that is, the established firms whose technological paradigm is undermined by the focal discontinuous technology (Benner 2007)—tend to be notoriously paralyzed by inertia, some deviate from that pattern and adopt the technology quickly and aggressively (Gilbert 2005; Gerstner et al. 2013).

A rich body of scholarship has studied incumbent heterogeneity from a strategic leadership perspective (Kurzhals et al. 2020). Particularly, this research seeks to understand how discontinuous technology adoption is shaped by the characteristics of incumbents' Chief Executive Officer (CEO) and other members of the Top Management Team (TMT) (Maula et al. 2013; Eggers and Kaplan 2009). Because discontinuous

Summary

- Incumbency capital is a double-edged sword: Outside directors' incumbency social capital (i.e., social ties within the legacy industry and elite networks that historically co-emerged with a focal technology) can facilitate quicker and bolder adoption of discontinuous technologies by helping incumbents gain legitimacy and stakeholder support.
- In contrast, outside directors' incumbency human capital (i.e., cognitive entrenchment in the established technology and a lack of knowledge related to the discontinuous technology) can foster cognitive rigidity and, in turn, slow down and dampen an incumbent's discontinuous technology adoption.
- The positive (negative) effects of outside directors' incumbency social (human) capital dynamically reinforce each other.
- Appointing outside directors with strong ties in the old "social world," but limited ties in the old "thought-world" may improve firms' adaptability to technological disruptions.
- In times of discontinuous technological change, boards and shareholders should carefully consider the composition of the group of outside directors, balancing legacy ties for stakeholder legitimacy with openness and exposure to emerging technological paradigms.

technologies involve extreme uncertainty, their adoption requires incumbents to depart dramatically from their established innovation trajectories and to radically alter central processes and structures (Anderson and Tushman 1990; Christensen 1997; Christensen et al. 2018; Danneels 2004). As such, discontinuous technologies create precisely the context in which strategic leaders and their characteristics—for example, narcissism (Gerstner et al. 2013) and emotional abilities (Vuori and Tushman 2024)—shape organizational outcomes (Hambrick and Mason 1984).

Research increasingly suggests that also the nonexecutive board members—the so-called *outside directors*—may influence incumbent heterogeneity (Kurzhals et al. 2020; Sierra-Morán et al. 2024). Outside directors are the dominant governance structure in many firms, particularly in the Anglo-American legal domain (Boivie et al. 2016). In fact, 85% of directors on S&P 500 firms' boards are outside directors (Spencer Stuart 2024), and the CEO is often the only executive "inside" board member (Boivie et al. 2016). Given their specific tasks, relative independence from the firm, and formal and informal influence on the TMT (Boivie et al. 2021), outside directors strongly affect strategic renewal and innovation in idiosyncratic ways (Dalziel et al. 2011). Particularly, outside directors advise strategic innovation initiatives (Klarner et al. 2023), stimulate TMT reflection (Pugliese et al. 2009), and provide resources such as legitimacy and external ties (Haynes and Hillman 2010). In this vein, studies have shown that outside directors' characteristics influence firm-level outcomes closely related to technology adoption (Genin et al. 2023; Kor and Sundaramurthy 2009; Kor and Misangyi 2008; Westphal and Fredrickson 2001; Balsmeier et al. 2014). For example, Oehmichen et al. (2017) have demonstrated that outside directors with greater industry expertise drive strategic change, and Li (2019) showed that firms explore new technologies more extensively the more interlocking board positions are held by their outside directors.

However, despite these achievements, current research on outside directors' role in technology adoption remains theoretically limited in that only a few studies consider the unique nature of discontinuous technological change (Kurzhals et al. 2020). Notably, the core assumption underlying the research on discontinuous technologies is that they depart so fundamentally from continuous technological change—undermining established business models, industry structures, and institutions (Weber et al. 2019; Tushman and Anderson 1986)—that it is almost inherently inaccurate to simply generalize theory on continuous technologies to discontinuous technologies (Dosi 1982). Hence, explanations of outside directors' role in discontinuous technology adoption *inherently* require idiosyncratic theory. For example, the same expertise and ties that allow outside directors to spur a firm's continuous technological change may prove less valuable—or even counterproductive—for discontinuous change (Leonard-Barton 1992). Yet, as evidenced in recent reviews (Eggers and Park 2018; Kurzhals et al. 2020; Christensen et al. 2018), the necessary idiosyncratic theory is largely missing. In fact, we are only aware of two qualitative, tangentially related studies on boards and innovation—Hoppmann et al. (2019) and Morais et al. (2020)—that explicitly recognize the uniqueness of discontinuous change.

In this article, we thus address the overarching research question of "How do outside directors' characteristics affect incumbents' adoption of discontinuous technologies?" Following previous research, we focus on adoption speed and adoption aggressiveness, in other words, how swiftly and boldly an incumbent embraces a discontinuous technology (König et al. 2013). Our theorizing integrates board capital theory (Hillman and Dalziel 2003), the "barrier" approach to incumbent adaptation (Eggers and Park 2018), and Leonard-Barton's (1992) notion that, under conditions of discontinuous change, core capabilities (or capital) can become core liabilities. On this basis, we examine what we label as *outside director incumbency capital*—defined as the specific subset of outside directors' social and human capital that they have accumulated through their educational, professional, and social exposure to and entrenchment in the established technological paradigm that is challenged by a discontinuous technology (König et al. 2012). We distinguish between two types of outside director incumbency capital: *Outside director incumbency social capital* denotes outside directors' embeddedness in the business environment and social elites that have co-evolved with the established technological paradigm (Kor and Sundaramurthy 2009; Hillman and Dalziel 2003), and *outside director incumbency human capital* encompasses the knowledge structures (Walsh 1995) outside directors have internalized through their exposure to the established technology and through a lack of exposure to knowledge structures foundational to the discontinuous technology (Tripsas and Gavetti 2000).

We propose opposing effects of the two types of outside director incumbency capital. Invoking the idea that an incumbent's discontinuous technology adoption requires particularly high levels of legitimacy among established stakeholders (e.g., Benner 2007), we argue that outside director incumbency *social* capital is positively associated with both speed and aggressiveness of adoption. Conversely, drawing on the notion that established knowledge structures are inherently dysfunctional for making sense of and commercializing a discontinuous technology (Tripsas and Gavetti 2000), we suggest that incumbency *human* capital will be associated with slower and less aggressive adoption. Finally, we hypothesize that outside directors' incumbency human capital weakens the positive effects of their incumbency social capital, whereas outside directors' incumbency social capital exacerbates the negative effects of their incumbency human capital. Analyzing 1111 firm-year observations of 75 US incumbent retailers' adoption of e-commerce between 1995 and 2019, we find support for most of our hypotheses.

Our study makes three central contributions. First, focusing on the characteristics of outside directors, we present and empirically scrutinize a board-level perspective on incumbent heterogeneity (Eggers and Park 2018; Christensen et al. 2018). This perspective is vital as outside directors likely affect discontinuous technology adoption in unique ways compared to the TMT. Second, by focusing on outside director incumbency capital, we highlight a specific domain of board capital that affects discontinuous technology adoption in ways that challenge existing theories on outside directors and technological change. In particular, we show that directors' social ties in the "old world" may—contrary to their textbook portrayal as a source of inertia—benefit the transition to the "new world" (Benner 2010; Graf-Vlachy et al. 2023). Third, showing how outside director incumbency human capital becomes a liability that protracts organizational adaptation, we contribute to the emerging critical view of board capital at the nexus of strategic governance and organizational innovation and adaptability (Arzubiaga et al. 2018; Hudson and Morgan 2023; Khanna et al. 2014; Li 2019; Zahra et al. 2009; Sun et al. 2016; Bendig et al. 2020).

2 | Discontinuous Technology Adoption and Strategic Leaders

2.1 | Discontinuous Technologies and Their Heterogeneous Adoption by Incumbent Firms

Our theorizing is rooted in research that defines discontinuous technologies by their "non-paradigmatic" nature (König et al. 2012; Dosi 1982). Discontinuous technologies depart nonlinearly "from the norm of continuous incremental innovation" (Anderson and Tushman 1990, 606), challenging established knowledge structures and patterns of value creation and value capture that are "rooted in deeply embedded shared principles, beliefs, and norms [in a given industry]" (König et al. 2021, 774). A discontinuous technology has, despite the high uncertainty surrounding its ultimate success, the potential to bring about significant progress and industry disruption (Hill and Rothaermel 2003). Therefore, an incumbent's failure to embrace it could eventually result in the incumbent's demise (Vuori and Huy 2016).

Three characteristics differentiate discontinuous technologies from other technological changes and render their adoption challenging for incumbent firms (Weber et al. 2019). First, they introduce new bundles of customer benefit dimensions (Christensen 1997). Second, they tend to be competence-destroying for incumbents and necessitate fundamentally new skills and competencies (Tushman and Anderson 1986). Third, discontinuous technologies disrupt established ways of value appropriation, particularly in terms of new revenue and pricing models (Christensen 2006). In turn, decision makers in incumbent firms often struggle to recognize the relevance of a discontinuity (Kaplan et al. 2003; Weber et al. 2019; Kammerlander and Ganter 2015), to acquire and assimilate the necessary resources (e.g., Christensen and Bower 1996), and to reconfigure organizational structures and processes to commercialize the new technology (e.g., Gilbert 2005, 2006).

In fact, a central theme in the literature, echoing Leonard-Barton's (1992) contextualized view of capabilities as potential rigidities, is that discontinuous strategic renewal is inherently difficult for incumbent firms. The same assets—resources, capabilities, and routines—that have enabled an incumbent to achieve a dominant position in the past likely become liabilities and sources of inertia when it faces an emerging discontinuous technology (Christensen 1997). Formalized (and thus efficient) interpretation, evaluation, and allocation processes (Hannan and Freeman 1984) and time-tested knowledge structures (Walsh 1995; Helfat and Martin 2015), such as technological frames, norms, and identity construals, lead incumbent decision makers to misinterpret or marginalize discontinuous technologies and to respond with old and no longer applicable routines (e.g., Danneels 2002; Tripsas and Gavetti 2000; Kammerlander et al. 2018; Gilbert 2006). Stakeholders also often oppose an incumbent's adoption of a discontinuous technology because it disrupts the innovation ecosystem's social structure and violates the incumbent's role in ensuring stable growth and upholding regulatory, normative, and cultural-cognitive institutions (e.g., Benner 2010; Boivie et al. 2021; Graf-Vlachy et al. 2023). In other words, it is, in many ways, illegitimate for an incumbent to adopt a discontinuous technology (Benner and Ranganathan 2012).

