CORPORATE DEVELOPMENT AS AN ADAPTIVE MECHANISM IN EVOLVING TECHNOLOGY ECOSYSTEMS: THREE ESSAYS

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As contemporary business environments across the globe are increasingly affected by the advent of disruptive technologies, several technology ecosystems are in a consistent state of flux driven by the fast paced and discontinuous nature of technological change. This dissertation addresses the adaptive role of firms' corporate development decisions in these dynamic and fast changing environments. I theorize on and empirically evaluate the role of four corporate development decisions – internal development, alliances, acquisitions and divestitures as adaptive mechanisms towards improving the likelihood of survival in evolving technology ecosystems.

This dissertation examines how corporate development decisions exert an adaptive influence on strategic decisions taken at the product portfolio level (essay one), firm level (essay two) and transaction level (essay three). Each essay focuses on a unique challenge that accosts managers in evolving technology ecosystems – product configuration (essay one), corporate growth (essay two) and technology driven inertia (essay three). Also, each essay proposes that corporate development decisions contribute to the adaptive behavior of firms in different ways and hence, they represent strategic alternatives through which managers can overcome these challenges to enhance the likelihood of survival of their firms in evolving technology ecosystems.

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PREFACE

"If I have seen further, it is by standing on the shoulders of giants." - Sir Isaac Newton

No major initiative in a person's life can be considered complete without acknowledging the collaborative and supportive efforts of mentors, colleagues and loved ones. My dissertation bears no exception to this rule and there have been several individuals who have made it a reality. My heartfelt gratitude goes to my advisor and mentor, Prof. John E. Prescott who was a guiding light to my scholarly efforts well before I arrived in Pittsburgh, PA to begin the doctoral program in strategic management at the Katz school. His scholarly and insightful views on multiple research questions and projects have been seminal to my research program of which this dissertation forms a central part. His emphasis on scholarly research having a high level of managerial relevance is one of the cornerstones of this dissertation. Prof. Prescott's flexibility with time, patience with my struggles and failures and constant encouragement have been critical to forging and sustaining my scholarly spirit. I hope our collaboration can continue beyond this dissertation to alternative conundrums in corporate strategy.

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A token of gratitude goes to all the teachers in my life (in presence and in spirit) in addition to my mentors and guides from the Katz doctoral program. These individuals have always taught me the value of proactively maintaining a scholarly spirit and an intellectually inquisitive mind – Mr. C. Natarajan, Mr. C.D. Sinha (late), Mr. Prem Prakash, Ms. Sabitha Raghunath, Mr. Terry Goodwin and Prof. Ilias Tsiakas. Finally, this dissertation has been influenced to a significant extent by the late Prof. Sumantra Ghoshal (thanks to his books and to YouTube!). His infectious enthusiasm and boundless energy for management scholarship has been a consistent source of motivation. Given his cherished goal of scholarly work being relevant to the immediate needs of practicing managers, I hope my dissertation presents a meaningful message for a corporate strategy practitioner who happens to read it.

The above-mentioned individuals indeed have been the metaphorical giants who were kind enough to lend me their shoulders to stand and see ‘further’.

1. INTRODUCTION

Since the inception of strategic management research, firm adaptation to rapidly changing external environments has been theorized to be a central driver of firm heterogeneity – a significant concern for strategic management scholars (Aldrich, 1979; Drazin and Van de Ven, 1985; Levinthal, 1991; Miller and Friesen, 1983; Porter, 1980; Prescott, 1986; Rumelt, Schendel and Teece, 1994; Scott and Davis, 2006). Within this narrative of scholarly research, corporate strategy scholars have upheld the role of a firm's corporate development function as a central pillar of its corporate strategy (Ansoff, 1965; Capron and Mitchell, 2012; Dyer, Kale and Singh, 2004; Puranam and Vanneste, 2016). The decisions aligned to the corporate development function (e.g. internal development, alliances, acquisitions and divestitures) underpin critical firm level outcomes such as product market survival, growth, profitability and shareholder returns. As a result, these decisions are popular in the realm of corporate strategy practice as they enable managers to leverage several drivers of competitive advantage.

As contemporary business environments across the globe are increasingly affected by the advent of disruptive technologies, several technology ecosystems are in a consistent state of flux driven by the fast paced and discontinuous nature of technological change (Adner and Kapoor, 2010; 2016; Dattee, Alexy and Autio, in press; McIntyre and Srinivasan, 2017; Parker, Van Alstyne and Choudary, 2016). Firms serving as the vanguards of technological disruption – Apple, Amazon, Alphabet and Microsoft have been responsible for disrupting established technology and product market ecosystems thus threatening the corporate vitality and longevity of firms left trailing in their path (Gawer and Cusumano, 2002; Galloway, 2017; Simon, 2011). For firms that are less endowed and more reactive in strategizing in evolving technology ecosystems, adaptation becomes critical to ensuring survival. Scholarly and practitioner findings show that about 50 percent of firms in the Standard and Poor 500 Index are embedded in global technology ecosystems experiencing diverse variants of technological change (Hsu and Prescott, 2017; Kim et.al., 2015; Pricewaterhouse Coopers, 2016). These are - technological convergence (Hsu and Prescott, 2017), legacy vs new technology dialectics (Eggers and Park, 2018), eras of ferment (Benner and Tripsas, 2012), technology speciation and exaptation (Cattani, 2006; Garud, Gehman and Giuliani, 2016) and non-linear variants of technological substitution or obsolescence (Adner and Kapoor, 2016).

In view of this, corporate strategy practitioners have heralded the role of corporate development decisions as adaptive mechanisms that improve the likelihood of product market and firm survival in these environments. About 61 percent (on average) of corporate strategy practitioners surveyed by prominent global management consulting organizations think that the corporate development function is likely to assume survival enhancing significance as technology ecosystems evolve under the influence of technologies such as the Internet of Things, blockchain, artificial intelligence, artificial and virtual reality and machine learning (The Boston Consulting Group, 2016, 2017; Deloitte, 2016, 2018; Ernst and Young, 2015). Corporate strategy scholars seem to concur with this prediction with research on corporate development decisions being a subject of growing interest in recent years (Capron and Mitchell, 2012; Kapoor and Lee, 2013; Kapoor and Klueter, 2015; Lungeanu, Stern and Zajac, 2016; Stettner and Lavie, 2014). Given the rapidly transforming landscape of global technology ecosystems and the concurrent acknowledgement of the need for adaptive action by corporate strategy managers and scholars, a pertinent question that arises is – *'How do corporate development decisions enable firms to adapt* *to technological change and increase the likelihood of survival (product market/firm level) in rapidly evolving technology ecosystems?'*

This dissertation addresses this question by theorizing on and empirically evaluating the role of four corporate development decisions – internal development, alliances, acquisitions and divestitures as adaptive mechanisms towards improving the likelihood of survival as technological ecosystems undergo structural and strategic change. Each of the three essays comprising this dissertation employs a distinctive context of change affecting technology ecosystems and examines how corporate development decisions exert an adaptive influence on strategic decisions taken at the product portfolio level (essay one), firm level (essay two) and transaction level (essay three). The dissertation addresses three different types of strategic challenges that managers face during these contexts – what is an appropriate product configuration? (essay one), how can the firm achieve corporate growth? (essay two) and how can the firm overcome the inertia of a legacy technology? (essay three). It proposes that corporate development decisions represent a strategic alternative through which managers can overcome these challenges and enhance the likelihood of survival of their firms in evolving technology ecosystems.

Essay one employs the empirical context of an era of ferment in the mass market photography ecosystem between 1991-2006. It studies how three corporate development decisions - alliances, internal development – patenting and acquisitions assumed the role of knowledge accessing adaptive mechanisms and enabled firms to overcome the survival-threatening disadvantages of a feature implementation gap arising in digital camera product models. The challenge of maintaining an optimal product configuration increased in significance as the mass market photography ecosystem evolved to support digital camera firms and led to the obsolescence of analog photography ('adaptation at the product level').