Although in some cases, such as the mini-computer industry (Christensen 1997), entire industries have faltered in the face of discontinuous technologies, affected incumbents often vary in their responses. Some exhibit the expectable inertia, but others show the idiosyncratic kinds of strategic agility (Weber and Tarba 2014) necessary to overcome the inherent adoption barriers (König et al. 2013). Examples of such "incumbent heterogeneity" (Eggers and Park 2018, 357) are newspapers adapting to online news (Gilbert 2005) and computer firms responding to the rise of wireless technologies (Maula et al. 2013).

Research in this field has particularly often emphasized incumbent heterogeneity in two decisive dimensions—namely, adoption speed and adoption aggressiveness (König et al. 2013). *Adoption speed* refers to the swiftness with which an incumbent adopts a discontinuous technology, a cumulative function of how fast its strategic leaders recognize (Maula et al. 2013;

Kaplan et al. 2003), decide to implement (Gilbert 2005), and commercialize a discontinuous technology (König et al. 2013). *Adoption aggressiveness* refers to the level of an incumbent's "impetus of resource commitment to a discontinuous change" (König et al. 2013, 420). Together, adoption speed and adoption aggressiveness reverberate notions of swiftness and boldness that are inherent to concepts of organizational agility (Weber and Tarba 2014) and firm innovation more generally (Caridi-Zahavi et al. 2016), and fundamental to organizational adaptability (Röth et al. 2023).

2.2 | Strategic Leadership and Incumbent Heterogeneity: What About Outside Directors?

Substantial evidence underscores the notion that strategic leaders are highly involved in all steps of discontinuous technology adoption and that a strategic leadership focus helps explain heterogeneity in adoption speed and aggressiveness (Maula et al. 2013; Gerstner et al. 2013, 2011; Weber et al. 2019; König et al. 2021; Kaplan et al. 2003). Much of the literature centers specifically on how strategic leaders' dispositions, experiences, and knowledge—their cognitive base (Hambrick and Mason 1984)—shape their perceptions and interpretations of discontinuous technologies and, in turn, their attention, commitment, and implementation approaches to adopting such changes. For example, prior research found that CEOs' attention to discontinuous technologies accelerates both the timing and aggressiveness of adoption, with their personal goals and perceptions shaping whether and how boldly firms respond (Eggers and Kaplan 2009; Kaplan 2008a; Kammerlander and Ganter 2015). Indeed, given the strategic nature and inherent riskiness of discontinuous technology adoption, it is hard to find an in-depth study that does not involve strategic leaders in one way or another.[1]

However, this is true only for C-level executives, meaning that there is concerningly little research on the role of outside directors—the nonexecutive branch of incumbents' upper echelons—in the context of discontinuous technology adoption (Kurzhals et al. 2020; Eggers and Park 2018). This is troubling given that outside directors have become increasingly prevalent over time (Adams et al. 2010; Gordon 2006), to the point where boards today "are comprised primarily of outside directors" (Boivie et al. 2016, 324). Moreover, and perhaps more importantly from a theoretical perspective, outside directors affect strategic outcomes through idiosyncratic functions and mechanisms (Withers et al. 2012; Johnson et al. 2013). Outside directors are typically independent and hired for the "board capital they have" (Boivie et al. 2016, 327)—that is, their external networks, experience, and influence. In contrast to TMT members, they often provide resources outside of board meetings, in the form of counsel and strategic guidance, their status and reputation, and by building informal communicative interfaces to important external stakeholders (Boivie et al. 2016). As such, outside directors offer resources and viewpoints complementary to those of the TMT (Haynes and Hillman 2010; Boivie et al. 2016), and while they may view themselves as part of the upper echelons (Chen et al. 2025; Boivie et al. 2021), their influence on strategic outcomes differs from that of the CEO and the other TMT members.

Importantly, outside directors and their characteristics have been found highly and uniquely influential *especially* as it relates to strategic renewal and innovation (Haynes and Hillman 2010; Zahra et al. 2009; Klarner et al. 2023; Balsmeier et al. 2014; Chang and Wu 2021; Hsu et al. 2024). For instance, Oehmichen et al. (2017) focus on outside directors' experience—a construct often studied in research on outside directors (Golden and Zajac 2001; Kor and Misangyi 2008; Kor and Sundaramurthy 2009; Genin et al. 2023; An et al. 2021). Specifically, Oehmichen et al. (2017, 646) suggest that industry experience allows outside directors to better understand "the peculiarities and challenges endemic to the industry in which the firm operates," sense the firm's strategic weaknesses, and use governance instruments to motivate otherwise change-avoidant and opportunistic executives. Dalziel et al. (2011) found that directors' insider or outsider status differentially moderates how their human and social capital affect R&D spending, underscoring the importance of idiosyncratic theory for outside directors' impact on innovation.

Although an encompassing overview of the extensive literature on directors' involvement in and impact on firm innovation and adaptability is beyond the scope of this article and provided in recent reviews (e.g., Klarner et al. 2023; Sierra-Morán et al. 2024), there is evidently only very limited research that studies outside directors' influence in the unique context of discontinuous technological change. We seek to remedy this shortcoming by integrating the incumbent heterogeneity literature with established theory on outside directors, namely board capital theory (Haynes and Hillman 2010; Hillman and Dalziel 2003). In particular, we highlight a thus far underexamined subset of outside directors' human and social capital that we call outside director incumbency capital.

3 | Outside Director Incumbency Capital and Discontinuous Technology Adoption

Figure 1 illustrates our conceptual model and its central constructs. At its core is the notion of outside director incumbency capital, comprising the two dimensions of outside director incumbency social capital and outside director incumbency human capital.

3.1 | Outside Director Incumbency Capital

We define *outside director incumbency capital* as the social and human capital that outside directors have accumulated given their educational, professional, and social exposure to and their entrenchment in the established technological paradigm that is challenged by a discontinuous technology. We view outside director incumbency capital as a specific form of board capital (Hillman and Dalziel 2003). The concept of board capital builds on economic and sociological theories of the role of social actors' physical, cognitive, experiential, and relational resources for the attainment of economic and social goals (Bourdieu 2018; e.g., Becker 1964). Board capital theory highlights that directors, and particularly outside directors, not only act as monitors but also provide the firm and its executives with vital resources, such as "legitimacy, advice and counsel, [and] links to other

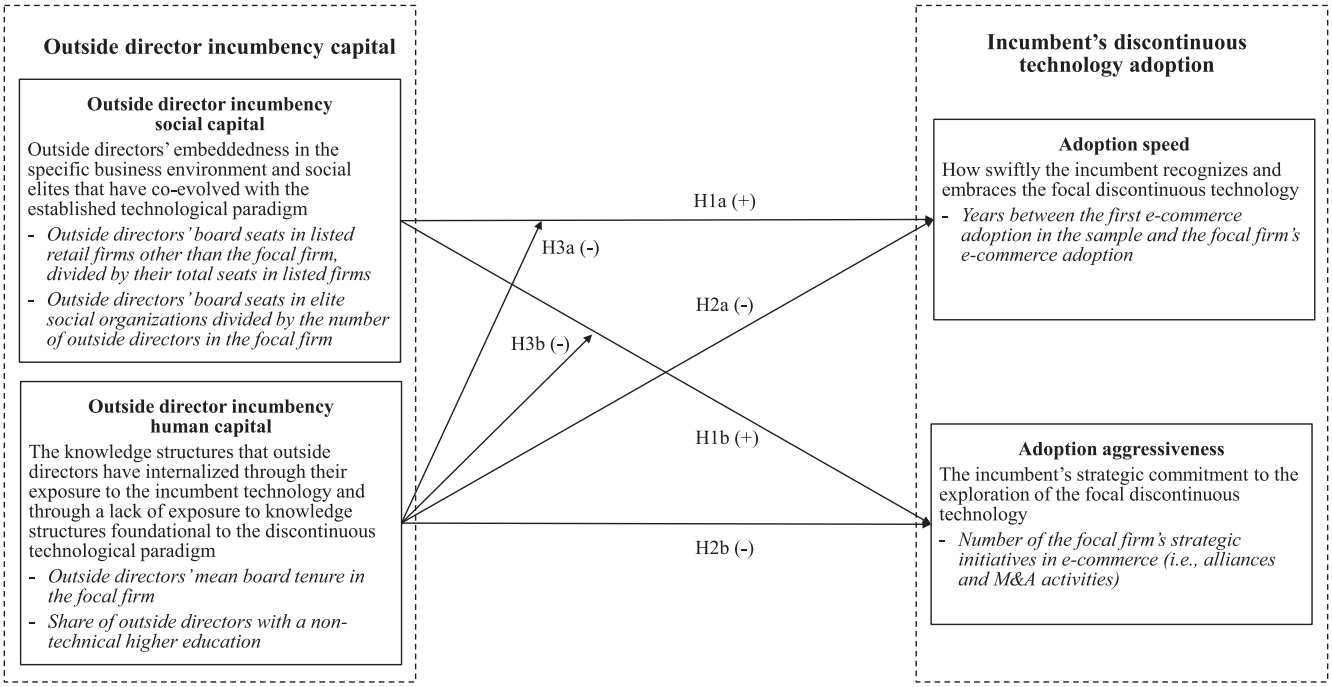

FIGURE 1 | Conceptual model for analyzing the effects of outside director incumbency capital on an incumbent's discontinuous technology adoption. (1) Italics indicate the respective constructs' operationalization in our study. (2) H3a and H3b hypothesize interactions: outside director incumbency human capital weakens the positive effects of outside director incumbency social capital, and outside director incumbency social capital strengthens the negative effects of outside director incumbency social capital.

organizations" (Hillman and Dalziel 2003, 383). In line with prior related concepts—such as Kor and Sundaramurthy's (2009) notion of outside directors' experience-based human capital and social capital—outside director incumbency capital is a collective, group-level concept (Hillman and Dalziel 2003) that focuses on specific aspects of outside directors' human and social capital.

Importantly, as indicated by the term "incumbency," the concept of outside director incumbency capital integrates the Kuhnian notion that social actors accumulate human and social capital in epistemic and social domains that co-emerge with technological paradigms (Dosi 1982; König et al. 2012). In other words, over time, actors in the respective industry not only come to share relatively stable concepts or frames of how to create and capture value, but also form social communities structured by norms, roles, practices, routines, social meaning systems, and hierarchies (e.g., Benner and Tripsas 2012; Kaplan and Tripsas 2008; Kaplan 2011; Hargadon and Douglas 2001; Weber et al. 2019; Spieth et al. 2021).