Essay two uses the empirical context of technological convergence in the telecommunication equipment (equipment) and computer networking (networking) ecosystems between 1989-2003. It focuses on how four corporate development decisions: internal development, alliances, acquisitions and divestitures served as exploratory and exploitative growth modes that affected the relationship between a firm's growth orientation and its likelihood of surviving in the converging product market ecosystem ('adaptation at the firm level'). The advent of packet switching (networking) technologies substituted for the legacy circuit switching (equipment) technologies led to product market convergence, posing the challenge of seeking new sources of revenue and market share for corporate growth to managers.

Essay three returns to the empirical context of the mass market photography ecosystem by focusing on the substitutive effect that the emergence of digital photography exerted on analog photography between 1991-2006. It studies how the choice and implementation of two corporate development decisions: new technology (digital photography) acquisitions and legacy technology (analog photography) divestitures contributed to resource reconfiguration ('adaptation at the transaction level'). This enabled managers to overcome the challenge of technological substitution from digital photography that had adverse implications for the legacy technology of analog photography in terms of survival in the evolving technology ecosystem.

In the following sections, I provide descriptive commentary on each essay in terms of the research question, theoretical framework, empirical context and results and intended contribution. I then conclude with a bird's eye view of where this dissertation fits in the broader landscape of corporate strategy research and managerial practice given the reality of fast changing and continuously evolving technology ecosystems.

1.1 ESSAY ONE - SURVIVING THE “LIABILITY OF FERMENT” IN AN ERA OF FERMENT – THE MODERATING ROLE OF CORPORATE SCOPE

Eras of ferment are periods of change for technology ecosystems affecting both their demand and supply sides (Adner, 2017; Adner and Kapoor, 2010, 2016; Kapoor and Lee, 2013). On the demand side, changes in customer preferences influence the desirability of a firm’s products (Benner and Tripsas, 2012; Benner and Waldfogel, 2016). On the supply side, corporate scope decisions affect the types of product features that a firm offers (Davis, 2016; Kapoor and Lee, 2013). Firms that do not adopt the features of the evolving product dominant design are disadvantaged and theorized to exit the ecosystem (Anderson and Tushman, 1990; Suarez and Utterback, 1995; Tegarden, Hatfield and Echols, 1999). Given that product market survival determines the winners and losers after the proverbial dust has settled on an era of ferment, understanding how corporate scope decisions facilitate firms in adopting features of the evolving product dominant design to enhance the likelihood of product market survival has strategic relevance.

I theorize that one driver that threatens product market survival is a firm’s *feature implementation gap* defined as ‘the number of features of the evolving product dominant design that are absent from a given firm’s product design’. I also theorize that the focal mechanism that explains the relationship between a firm’s feature implementation gap and product market exit is the *‘liability of ferment’*. When a firm has a feature implantation gap, it is subject to a liability of ferment due to competitive disadvantages in the product market ecosystem (Christensen, Suarez and Utterback, 1998; Suarez and Utterback, 1995; Tegarden et.al., 1999) and delegitimization by institutional stakeholders leading to a threat to product market survival (Aldrich and Fiol, 1994; Baum and Oliver, 1991; Ruef and Scott, 1998).

The joint effect of demand-side changes in customer preferences for product features and the strategic relevance of supply-side corporate scope decisions as adaptive mechanisms in technology ecosystems experiencing an era of ferment motivated my research question. *In an era of ferment, how do corporate scope decisions (alliancing, internal development and acquisitions) moderate the relationship between a firm's feature implementation gap and its likelihood of product market survival?*

Second, adopting a knowledge-based view (KBV) lens, I theorize that in an era of ferment, corporate scope decisions represent knowledge accessing adaptive mechanisms on the supply side of the technology ecosystem (Capron and Mitchell, 2012; Katila and Ahuja, 2002; Mowery, Oxley and Silverman, 1996; Vermeulen and Barkema, 2001). These decisions facilitate access to extramural knowledge (e.g. technological, product, market and customer related knowledge) through alliancing and acquisition activity (Mowery et.al., 1996; Vermeulen and Barkema, 2001) or leveraging knowledge within firm boundaries (i.e., patenting) (Katila and Ahuja, 2002; Rosenkopf and Nerkar, 2001).