Following Hillman and Dalziel (2003), we distinguish between a social capital dimension and a human capital dimension of outside director incumbency capital. Social capital reflects persons' relational ties (i.e., who they know), while human capital describes their skills and knowledge (i.e., what they know) (Johnson et al. 2013). Correspondingly, we define *outside director incumbency social capital* as outside directors' embeddedness in the business environment and social elites that have co-evolved with the established technological paradigm. In contrast, we conceptualize *outside director incumbency human capital* as the knowledge structures—expertise and experience, mental models, beliefs, frames, schemas, scripts, categories, heuristics, skills, and routines (see Walsh 1995, for a review of knowledge structures)—that outside directors have internalized through their exposure to the incumbent technology and through a lack of exposure to the knowledge structures foundational to the discontinuous technological paradigm. Notably, by this definition, it also comprises the absence of human capital that will eventually become a foundation of the focal discontinuous technology. For example, at the advent of biotechnology (a discontinuous technology to incumbent pharmaceutical companies), the presence of a trained microbiologist among the outside directors of a pharmaceutical company would lower that company's outside director incumbency human capital because microbiology was key to biotechnology (Sosa 2013).

In contrast to the rather positive portrayal of board capital in the literature, including its relation to innovation (Chen 2014; Wincent et al. 2010; Genin et al. 2023; Dalziel et al. 2011; Hillman and Dalziel 2003), our approach echoes recent advances toward a more nuanced view, highlighting both "bright sides" and "dark sides'" of board capital (Sundaramurthy et al. 2014; Sun et al. 2016). To this end, we follow the approach of previous studies (Gerstner et al. 2013; König et al. 2013) by considering how the two types of outside director incumbency capital may respectively weaken or fortify the "barriers"—the deeply rooted sources of rigidity or inertia—that protract incumbents' discontinuous technology adoption (Eggers and Park 2018). Our idea is that, while some facets of outside director incumbency capital may constitute a core liability under conditions of discontinuous change (Leonard-Barton 1992), others may fuel an incumbent's adaptability—more in line with the board capital literature (Hillman

and Dalziel 2003). Specifically, we focus on how outside directors' incumbency social and human capital differentially affect three central and interrelated barriers to adoption (König et al. 2013): stakeholders' resistance (Benner 2007; Graf-Vlachy et al. 2023), resource dependence (Christensen and Bower 1996), and the rigidity of executives' mental models (Tripsas and Gavetti 2000).

3.2 | Outside Director Incumbency Social Capital and Discontinuous Technology Adoption

As for outside director incumbency social capital, we—counterintuitively, if viewed through Leonard-Barton's (1992) lens of incumbency-related capabilities as potential rigidities—extend the positive account of board capital. In particular, we argue that outside director incumbency social capital facilitates discontinuous technology adoption.

Incumbents seeking to adopt a discontinuous technology are likely to face opposition from key stakeholders (Benner 2007; König et al. 2021; Graf-Vlachy et al. 2023). Discontinuous technologies tend to be notoriously unattractive to established customers, cannibalize sales (Christensen 1997; Chandrasekaran et al. 2022), and underperform financially in the short term (Gilbert 2005). As a result, investors and analysts frequently view such initiatives as violations of an incumbent firm's identity as an "income stock" (Benner 2010, 2007), often responding with downgrades that, in turn, lead to reduced strategic investments by incumbents (Benner and Ranganathan 2017). Other stakeholders—such as employees and ecosystem partners—may also resist discontinuous technology adoption due to the significant uncertainty and organizational upheaval involved that can arouse strong political and emotional responses (Kaplan 2008b; Vuori and Tushman 2024). Despite their promises, discontinuous technologies can entail job losses, threaten institutional roles and norms, and destabilize the social equilibrium of the established innovation ecosystem (Kaplan and Tripsas 2008; Hargadon and Douglas 2001; Graf-Vlachy et al. 2023).

We propose that outside director incumbency social capital helps an incumbent overcome such economic and socio-political resistance in two ways. First, the more ties they have within the focal industry and established social elite, the better their connections to financial institutions—the "traditional center of the interlock network" (Davis et al. 2003, 302). Outside directors can use their social relations to sway capital market actors to evaluate the discontinuous technology adoption less negatively, helping the firm receive more financing, more rapidly, and on better terms (Uzzi 1999). In short, the legitimacy that stems from outside directors' incumbency social capital spills over to the firm's adoption efforts.

Second, outside director incumbency social capital strengthens nonfinancial stakeholders' perception of the directors as part of their "in-group." This fosters relational legitimacy, encouraging trust and reducing opposition due to expectations of fairness and benevolence (Tost 2011). In particular, stakeholders such as employees or partners who fear becoming redundant (König et al. 2012) are less likely to protract and dampen an incumbent's discontinuous technology adoption the more its outside directors are anchored in the business environment and social networks that have co-evolved with the incumbent technology, rather than other, more distant industry and social environments.

In sum, outside directors' social rootedness in the "old" business world will make it easier for an incumbent to obtain financial and social endorsement for its entry into the "new world" by adopting a discontinuous technology. Hence, outside director incumbency social capital likely increases discontinuous technology adoption speed and aggressiveness.

H1. *Outside director incumbency social capital is positively associated with the focal incumbent's adoption speed (a) and adoption aggressiveness (b).*

3.3 | Outside Director Incumbency Human Capital and Discontinuous Technology Adoption

Beyond legitimacy, board capital theory highlights the significance of strategic advice as a key resource provided by outside directors (Hillman and Dalziel 2003; Pugliese et al. 2009; Golden and Zajac 2001). Many outside directors see their role less as watchdogs and more as strategic advisors and collaborators (Boivie et al. 2021), drawing on not only industry-specific but also firm-specific expertise to evaluate strategic issues and provide informed counsel (Kor and Misangyi 2008; Cheng and Groysberg 2018).

We, however, contend that such specific expertise, skills, and knowledge—captured by outside director incumbency human capital—can be dysfunctional in the context of discontinuous technology adoption. Incumbency-related knowledge structures internalized by outside directors through their advisory role may reinforce their cognitive rigidity (Tripsas and Gavetti 2000), a focal barrier that hinders speedy and aggressive discontinuous technology adoption (Eggers and Park 2018). What typically is a strength under stable conditions may thus become a liability during discontinuous change (Leonard-Barton 1992). Notably, the knowledge structures that outside directors have internalized during their education and professional experience, particularly with the focal firm, will generally shape how they interpret technological developments and discuss them with TMT members (Rindova 1999; Walsh 1995; Kaplan 2008b; König et al. 2021). Research shows that outside directors tend to rely on existing knowledge rather than expanding it (Boivie et al. 2016), particularly under conditions of uncertainty, complexity, and ambiguity (Khanna et al. 2014).

We make two specific arguments for why outside director incumbency human capital hinders incumbents' swift and aggressive adoption of discontinuous technologies. First, the higher their incumbency human capital, the later outside directors will recognize an emergent technological discontinuity and advise executives to adopt it (Eggers and Kaplan 2009). The greater their incumbency human capital, the more outside directors will be entrenched in narrow, established thinking and the less receptive they will be to external information about new technologies (Tuggle et al. 2010; Haynes and Hillman 2010; Hambrick et al. 1993). In turn, rather than making them focus

on technological discontinuities, which typically emerge at the periphery of established business fields and are often complex (Jones et al. 2001; Weber et al. 2019), "sticky cognitive schemata" (König et al. 2013, 426) direct outside directors' focus to local, more incremental developments.

Second, higher outside director incumbency human capital also hampers decision making and implementation processes, reducing adoption aggressiveness (König et al. 2013). The more outside directors have internalized the established technological paradigm—cognitively and in their routines (Gilbert 2005)—the more likely they are to apply established heuristics and metrics when evaluating strategic proposals, likely underestimating the potential of discontinuous technologies (Tushman and Anderson 1986). In contrast, outside directors familiar with technological "thoughtworlds" (Dougherty 1992) will be more open to, or less likely to object to, bold initiatives and resource reallocation (Vuori and Tushman 2024). Moreover, incumbency human capital may exacerbate outside directors' confirmation bias (Nickerson 1998), specifically their tendency to overestimate established technologies and their receptiveness to stakeholder skepticism or resistance, leading them to favor continuing on the existing innovation trajectory (Cohen and Levinthal 1990; Eggers and Kaplan 2009).

In sum, we argue that the more highly they rank on incumbency human capital, the more outside directors' advising and counseling—as well as their monitoring—manifest in preserving the existing ways of creating and capturing value (Rindova 1999; Golden and Zajac 2001; Hambrick et al. 1993). Consequently, they will be less likely to recommend, approve, and support the swift and aggressive adoption of a discontinuous technology:

H2. *Outside director incumbency human capital is negatively associated with the focal incumbent's adoption speed (a) and adoption aggressiveness (b).*

3.4 | The Interactive Effects of Outside Director Incumbency Social and Human Capital

Board capital theory suggests that human and social capital influence firm-level outcomes both individually and interactively (Kor and Sundaramurthy 2009). Adopting this logic, we argue that outside director incumbency social and human capital interactively affect the speed and aggressiveness of incumbents' discontinuous technology adoption.

First, we propose that outside director incumbency human capital weakens the positive effects of outside director incumbency social capital. Specifically, outside directors' cognitive entrenchment in and commitment to the incumbent technology will likely affect the extent to which they utilize their social ties and legitimacy within the established industry and social elite networks to overcome resistance from internal and external stakeholders (Kor and Sundaramurthy 2009). The more outside directors interpret a technological discontinuity through established knowledge structures, the less likely they are to recognize the discontinuous technology as strategically relevant or urgent. If such outside directors have high legitimacy and influence, it may actually reinforce stakeholder skepticism and resistance against the incumbent's adoption efforts (Cohen and Levinthal 1990; Eggers and Kaplan 2009). For instance, along these lines, Vuori and Huy (2022, 340) quote a Nokia top manager who recalled how certain cognitively entrenched directors actively used their social power to stymie Nokia's responses to Apple's smartphone technologies: "[Some of the most influential board members] at Nokia had told Nokia people, 'Do not touch an iPhone, do not use that word in the building. Don't even talk about it'." In contrast, if outside directors' cognition is less constrained by the established technological paradigm and instead includes knowledge structures closer to the emerging discontinuity, they are more likely to leverage their legitimacy to overcome resistance, help secure resources, and advocate for resource allocation toward technology adoption (Uzzi 1999).

Second, and correspondingly, we suggest that outside director incumbency social capital may exacerbate the negative effects of incumbency human capital. A board with relatively more ties to the established business and social elite networks wields greater influence over both stakeholders and executives (Certo 2003; Johnson et al. 2011). When such influential outside directors are cognitively anchored in the incumbent paradigm, their skepticism can further entrench organizational inertia by deepening resistance and delaying strategic action.

H3. *Higher levels of outside director incumbency human capital weaken the positive association between outside director incumbency social capital and the focal incumbent's adoption speed (a) and adoption aggressiveness (b); correspondingly, higher levels of outside director incumbency social capital strengthen the negative association between outside director incumbency human capital and the focal incumbent's adoption speed (a) and adoption aggressiveness (b).*

4 | Methods

4.1 | Sample and Data Collection

We tested our hypotheses by studying the responses of public US retail firms to the emergence of e-commerce. Previous research characterizes e-commerce as an archetypal discontinuous technology as it required incumbent retailers to fundamentally depart from their established paradigm of creating and capturing value (Kim and Min 2015; König et al. 2012). Importantly, incumbent retailers' responses showed substantial heterogeneity. Some traditional retailers in the United States, such as Rite Aid, adopted e-commerce rather quickly, in 1999, while similar retailers, such as Walgreens, launched e-commerce rather late, in 2011.

Our sample comprises retail firms listed in the S&P 1500 index at the beginning of 1995.[2] We began our analysis in that year because large US firms started to mention the Internet in their annual reports around that time, indicating a growing awareness of this technological development with initial adoption efforts shortly thereafter (Kim and Min 2015). The first retail firms in our panel launched online shops in 1997. We followed

the panel until the end of 2019 to fully capture adoption heterogeneity (i.e., early and late adopters as well as laggards). This seemingly long sampling frame is in line with that of other studies on discontinuous technology adoption and the scholarly consensus that the evolution of discontinuous technologies can take decades (Christensen 1997; Eggers and Kaplan 2009).

We identified relevant retail firms using the companies' historical primary standard industrial classification (SIC) codes. Notably, no predefined group of SIC codes appropriately represents the retail sector. For example, in 1995, the shoe manufacturer and retailer Nike Inc. was assigned SIC code 3021 "Rubber & plastics footwear," while the shoe retailer Foot Locker Inc. was assigned SIC code 5661 "Retail-shoe stores." To address this issue, two authors and one additional scholar independently reviewed all descriptions of 4-digit SIC codes to select those likely to represent firms with a retail-driven business model relying on physical outlets. With a satisfactory initial interrater reliability of 0.70 (Krippendorff 2004), we resolved any disagreements by discussion to identify 81 SIC codes, which we then triangulated with extant literature (Kim and Min 2015). Of these 81 codes, 25 were assigned to at least one firm listed in the S&P 1500 as of the beginning of 1995. Next, we manually ensured that all corresponding firms operated physical retail outlets (Krippendorff's alpha: 1.00) and removed firms with insufficient SEC filings due to bankruptcy. Ultimately, we identified 75 retail firms, 32 of which remained in the panel until the end of 2019, yielding 1111 firm-year observations. Supporting Information: Appendix 1 lists all firms in our sample by SIC code. Below, we discuss the key variables, with full descriptions and data sources in Supporting Information: Appendix 2.

4.2 | Dependent Variables

4.2.1 | Speed of e-Commerce Adoption

Our first dependent variable, *adoption speed*, measured the time retailers took to launch their first online shops. We determined the launch dates by reviewing firms' 10-Ks and verified the launches using the Internet Archive's "Wayback Machine" (Kammerlander et al. 2018). In the case of multi-brand firms, we considered the launch of the first online shop within each financially consolidated firm.

We gauged adoption speed using two measures, both of which are required to employ our chosen estimation method (proportional Cox hazard model; see Section 4.5). First, we calculated a binary variable coded as 1 if the focal firm operated an online shop in the given year and 0 if it did not (Eggers and Kaplan 2009). Second, we measured adoption speed as the discrete time difference (in years) between the first e-commerce adoption in our sample (in 1997) and the focal firm's e-commerce adoption (Maula et al. 2013).

4.2.2 | Aggressiveness of e-Commerce Adoption

Our second dependent variable, *adoption aggressiveness*, measured incumbents' adoption efforts in terms of how many strategic initiatives (i.e., alliances and mergers and acquisitions (M&A)) retailers undertook to adopt e-commerce (Jones et al. 2001; Kaplan et al. 2003; Gerstner et al. 2013). We extracted detailed information on firms' strategic initiatives from the Capital IQ Transaction Database. In the rare cases where information from Capital IQ was insufficient, we cross-checked the strategic initiatives using the Bloomberg and Thomson Reuters deal databases. Two raters independently assessed whether each initiative supported the establishment, continuation, or advancement of e-commerce activities (Krippendorff's alpha: 0.95). Examples of strategic initiatives were the acquisition of an online-based retail brand or a joint venture with a customer-data analytics firm.

We computed adoption aggressiveness by counting the number of strategic initiatives directed at e-commerce adoption in each year $t+n$. We considered the year of alliance formation or deal closing as the relevant year (Gerstner et al. 2013). Counts of alliances and M&As across all firm years co-varied significantly ($r=0.107$, $p<0.001$). Figure 2 shows the development of both dependent variables (i.e., e-commerce adoption speed and e-commerce adoption aggressiveness) over time.

4.3 | Independent Variables

Corresponding with our theoretical conceptualizations and following prior research, we aggregated individual outside director data at the group level (Haynes and Hillman 2010; Khanna et al. 2014). We gathered outside director data from BoardEx, Capital IQ, company proxy statements, LinkedIn, Bloomberg Executive Profiles, and university alumni networks.

4.3.1 | Outside Director Incumbency Social Capital

Our *outside director incumbency social capital* measure consisted of two factors capturing the degrees to which outside directors are embedded within the industry and broader elite societal circles formed around established business paradigms. For the first factor, we used the established measure of *industry embeddedness* and focused on the outside directors' industry ties relative to all their business ties (Haynes and Hillman 2010). Specifically, we divided the total number of outside directors' board seats in listed firms within the retail industry other than the focal firm by the total number of other board seats in listed firms in a year $t+n$. To ensure consistency with the identification logic for sample firms, we considered firms to be in the retail industry if the SIC code was among the previously identified retail SIC codes. Two authors manually verified the presence of a retail-based business model for all corresponding firms by checking the descriptions on firms' homepages or in Bloomberg's (Krippendorff's alpha: 0.80). We deem this operationalization of outside director incumbency social capital as particularly suitable in our context since retail, in comparison to other industries, experienced a material impact of e-commerce particularly early and extensively (König et al. 2012). Thus, in our empirical context, an outside director possesses high incumbency social capital when ties within the retail industry are plentiful but ties outside this industry are rare.

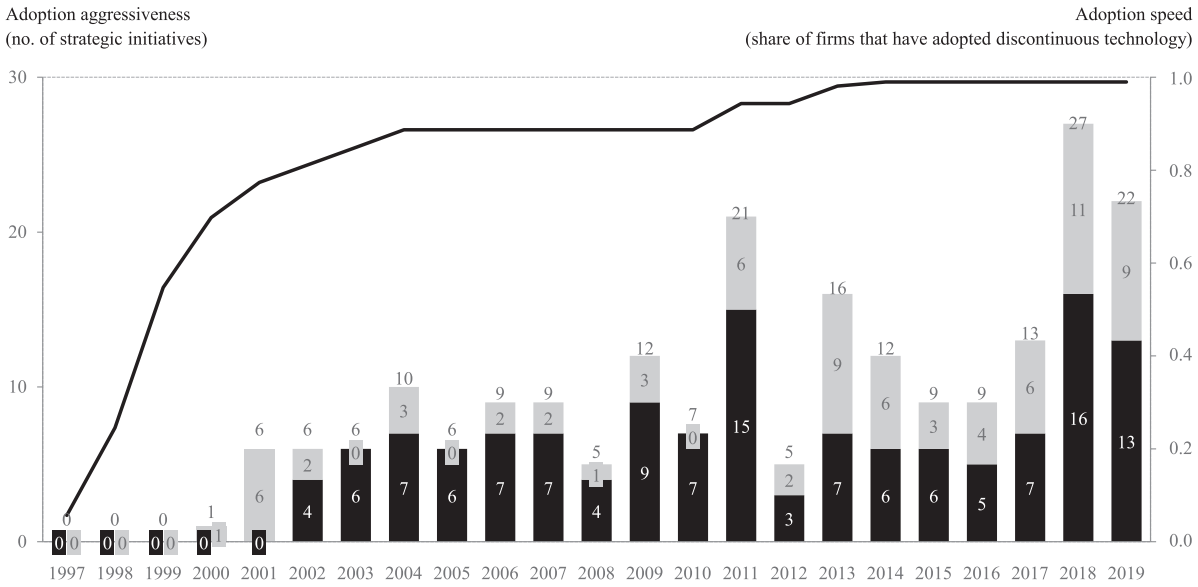

FIGURE 2 | Development of e-commerce adoption speed and e-commerce adoption aggressiveness over time.

For the second factor, *elite embeddedness*, we considered ties to elite social circles that are adjacent to and important for an incumbent's business activities but that transcend the narrow realm of business ties. By considering social elite ties, we aimed to capture the degree to which boards are part of and embedded in the established social elite networks. In the United States, membership in the social realms of the military (Berger et al. 1972), academia (Moore 1968), non-profits or philanthropy (Cornforth and Edwards 1999), and politics (Mills 1945) can be regarded as a specific marker of social elite membership. We measured elite embeddedness as the outside directors' number of board-level seats in these social realms divided by the total number of outside directors in the focal firm year $t+n$. We used data from BoardEx, determining the categories based on BoardEx's association type (e.g., "university" or "non-/for-profit"). This measure captured incumbency social capital in that it reflects links to social elites that have either co-evolved with the incumbent technology or are the result of the incumbent technology's continued success.

We performed three operations to arrive at our final variable scores. First, we standardized both factors across all observations. Second, we averaged the respective scores for the years $t+n-2$, $t+n-1$, and the focal year $t+n$ to account for lengthy technology adoption processes (Eggers and Kaplan 2009; Kaplan et al. 2003). Third, we took the mean of the standardized and averaged values. In our final composite incumbency social capital measure, higher values indicated higher degrees of social capital rooted in the incumbent industry and established social elite circles.

4.3.2 | Outside Director Incumbency Human Capital

Following our conceptualization, our *outside director incumbency human capital* measure specifically aimed to capture outside directors' human capital related to the incumbent technology paradigm (i.e., retail before e-commerce). We operationalized this variable as the sum of directors' incumbent board experience and their non-technology-focused higher education.

For *incumbent board experience*, we used outside directors' board tenure at the focal incumbent. The longer outside directors govern a given firm, the more they acquire and internalize incumbent-specific expertise, including how the focal incumbent leverages and exploits its assets (Rindova 1999; Tuggle et al. 2010). We calculated it as the mean of all outside directors' tenure in a year $t+n$.

To capture outside directors' *non-technology education*, we used the inverse ratio of outside directors with science or engineering degrees divided by the total number of outside directors in a year $t+n$. This measure aimed to distinguish higher education with a focus on the needs of the "old" versus "new" retail industry because outside directors' educational backgrounds affect their monitoring and advisory patterns (Zhu 2014). Specifically, outside directors with science and engineering degrees are likely to have experienced the Internet and related technologies earlier and more extensively than others (think, for example, of the emergence of the World Wide Web at CERN in 1989 and its early spread in academia).