Using a longitudinal dataset of 843 firm-years involving 62 firms that participated in an era of ferment (1991-2006) in the mass market photography product market ecosystem, I used event history modeling and found that a firm's feature implementation gap had a negative effect on its product market survival (i.e. increased the hazard rate of product market exit). Firms' alliancing and acquisitions activity negatively moderated this relationship (decreased the hazard rate of exit). I found that the moderating effect of feature specific knowledge breadth patenting increased the hazard rate of product market exit but that feature specific knowledge depth patenting decreased the hazard rate of product market exit.

This essay makes two contributions to era of ferment and corporate scope streams of research. First, I contribute to research on eras of ferment by adopting a demand side perspective and theoretically linking it to product market survival. I develop theory as to how the lack of alignment at the feature level between a firm's product design and the evolving dominant design creates a feature implementation gap that imperils product market survival in technology ecosystems experiencing an era of ferment. By taking a demand side perspective (product feature level), I complement research on eras of ferment that takes a product configuration and entry timing perspective (e.g., Benner and Tripsas, 2012; Eggers, 2016; Tegarden et.al., 1999)

Second, drawing on the KBV, I add a novel perspective to the era of ferment literature by theorizing on the importance of supply side corporate scope decisions as knowledge accessing adaptive mechanisms that weaken or strengthen the negative effect of a feature implementation gap. Together, both contributions provide a novel perspective to research on eras of ferment by linking the supply and demand sides of technology ecosystems during an era of ferment and theorizing how they jointly affect product market survival in heterogeneous ways.

1.2 ESSAY TWO - "PROLIFERATE AND MOBILIZE" – HOW FIRMS EXPLORE AND EXPLOIT THROUGH GROWTH MODES TO SURVIVE IN EVOLVING TECHNOLOGY ECOSYSTEMS

Change in technology ecosystems require firms to adapt their growth strategies or face the threat of failure due to technological substitution/obsolescence (Adner and Kapoor, 2016; Christensen et.al., 1998; Tripsas and Gavetti, 2000). Rapidly evolving technology ecosystems are characterized by the emergence of new product markets (growth markets) underpinning opportunities for increasing revenue and market share (Luksha, 2008; Navis and Glynn, 2010; Woolley, 2010). Firms that realign their revenue and market share enhancement strategies around growth markets are more likely to survive as they can overcome the threats of technological substitution and obsolescence (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993).

In this context, I theorize that a firm's *growth orientation* increases its likelihood of survival in evolving technology ecosystems as it is an adaptive response to technological change (Favaro, Meer and Sharma, 2012; Gulati, 2004; Penrose, 1959). Growth orientation is defined as 'the relative emphasis placed on the investment of firm resources towards increasing revenue and market share'. It is based on identifying and accessing new growth opportunities for increasing revenue and market share (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993). It also entails committing resources to develop and leverage a limited subset of growth opportunities while diverting resources away from less attractive growth opportunities (Helfat and Eisenhardt, 2004; Chakrabarti, Vidal and Mitchell, 2011; Kaul, 2012).

A firm's corporate development decisions - internal development, alliances, acquisition and divestitures represent *growth modes* that drive the revenue and market share growth imperatives of firms (Capron and Mitchell, 2012; Dyer et.al., 2004). I theorize that firm growth modes are adaptive mechanisms that influence the relationship between growth orientation and the likelihood of firm failure through their ability to support the survival enhancing benefits of a growth orientation thus motivating my research question – *In evolving technology ecosystems, how do growth modes (i.e. internal development, alliances, acquisitions and divestitures) moderate the relationship between growth orientation and the likelihood of firm failure?*