We then created our index measure in the same way as for outside director incumbency social capital. Our decision to aggregate experience and education mirrors previous studies on how such factors influence group performance and outcomes (McDonald et al. 2008).

4.4 | Control Variables

We controlled for several board-, CEO-, and firm-related characteristics. We combined four factors in a *board power* index to control for the fact that the board's influence on strategic decision making depends on its power relative to the CEO (Golden and

Zajac 2001): CEO non-duality (i.e., the CEO is not simultaneously the board's chairperson; binary variable); the share of outside directors; the share of outside directors appointed prior to the current CEO; and the ratio of the board's equity holdings to those of the CEO (Haynes and Hillman 2010). Again, we standardized the four factors, averaged them over the 3 years $t+n-2$, $t+n-1$, and $t+n$, and then took their mean to compute the index.[3]

In addition, we controlled for other board-related variables. We considered the logarithmic dollar value of *board compensation* because it might influence the board's incentives to favor technology adoption. We controlled for the share of directors with an *elite education*, as an elite education can be a source of status and prestige for directors that affects the board's informal discretion and influences stakeholders (Certo 2003). Next, we included the mean *board age*, as research suggests that mental and social flexibility decline with age, resulting in an overreliance on previously established routines and social ties (Walsh 1995). Finally, we considered *board size*, as larger boards often have lengthier decision-making processes (Pfeffer 1972). We standardized these variables and took the 3-year averages of $t+n-2$, $t+n-1$, and $t+n$.

We also controlled for an array of CEO-related factors. *CEO incumbency social capital* and *incumbency human capital*—measured using the same method as for the outside director incumbency social and human capital indices—recognize the potential importance of such capital for CEOs' influence on discontinuous technology adoption (Gerstner et al. 2013). We further controlled for *CEO compensation*, *CEO elite education*, and *CEO age*.

As for firm characteristics, we controlled for *R&D intensity* and *slack resources*, which might influence firms' ability to adopt new technologies (Greenley and Oktemgil 1998; Cohen and Levinthal 1990). Moreover, we considered prior operational performance in terms of *return on assets* (ROA), and capital market performance in terms of *total shareholder return* (TSR) and *Tobin's Q*. Next, as larger organizations might have more resources to pursue novel technologies but face more bureaucracy (Hannan and Freeman 1989), we controlled for firm size as represented by the logarithm of *total assets* and *market capitalization*. Data for these measures came from Compustat. We lagged all accounting-based controls by 1 year ($t+n-1$). We also controlled for *firm age*, as it can influence how firms pursue risky innovation (Eggers and Kaplan 2009) and for *family-influenced firms*, as they may adopt discontinuous technologies differently (Chrisman et al. 2015; Arzubiaga et al. 2018). Next, we accounted for the fact that firms with a *mail-order business* as of 1995 might be more inclined to adopt e-commerce than companies with a one-channel, brick-and-mortar business model (König et al. 2021). To identify mail-order businesses, we manually searched firms' 10-K filings. Further, in the estimations focused on adoption aggressiveness, we controlled for *other strategic initiatives* that were not directed at e-commerce as firms engaging in more initiatives overall might also engage in more e-commerce initiatives without necessarily having a higher inclination toward technology adoption (Gerstner et al. 2013). Finally, we included year dummies to capture all time-specific factors, such as the availability of off-the-shelf e-commerce software or the general visibility of e-commerce over time.

4.5 | Analysis

We employed different estimation methods for our two dependent variables due to their different distributions. We used Cox proportional hazard models with standard errors clustered at the firm level to test our hypotheses regarding adoption speed (H1a, H2a, H3a). Such models are well-suited for our panel data and are a common choice for analyzing time-to-event data in discontinuous technology settings (Maula et al. 2013; Eggers and Kaplan 2009). They also account for the fact that there is a non-linear change in the likelihood of technology adoption based on the firm-specific time at risk, that our data is right-censored, and that we found ties in the timing of technology adoption among firms. We confirmed the hazard rate proportionality assumption using formal tests based on Schoenfield's residuals. These tests yielded statistically insignificant results (SCE: $\chi^2 = 18.34$, $p > 0.565$; KSE: $\chi^2 = 16.78$, $p > 0.667$; SCE and KSE: $\chi^2 = 20.09$, $p > 0.637$), supporting our choice.

We used multilevel mixed-effects Poisson models (Certo et al. 2017) with clustered standard errors to test our hypotheses concerning adoption aggressiveness (H1b, H2b, H3b). Poisson models are particularly suitable for investigating dependent non-negative count variables and a common choice in innovation research (Sunder et al. 2017; Gerstner et al. 2013). These estimation models tend to be extremely robust in econometric terms when analyzing nonlinear panel data (Clarke 1946).

Our dependent count variable—adoption aggressiveness—has "excessive firm-years with zero [...] counts" (Sunder et al. 2017, 215). Consequently, we could not use standard random-effects Poisson models. Additionally, board members tend to sit on multiple boards in an industry at the same time (Haynes and Hillman 2010). This makes multilevel mixed-effects Poisson models (Certo et al. 2017), which consider between- and within-variance, the appropriate choice. We are confident that the general Poisson assumption of equidispersion is fulfilled (Clarke 1946) because all Pearson dispersion statistics were considerably below the recommended overdispersion threshold of 1 (Hilbe 2011) and all dispersion parameters estimated using negative binomial regression models were not substantially different from zero (Chen et al. 2008).

5 | Results

5.1 | Findings

Table 1 displays the descriptive statistics including the pairwise correlations. Although we find several high pairwise correlations in our data, no variance inflation factor exceeds 3.554. We conclude that our models are not plagued by multicollinearity.

Table 2 presents the models that test our hypotheses. Models 1–5 test the effects on adoption speed (H1a, H2a, H3a), and Models 6–10 test the effects on adoption aggressiveness (H1b, H2b, H3b). Models 1 and 6 include only controls. Models 2 and 7 include outside directors' incumbency social capital, and Models 3 and 8 include their incumbency human capital. Models 4 and 9 contain both outside director incumbency social and human

TABLE 1 | Summary statistics and correlations.

Variable	Mean	SD	(1)[a]	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Adoption speed	5.009	5.373	1.000												
(2) Adoption aggressiveness	0.096	0.414	0.153	1.000											
(3) Outside director incumbency social capital	0.002	0.628	0.171	0.148	1.000										
(4) Outside director incumbency human capital	0.020	0.680	0.251	−0.103	0.169	1.000									
(5) Board power	0.010	0.537	0.346	0.175	0.208	−0.045	1.000								
(6) Board compensation	0.021	0.869	0.446	0.025	0.116	0.191	0.129	1.000							
(7) Board elite education	0.003	0.962	0.134	0.032	0.210	0.055	0.101	0.074	1.000						
(8) Board age	0.041	0.950	0.248	0.025	0.177	0.411	0.145	0.245	−0.054	1.000					
(9) Board size	0.046	0.940	0.236	0.249	0.131	0.085	0.143	0.093	0.157	0.172	1.000				
(10) CEO incumbency social capital	0.004	0.630	0.238	0.165	0.207	−0.023	0.084	0.005	0.063	0.014	0.190	1.000			
(11) CEO incumbency human capital	−0.006	0.666	0.043	−0.123	0.106	0.203	−0.274	−0.031	0.059	0.064	−0.057	0.032	1.000		
(12) CEO compensation	0.030	0.914	0.231	0.219	0.197	0.097	0.232	0.275	0.173	0.166	0.255	0.133	0.025	1.000	
(13) CEO elite education	0.002	0.950	0.066	0.016	−0.031	−0.010	−0.071	0.023	0.007	0.026	0.164	0.120	0.061	0.066	1.000
(14) CEO age	−0.001	0.924	−0.016	0.027	0.137	0.091	−0.191	−0.001	0.076	0.225	0.075	0.073	0.323	0.100	−0.023
(15) R&D intensity	0.002	0.009	0.032	0.112	0.107	−0.009	0.092	−0.064	0.115	0.106	0.081	0.057	−0.038	0.080	0.263
(16) Slack resources	2.284	1.186	−0.210	−0.126	−0.006	0.065	−0.231	−0.135	−0.216	−0.107	−0.249	−0.071	0.087	−0.150	−0.036
(17) Return on assets	0.055	0.089	0.150	0.029	0.071	0.183	−0.084	0.156	0.017	0.105	0.126	0.025	0.030	0.175	−0.068
(18) Total shareholder return	0.204	1.055	−0.076	−0.027	−0.010	−0.024	0.008	0.049	−0.045	−0.032	−0.049	−0.037	−0.032	0.004	−0.027
(19) Tobin's *Q*	0.648	1.210	0.391	−0.008	0.019	0.137	0.010	0.294	0.042	0.154	0.150	0.000	0.018	0.197	−0.070
(20) Total assets	7.695	1.618	0.281	0.316	0.190	0.035	0.288	0.112	0.298	0.114	0.663	0.249	−0.055	0.444	0.058
(21) Market capitalization	6.740	3.278	0.623	0.225	0.219	0.150	0.263	0.264	0.200	0.247	0.558	0.188	−0.032	0.407	0.029
(22) Firm age	63.867	35.521	0.228	0.016	0.035	0.063	0.054	−0.064	0.024	−0.008	0.234	0.208	−0.078	−0.050	0.022

(Continues)

TABLE 1 | (Continued)

Variable	Mean	SD	(1)[a]	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(23) Family-influenced firm	0.431	0.495	−0.042	−0.040	0.106	0.185	−0.135	−0.070	−0.171	0.088	−0.070	−0.078	0.270	−0.074	0.038
(24) Mail-order business	0.146	0.353	0.085	0.033	0.063	0.005	0.031	0.027	0.156	0.092	0.073	0.347	0.029	−0.007	−0.097
(25) Other strategic initiatives	0.971	2.121	n.a.	0.432	0.141	−0.130	0.181	−0.007	0.051	0.021	0.313	0.244	−0.107	0.211	0.006

Variable	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
(1) Adoption speed												
(2) Adoption aggressiveness												
(3) Outside director incumbency social capital												
(4) Outside director incumbency human capital												
(5) Board power												
(6) Board compensation												
(7) Board elite education												
(8) Board age												
(9) Board size												
(10) CEO incumbency social capital												
(11) CEO incumbency human capital												
(12) CEO compensation												
(13) CEO elite education												
(14) CEO age	1.000											
(15) R&D intensity	−0.007	1.000										
(16) Slack resources	0.018	−0.022	1.000									
(17) Return on assets	0.047	0.009	0.078	1.000								
(18) Total shareholder return	−0.004	−0.021	0.000	0.133	1.000							
(19) Tobin's *Q*	0.016	0.021	0.099	0.574	0.077	1.000						
(20) Total assets	0.106	−0.030	−0.392	0.130	−0.062	0.103	1.000					
(21) Market capitalization	0.106	0.032	−0.226	0.325	−0.024	0.534	0.660	1.000				