To address this research question, I theorize that growth modes represent domains through which firms selectively determine the *degree of exploration and exploitation* defined as the relative emphasis on exploratory or exploitative corporate development decisions aligned to a given growth mode (Lavie and Rosenkopf, 2006; Lavie, Kang and Rosenkopf, 2011; Stettner and Lavie, 2014). A high degree of exploration within a growth mode implies a focus on distant search and technological variation - entering new product markets to identify and access opportunities for revenue and market share growth (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993). A high degree of exploitation within a growth mode implies local search or selection - committing resources to develop and leverage a limited subset of opportunities and diverting resources away from less attractive opportunities for achieving growth related outcomes (Helfat and Eisenhardt, 2004; Chakrabarti et.al., 2011; Kaul, 2012). As growth modes allow firms to selectively modify the relative emphasis on exploration or exploitation, they represent adaptive mechanisms that decrease the likelihood of firm failure.

My empirical context is a salient case of technological change involving the convergence between the telecommunication equipment and computer networking product market ecosystems during 1989-2003 (Hsu and Prescott, 2017; Lee, 2007). Using a sample of 3,327 growth mode decisions made by firms in both sets of product markets, I examined my hypotheses using event history modeling. First, I found that maintaining a growth orientation had a negative effect on the likelihood of firm failure. Subsequently, I found that a high degree of exploration in the internal development and alliance activity growth modes exerted a *'growth proliferation effect'* that strengthened the negative effect of growth orientation on firm failure. Finally, I found that a high degree of exploitation in the acquisition and divestiture activity growth modes exerted a *'growth mobilization effect'* that strengthened the negative effect of growth orientation on firm failure. My findings indicate that firms that selectively emphasized exploration in certain growth modes i.e. internal development and alliance activity while emphasizing exploitation in alternative growth modes i.e. acquisition and divestiture activity were less likely to fail as they managed the twin imperatives of search and selection with their growth modes for superior adaptability.

This paper makes two contributions to strategy research. First, I contribute to scholarly research at the intersection of corporate strategy and firm growth by demonstrating how firm growth modes serve as adaptive mechanisms in evolving technology ecosystems. By theorizing on the growth proliferation and growth mobilization effects, I demonstrate that a plausible driver of firm heterogeneity refers to the differences in firm growth mode choices and their influence on the relationship between growth orientation and survival. Second, I contribute to scholarly work on exploration/exploitation by showing the role of exploration and exploitation towards firm growth – a theoretical link that has received scant attention (cf. Raisch, 2008). By theorizing and finding support for the two effects, I extend research at the intersection of corporate strategy and exploration/exploitation by showing how selectively modifying the relative emphasis on exploration and exploitation in a firm's growth modes improved the adaptive capability of the firm thus increasing its likelihood of survival during technological change.

1.3 ESSAY THREE - "REINFORCE, ATTENUATE, RECONCILE" – HOW RESOURCE RECONFIGURATION THROUGH CORPORATE SCOPE DECISIONS OVERCOMES THE INERTIA OF A LEGACY TECHNOLOGY ORIENTATION

Resource reconfiguration (Folta, Helfat and Karim, 2016; Karim and Capron, 2016) assumes importance as an adaptive mechanism when the emergence of a new technology poses a threat of obsolescence or substitution to firms with legacy technology units – business units operating in technology ecosystems based on an established or pre-existing technology (Agarwal and Helfat, 2009; Lavie, 2006; Sosa, 2011). Legacy technology units are vulnerable to a *'legacy technology orientation'* defined as– 'the relative emphasis on technological knowledge and products aligned to an incumbent technology'. To enhance the likelihood of product market survival, resource reconfiguration involves reconciling the tension between inertia associated with legacy technology units and adaptation to the new technology ecosystem (Adner and Snow, 2010; Huy, 2002).

While resource reconfiguration assumes many forms, focusing on corporate scope decisions represents one way to examine what firms do to reconfigure their resources (i.e., acquisitions and divestitures) and how they reconfigure their resources (i.e., structural arrangement choices for integrating acquired resources and divesting resources) (Capron, Dussauge and Mitchell, 1998; Capron, Mitchell and Swaminathan, 2001; Puranam, Singh and Zollo, 2006). Corporate scope decisions and their associated structural arrangement choices are central to the reconciliation of the tension between the two technologies as they affect the joint deployment of legacy and new technology resources that have a high potential for redeployment, recombination and complementarity (Cassiman and Veugelers, 2006; Galunic and Rodan, 1998).