(Continues)

TABLE 1 | (Continued)

Variable	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
(22) Firm age	−0.054	−0.016	0.022	−0.065	−0.028	−0.111	0.202	0.139	1.000			
(23) Family-influenced firm	−0.035	0.071	0.102	0.185	−0.012	0.119	−0.142	−0.062	−0.064	1.000		
(24) Mail-order business	0.134	−0.100	−0.012	0.086	−0.016	0.108	0.246	0.147	0.294	−0.123	1.000	
(25) Other strategic initiatives	0.022	0.014	−0.175	0.011	−0.021	0.006	0.463	0.314	0.136	−0.116	0.136	1.000

Note: $n = 1111$; standardized values might deviate from Mean = 0 and SD = 1 due to taking the mean of $t+n$, $t+n-1$, and $t+n-2$; correlations greater than $|0.06|$ are significant at $p < 0.05$.
[a]Pairwise correlations with adoption speed are based on observations used before the cutoff in all Cox proportional hazard models ($n = 429$).

capital. Models 5 and 10 are the saturated models that comprise all controls, outside director incumbency social and human capital, and the interaction term. Adding our focal variables increases log-likelihood and pseudo-R^2 of the models, confirming their explanatory power.

As Models 2 and 7 show, outside director incumbency social capital is significantly positively related to the speed ($\beta = 0.886$, $p < 0.001$) and aggressiveness ($\beta = 0.854$, $p < 0.01$) of e-commerce adoption, which provides preliminary support for H1a and H1b. In Models 4 and 9, outside director incumbency social capital sustains its positive and significant effect on adoption speed ($\beta = 0.822$, $p < 0.01$) and aggressiveness ($\beta = 1.098$, $p < 0.001$). In the saturated Models 5 and 10, outside director incumbency social capital again has a significantly positive effect on both adoption speed ($\beta = 0.934$, $p < 0.001$) and aggressiveness ($\beta = 1.169$, $p < 0.001$). The average marginal effect for adoption speed is significant and positive (dy/dx = 0.085, $p < 0.01$), implying that the time-conditional probability of adopting e-commerce in a given year increases by 8.5% for each additional unit of outside director incumbency social capital.

Next, as observed in Models 3 and 8, outside director incumbency human capital is significantly negatively related to the speed ($\beta = -0.500$, $p < 0.05$) and aggressiveness ($\beta = -0.677$, $p < 0.01$) of e-commerce adoption, providing preliminary support for H2a and H2b. In Models 4 and 9, outside director incumbency human capital maintains its negative and significant effect on adoption aggressiveness ($\beta = -0.510$, $p < 0.05$) and speed ($\beta = -0.752$, $p < 0.01$). In the saturated Models 5 and 10, outside director incumbency human capital is not significant for adoption speed ($\beta = -0.304$, $p > 0.10$), but has a significantly negative relation with adoption aggressiveness ($\beta = -0.880$, $p < 0.001$). The average marginal effect for adoption speed is again significant and negative (dy/dx = −0.069, $p < 0.05$), implying that the time-conditional probability to adopt e-commerce in a given year decreases by 6.9% with each unit of outside director incumbency human capital.[4]

In Models 5 and 10, we find that the interaction between outside director incumbency human and social capital has, on average, no significant impact on adoption speed or adoption aggressiveness. Therefore, we cannot immediately affirm H3a and H3b. To better interpret the interaction terms, we plotted the interaction between low and high degrees of outside director incumbency human capital (±1 standard deviation from the mean) on the relationship between outside director incumbency social capital and the dependent variables (see Figure 3). As hypothesized, higher levels of outside director incumbency human capital reduce the positive effects of incumbency social capital on e-commerce adoption (the differences in the highly significant margins are 0.180 vs. 0.200 for adoption speed and 0.066 vs. 0.129 for aggressiveness). All margins and their 95% confidence intervals are strictly positive.

To analyze these effects in greater detail, we followed Busenbark et al. (2022). Figure 4 shows the impact of outside directors' incumbency human capital on the average marginal effects of their incumbency social capital on adoption speed and aggressiveness, respectively. Likewise, Figure 5 shows the impact

TABLE 2 | Empirical results for adoption speed and adoption aggressiveness.

	Cox proportional hazard models predicting e-commerce adoption timing (adoption speed)					Mixed-effects Poisson models predicting number of e-commerce initiatives (adoption aggressiveness)				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
Outside director incumbency capital										
Outside director incumbency social capital		0.886*** (0.264)		0.822** (0.266)	0.934*** (0.271)		0.854** (0.288)		1.098*** (0.272)	1.169*** (0.275)
Outside director incumbency human capital			−0.500* (0.225)	−0.510* (0.207)	−0.304 (0.257)			−0.677** (0.228)	−0.752** (0.257)	−0.880*** (0.243)
Outside director incumbency social capital × outside director incumbency human capital					0.668 (0.611)					0.387 (0.340)
Control variables										
Board power	−0.110 (0.356)	−0.293 (0.365)	−0.044 (0.358)	−0.131 (0.375)	−0.229 (0.373)	0.449* (0.217)	0.275 (0.212)	0.297 (0.210)	0.038 (0.277)	0.011 (0.284)
Board compensation	−0.118 (0.299)	0.026 (0.331)	−0.050 (0.310)	0.109 (0.353)	0.078 (0.373)	0.090 (0.138)	0.036 (0.162)	0.024 (0.141)	−0.042 (0.172)	−0.039 (0.168)
Board elite education	−0.086 (0.199)	−0.132 (0.232)	−0.050 (0.188)	−0.054 (0.222)	−0.056 (0.228)	0.041 (0.165)	−0.207 (0.157)	0.073 (0.167)	−0.246 (0.174)	−0.208 (0.171)
Board age	−0.020 (0.170)	0.156 (0.189)	0.194 (0.203)	0.342† (0.202)	0.445† (0.243)	−0.025 (0.178)	0.026 (0.169)	0.292 (0.228)	0.336 (0.238)	0.310 (0.228)
Board size	0.242 (0.200)	0.195 (0.194)	0.301 (0.207)	0.237 (0.200)	0.247 (0.194)	0.391 (0.245)	0.271 (0.235)	0.488** (0.185)	0.379* (0.163)	0.377* (0.167)
CEO incumbency social capital		0.484† (0.255)		0.617* (0.297)	0.738* (0.322)		0.330* (0.168)		0.448** (0.142)	0.454*** (0.137)
CEO incumbency human capital			0.428 (0.335)	0.536† (0.282)	0.281 (0.367)			−0.476*** (0.133)	−0.521*** (0.118)	−0.593*** (0.118)
CEO compensation	−0.218 (0.391)	−0.204 (0.433)	−0.182 (0.399)	−0.338 (0.477)	−0.443 (0.527)	0.169 (0.118)	0.156 (0.122)	0.264* (0.113)	0.242* (0.116)	0.225† (0.121)

(Continues)

TABLE 2 | (Continued)

	Cox proportional hazard models predicting e-commerce adoption timing (adoption speed)					Mixed-effects Poisson models predicting number of e-commerce initiatives (adoption aggressiveness)				
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
CEO elite education	0.110 (0.151)	0.118 (0.146)	0.097 (0.148)	0.088 (0.150)	0.032 (0.158)	−0.082 (0.117)	−0.037 (0.110)	−0.104 (0.148)	−0.031 (0.113)	−0.053 (0.126)
CEO age	−0.076 (0.164)	−0.065 (0.165)	−0.176 (0.165)	−0.196 (0.159)	−0.144 (0.161)	−0.011 (0.151)	0.019 (0.143)	−0.223 (0.179)	−0.168 (0.108)	−0.165 (0.107)
R&D intensity	−7.111 (14.421)	−5.102 (14.159)	−4.218 (12.405)	0.599 (12.754)	−2.453 (12.226)	60.465*** (15.385)	57.180*** (12.892)	50.889*** (14.444)	43.858*** (11.061)	44.298*** (11.216)
Slack resources	−0.230 (0.160)	−0.356† (0.193)	−0.266 (0.162)	−0.354* (0.174)	−0.415* (0.187)	0.141 (0.159)	0.047 (0.197)	0.095 (0.114)	−0.004 (0.176)	−0.014 (0.176)
Return on assets	2.967 (3.058)	3.998 (3.376)	5.730† (3.227)	6.632* (3.378)	7.012† (3.693)	7.609* (3.252)	8.346** (3.032)	6.451* (2.752)	7.111** (2.571)	6.714** (2.437)
Total shareholder return	−0.115 (0.194)	−0.089 (0.192)	−0.130 (0.201)	−0.094 (0.194)	−0.090 (0.195)	−0.488 (0.321)	−0.514† (0.285)	−0.541† (0.317)	−0.552† (0.286)	−0.507† (0.279)
Tobin's *Q*	0.156 (0.264)	0.331 (0.267)	0.171 (0.264)	0.321 (0.256)	0.340 (0.264)	−0.941** (0.354)	−0.615 (0.385)	−0.728* (0.317)	−0.405 (0.390)	−0.365 (0.386)
Total assets	0.524 (0.455)	0.763 (0.499)	0.707 (0.480)	0.885† (0.488)	0.972† (0.536)	0.025 (0.570)	0.387 (0.603)	0.146 (0.510)	0.530 (0.568)	0.560 (0.570)
Market capitalization	−0.372 (0.388)	−0.668 (0.409)	−0.573 (0.401)	−0.803* (0.391)	−0.855* (0.421)	0.514 (0.592)	0.206 (0.623)	0.303 (0.504)	−0.065 (0.557)	−0.081 (0.554)
Firm age	−0.003 (0.007)	0.000 (0.007)	−0.002 (0.007)	0.001 (0.008)	0.000 (0.008)	−0.011 (0.007)	−0.011 (0.007)	−0.009 (0.007)	−0.011 (0.008)	−0.010 (0.008)
Family-influenced firm	−0.197 (0.377)	−0.257 (0.374)	−0.255 (0.381)	−0.415 (0.376)	−0.374 (0.364)	−0.954* (0.460)	−1.209** (0.437)	−0.678† (0.404)	−0.893** (0.340)	−0.943* (0.368)
Mail-order business	−0.151 (0.539)	−0.037 (0.557)	−0.249 (0.599)	−0.265 (0.578)	−0.540 (0.680)	0.295 (0.692)	−0.211 (0.758)	0.130 (0.633)	−0.413 (0.657)	−0.461 (0.649)
Other strategic initiatives						0.066* (0.029)	0.051 (0.032)	0.073* (0.029)	0.049 (0.032)	0.054† (0.031)
Constant						−6.602*** (1.831)	−7.691*** (2.018)	−6.159*** (1.508)	−7.008*** (1.748)	−7.106*** (1.773)

(Continues)

TABLE 2 | (Continued)

Variables	Cox proportional hazard models predicting e-commerce adoption timing (adoption speed)					Mixed-effects Poisson models predicting number of e-commerce initiatives (adoption aggressiveness)				
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Log pseudo-likelihood	−171.3	−163.0	−167.9	−159.8	−158.8	−207.5	−203.6	−201.6	−194.6	−194.1
Pseudo-R^2	0.032	0.079	0.052	0.097	0.103	0.264	0.277	0.285	0.310	0.312
Wald χ^2	17.59	54.51***	28.91†	71.54***	74.28***	61,257***	84,379***	118,758***	72,700***	87,242***
Observations	429	429	429	429	429	1111	1111	1111	1111	1111

Note: Year dummies included in all models. Robust standard errors (clustered at firm level) are in parentheses. We used the Efron specification in all Cox proportional hazard models and converted the hazard rates in these models to more intuitive coefficients.
***$p<0.001$.
**$p<0.01$.
*$p<0.05$.
†$p<0.10$.

of outside directors' incumbency social capital on the average marginal effects of their incumbency human capital on adoption speed and aggressiveness, respectively. Both figures confirm that the interaction for adoption speed is not significant ($p>0.05$), whereas the interaction for adoption aggressiveness is significant ($p<0.05$) for at least 90% of all observations. In other words, for adoption aggressiveness, higher levels of outside director incumbency human capital result in increasingly less positive effects of their incumbency social capital, and higher levels of outside director incumbency social capital result in increasingly negative effects of their incumbency human capital. Thus, following Busenbark et al. (2022), we can partially confirm H3b but find no support for H3a.

Our measures for adoption speed and aggressiveness might explain why we found (partial) support only for the interaction effect related to adoption aggressiveness and not for adoption speed. Recall that we measured adoption speed as the first launch of an online shop. Although such shops were certainly novel and of importance for retailers, they might have initially been perceived as nice-to-have objects of curiosity requiring limited investments (Christensen and Tedlow 2000) and even highly entrenched outside directors might have been less opposed to experimenting with online shops. However, costly subsequent investments like strategic alliances and M&A to further develop firms' e-commerce capabilities might have made incumbency human capital-focused boards recoil from aggressive adoption.

5.2 | Post Hoc Analyses, Robustness Checks, and Consideration of Endogeneity

We performed several further analyses to gain additional insights, verify the robustness of our results, and address potential endogeneity. We report detailed explanations and results in the appendices. First, we re-ran our models using the individual components of our incumbency social and human capital measures and found general support for our hypotheses but obtained more nuanced insights into the effects of each component (see Supporting Information: Appendix 3). Second, we performed a computer-aided text analysis of shareholder letters to measure retailers' attention to digital transformation, revealing that it is positively associated with outside director incumbency social capital and negatively associated with human capital, which corroborates our main findings (see Supporting Information: Appendix 4). Third, we conducted extensive robustness checks using alternative model specifications, different operationalizations of outside director incumbency social capital, and additional control variables (see Supporting Information: Appendix 5). Fourth, we addressed potential endogeneity through multiple approaches, which collectively strengthen our confidence in the robustness of our findings (see Supporting Information: Appendix 6).

6 | Discussion

6.1 | Theoretical Implications

Our study makes three central contributions, primarily by bridging scholarly conversations on discontinuous innovation and organizational adaptation with research on outside

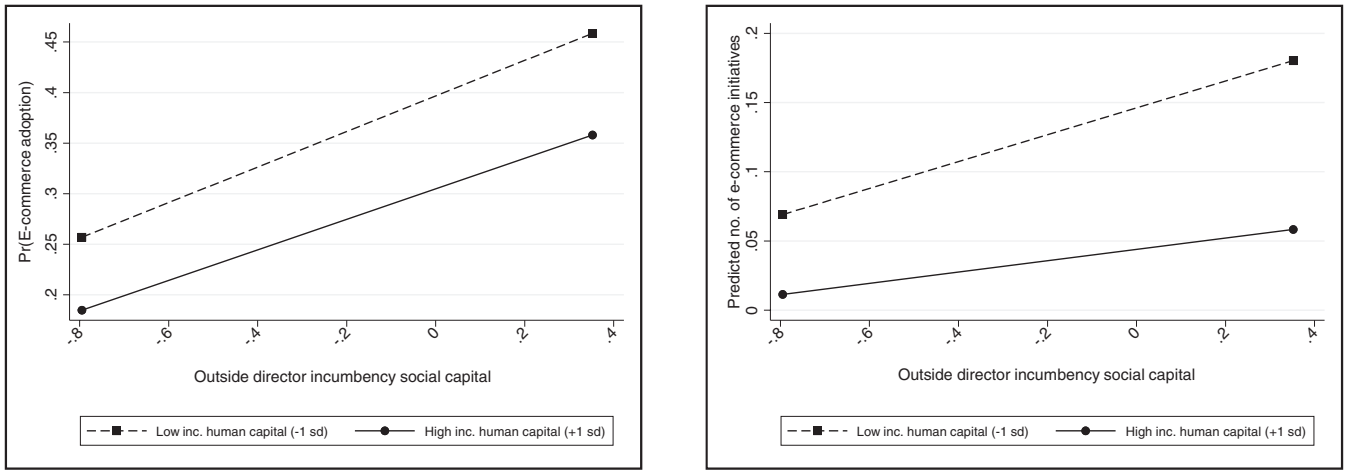

FIGURE 3 | Interaction effects of outside directors' incumbency human capital on the effects of their incumbency social capital on adoption speed (left) and adoption aggressiveness (right).

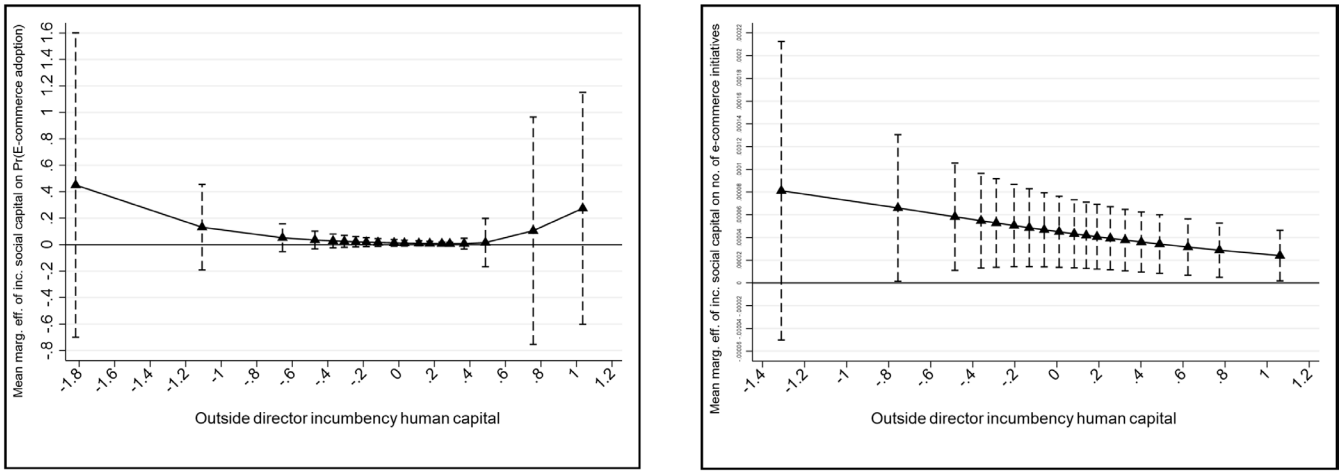

FIGURE 4 | Marginal effects of outside directors' incumbency social capital at various levels of their incumbency human capital on adoption speed (left) and adoption aggressiveness (right).

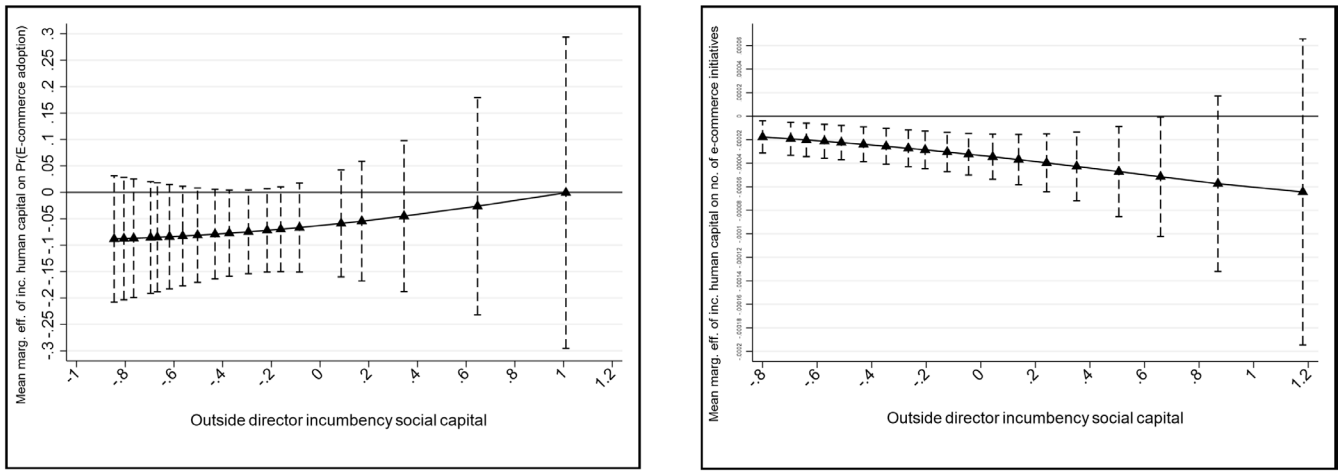

FIGURE 5 | Marginal effects of outside directors' incumbency human capital at various levels of their incumbency social capital on adoption speed (left) and adoption aggressiveness (right).

directors' effects on innovation. First, we introduce and empirically scrutinize a novel board-level perspective on incumbents' heterogeneous adaptation to discontinuous technologies (Eggers and Park 2018; Christensen et al. 2018)—a defining phenomenon in a "new normal" of rapid and potentially disruptive technological change (Weber and Tarba 2014;

Röth et al. 2023) and a unique type of change that inherently requires idiosyncratic adaptability (e.g., Anderson and Tushman 1990; Kammerlander et al. 2018; Hill and Rothaermel 2003). Unlike previous research on strategic leadership in this context (Kurzhals et al. 2020; Reuter and Floyd 2024; Simsek et al. 2024; Shylina et al. 2024), we focus on outside directors and conceptualize how and why a context-specific subset of their characteristics—incumbency capital—affects incumbent adaptation to discontinuous technologies. Given ample evidence for the increasing and unique involvement of outside directors in critical strategic decisions (Westphal and Garg 2021; Haynes and Hillman 2010; Boivie et al. 2021), as well as emerging calls for specific board-level research on discontinuous change (Hoppmann et al. 2019), we thus add a particularly meaningful facet to research on incumbent heterogeneity.

Second, our theorizing offers nuanced and partially counterintuitive insights into how board members' capital impacts organizational innovation and adaptation. Particularly, the speed and aggressiveness of discontinuous technology adoption have not previously been linked to outside directors' characteristics. In this regard, our findings about the positive relations of outside director incumbency human capital with incumbent inertia align well with the traditional portrayal of established resources—including a deep internalization of the ruling technological paradigm and how it has been historically enacted by the focal incumbent—as inherent sources of inertia (König et al. 2012; Leonard-Barton 1992; Weber et al. 2019; Tripsas and Gavetti 2000; Eggers and Kaplan 2009; Kammerlander et al. 2018; Danneels et al. 2018; Vuori and Tushman 2024). However, our findings regarding the advantages of outside director incumbency social capital challenge existing theory, particularly classic theory on nonparadigmatic technological change (Dosi 1982; Kaplan and Tripsas 2008; König et al. 2012). Specifically, we build on the idea that an incumbent's discontinuous technology adoption is a politically highly contested context as it involves extreme levels of uncertainty and violates central economic and sociocognitive expectations (Afuah 2000; Garud and Rappa 1994; Kaplan 2008b). We argue that, in this context, outside directors can use their ties into the "old world" (Hoppmann et al. 2019, 454), that is, established business and elite social circles, to "offset" (Benner and Ranganathan 2012, 213) the inherent illegitimacy of an incumbent's adoption of a discontinuous technology—at least as long as the outside directors are not highly cognitively entrenched in the established technological paradigm.

As such, we add a unique perspective to the conversation about the idiosyncratic challenges of incumbent firms to gain legitimacy while introducing innovations (Graf-Vlachy et al. 2023; Benner and Ranganathan 2017). Notably, this conversation has recently gained particular momentum in the context of incumbents' attempts to establish business ecosystems and digital platforms (Khanagha et al. 2022), also because incumbent adopters' legitimacy struggles quintessentially differ from those of new entrants introducing discontinuous technologies (Ansari et al. 2016). Altogether, outside directors' social incumbency capital may be a specific form of what Röth et al. (2019, 545) have termed "political capabilities" in the sense that it can help incumbent adopters to overcome political and economic barriers that otherwise paralyze incumbents' discontinuous technology adoption.

Third, our research also adds to a more nuanced and contextualized view of board capital, especially its role in strategic innovation (Lungeanu and Zajac 2019; Sierra-Morán et al. 2024). Almost all existing research portrays board capital positively, as a vital ingredient to strategic renewal and innovation (Hudson and Morgan 2023; Khanna et al. 2014; Li 2019; Zahra et al. 2009; Bazel-Shoham et al. 2024; Hillman and Dalziel 2003; Bendig et al. 2020). However, recently, scholars have begun to offer a more nuanced perspective, highlighting potential "dark sides" of certain facets of board capital and the impact of context on the effectiveness of board capital (Oehmichen et al. 2017; Sundaramurthy et al. 2014; Kraft and Bausch 2018; Haynes and Hillman 2010; Tian et al. 2011; Sun et al. 2016).

We add a theoretically new and empirically meaningful facet to this literature by studying outside director *incumbency* capital. This concept highlights the specific implications of paradigm-consistent resources in the unique context of discontinuous innovation, a context neglected in most previous research on boards and innovation. We also develop a conceptual framework to examine its potentially harmful implications, particularly as it relates to outside director incumbency human capital as a source of organizational inertia—in isolation and when paired with outside director incumbency social capital. Notably, our theorizing in this regard deviates from prior literature, which has highlighted "deep-level" expertise in the established industry as particularly valuable (Oehmichen et al. 2017; Kor and Misangyi 2008). All in all, our study responds to calls for more nuanced investigations of board member characteristics (Johnson et al. 2013), especially in the context of discontinuous innovation (Hudson and Morgan 2023; Kurzhals et al. 2020; Sundaramurthy et al. 2014).

6.2 | Practical Implications

Our research also has practical implications, resonating with a growing interest among practitioners in the role of boards in innovation (Cheng and Groysberg 2018). Most importantly, we provide guidance for boards and shareholders in times of discontinuous technological change. We suggest they strive for the right combination of directors' incumbency social capital (i.e., ties to the established industry and elite networks) and incumbency human capital (i.e., technological expertise and board experience).

First, in the context of discontinuous technological change, shareholders should consider seeking outside directors with high levels of incumbency social capital, as outside directors who are particularly connected with legacy stakeholders can promote the adoption of discontinuous technologies. Their ties to other incumbent industry companies and broader social elite circles afford them the relational legitimacy to gain the buy-in incumbents need to embrace a discontinuous technology, even during the technology's emergence when its commercial potential is still uncertain. Consequently, firms may appoint outside directors with these important ties or encourage their current outside directors to develop them.

Second, if they seek faster and more aggressive discontinuous technology adoption, we recommend shareholders look for outside directors with low incumbency human capital to ensure that they are cognitively unconstrained by the established technological paradigm and open to the emerging discontinuous technology. Primarily, our results suggest that shareholders might wish to appoint directors who hold science and engineering degrees to further discontinuous technology adoption. Simply swapping out old for new outside directors—reducing mean incumbent board experience—may not be enough, given that the statistical effect of outside directors' incumbent board experience was mostly nonsignificant. If firms do not want to replace directors, technology-focused training may help expose directors to emerging trends and perspectives.

Importantly, a caveat to our recommendations is that, as we have pointed out, many discontinuous technologies may ultimately fail. However, if they succeed, failure to adopt them in time can have formidable consequences for incumbents (Vuori and Tushman 2024).

7 | Limitations, Future Research, and Conclusion

Our study has limitations that present future research avenues. First, we deliberately followed the convention of focusing on outside directors as a distinct subgroup of the board (Johnson et al. 2013). However, prior research has shown that the human and social capital of outsiders versus insiders can influence firms' innovation inputs differently (Dalziel et al. 2011), suggesting that studies of the specific differences and interactions between outside and inside directors would be valuable. Although we refrained from parsing out board subgroup effects (Johnson et al. 2013), we suggest it might be fruitful to study how such differences affect power dynamics within boards (e.g., Zhu 2013, 2014) and concomitant innovation outcomes. In particular, complementarities between outside and inside directors in terms of expertise and networks might be impactful.

Second, we conceptualized our independent variables in an industry- and technology-agnostic way for the sake of a broader contribution. Future research may pursue context-specific operationalizations, such as measures of directors' experience with particular discontinuous technologies. Relatedly, our focus on outside director *incumbency* human capital excluded other specific types of human capital—including cognitive managerial abilities (Helfat and Martin 2015), emotional capabilities (Vuori and Huy 2022), or cognitive complexity (Graf-Vlachy et al. 2020)—that may independently or interactively influence incumbent adaptation. We encourage scholars to test these and other capabilities.

Third, we measure adoption aggressiveness as the sum of strategic alliances and M&A deals. Naturally, it would be ideal to also include firm-internal initiatives. However, firms rarely disclose these (Haynes and Hillman 2010). Our aggressiveness measure is also limited in that the dollar amounts invested in alliances and M&A were not available. Survey-based studies might gather this data to further validate our findings on adoption aggressiveness.

Fourth, our research focuses on adoption speed and aggressiveness, which are particularly important for discontinuous technology adoption (Eggers and Kaplan 2009; Gerstner et al. 2011; König et al. 2021) but do not guarantee success. Hence, other dimensions of adoption should also be considered. For instance, König et al. (2013) highlighted that adoption stamina and the flexibility of adoption—the opposite of routine rigidity (Gilbert 2005)—are other crucial facets of discontinuous technology adoption. Future studies could explore the implications of incumbency capital for these additional facets or study effects on what Adner and Snow (2010, 76) called a "bold retreat."

Fifth, and relatedly, there is ample opportunity to study actual adoption success. Future research could explore how outside director incumbency capital not only affects how fast and aggressively incumbents adopt discontinuous technologies but also whether they manage to develop commercially viable business models around them. Scholars could also examine how adoption speed and aggressiveness affect long-term success, including the ideal timing for adopting a discontinuous technology (Suarez and Lanzolla 2007; Maula et al. 2013).

In conclusion, our study shows that key facets of board capital could indeed have distinct and interactive effects on incumbent adaptation to discontinuous technologies. It also answers calls to investigate how strategic leaders' social connections and cognition shape incumbents' ability to identify and exploit digital opportunities (Röth et al. 2023). We hope our findings stimulate further research on the role of nonexecutive leaders in overcoming inertia and enhancing adaptability to novel technologies.

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Ethics Statement

The authors have read and agreed to the Committee on Publication Ethics (COPE) international standards for authors.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Research data are not shared.

Endnotes

[1] Notably, the research focused on strategic leadership and discontinuous technology adoption relates to but inherently differs from research studying the impact of strategic leadership characteristics on more

general forms of innovation Arzubiaga et al. (2018); Dalziel et al. (2011), patenting An et al. (2021); Hsu et al. (2024); Chen et al. (2025); Genin et al. (2023); Balsmeier et al. (2014), or research that is rather agnostic to the degree of innovation discontinuity, such as Cummings and Knott (2018) or van de Wal et al. (2020).

[2] Parts of the dataset used in this research were used in Szewczyk et al. (2022) to examine how family influence affects incumbents' adoption speed and aggressiveness of discontinuous technologies. Importantly, although the dependent and control variables substantially overlap, the present study takes a different theoretical perspective and therefore employs entirely distinct independent variables (while explicitly controlling for family influence).

[3] For the 1.89% cases with missing observations for individual equity holdings, we computed the index without them. Imputing the values based on values from the prior or next year yielded consistent results.

[4] We used discrete time-to-event models (as implemented in Stata's *xtcloglog*) for all marginal effects analyses regarding adoption speed because Cox proportional hazard models, by design, do not estimate specific hazard rates—they only assume that the hazard rates are proportional. Thus, investigating an absolute or relative change of the hazard rate is inherently inaccurate.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** jpim70006-sup-0001-Supinfo.docx.

Biographies

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