As product market survival is an outcome of successful adaptation in evolving technology ecosystems (Barnett and Hansen, 1996; Christensen et.al., 1998; Josefy et.al., 2017), how resource reconfiguration through corporate scope decisions and their structural arrangement choices enable firms to overcome and reconcile the inertia of a legacy technology orientation to improve the likelihood of product market survival is a strategic issue. The lack of theoretical insight into this issue and its relevance in managerial domains motivated my research question – *In evolving technology ecosystems, how does resource reconfiguration through corporate scope decisions and their structural arrangement choices affect the likelihood of product market survival?*

I approach this research question in three stages. First, I theorize that a legacy technology orientation exerts a *'legacy reinforcement effect'* that decreases the likelihood of resource reconfiguration through scope expanding new technology acquisitions and scope reducing legacy technology divestitures. A legacy reinforcement effect is driven by inertia associated with relatedness and coherence logic that contextualizes a legacy technology orientation (Ahuja and Lampert, 2001; Burgelman, 2002; Tripsas and Gavetti, 2000). Second, I theorize that new technology alliance experience induces a *'legacy attenuation effect'* that weakens the negative effect of legacy technology orientation and increases the likelihood of acquisitions and legacy divestitures. Alliance experience, a knowledge accessing mechanism, enhances absorptive capacity in the new technology thereby leading to greater familiarity and awareness of the threat posed by the new technology (Eggers and Kaplan, 2009; Lane, Salk and Lyles, 2001; Maula, Keil and Zahra, 2013; Schildt, Keil and Maula, 2012).

Third, I theorize that in the event of new technology acquisitions or legacy technology divestitures, firms that survived were more likely to adopt hybrid structural arrangements (e.g. partial integration or partial selloffs) instead of pure structural arrangements (e.g. full integration or unit selloffs) leading to a *'legacy reconciliation effect'*. Hybrid structural arrangements involve the joint deployment of legacy and new technology resources that have a high reconfiguration potential (i.e. capability for redeployment, recombination or complementarity) while isolating resources with low reconfiguration potential (Capron et.al., 1998, 2001; Moschieri and Mair, 2017; Zaheer, Castaner and Souder, 2013). Hybrid structural arrangements harmonize the pre-existing legacy context with the emerging new technology context thereby enhancing product market survival (Kale, Singh and Raman, 2009; Puranam, Singh and Chaudhuri, 2009).

Using a longitudinal dataset of 843 firm years based on 62 firms in the mass market photography product market ecosystem over the period 1991-2006, I found support for the hypothesized effects. As the technology ecosystem evolved due to the shifting emphasis on digital photography, I found that a legacy technology orientation aligned to analog photography exerted inertia decreasing the likelihood of new technology acquisitions and legacy technology divestitures unless they gained new technology alliance experience. Further, firms with legacy technologies were more likely to survive when they made new technology acquisitions and legacy technology divestitures while adopting hybrid structural arrangements for resource reconfiguration.

Recent work on resource reconfiguration has studied the role of resource redeployment and resource/unit recombination as antecedents to reconfiguration (Folta et.al., 2016; Galunic and Rodan, 1998; Karim and Kaul, 2015), reconfiguration as an environment alignment mechanism (Chakrabarti et.al., 2011); the role of reconfiguration in technological innovation contexts (Kaul, 2012); heterogeneity in reconfiguration approaches (Lavie, 2006) and reconfiguration in multi-business firms (Martin and Eisenhardt, 2010). My study contributes to the literature on resource reconfiguration in two ways. First, in contexts of changing technology ecosystems, when organizational inertia poses a challenge to firm adaptation, I theorize on how the nuances of resource reconfiguration associated with the legacy reinforcement, attenuation and reconciliation effects improve the likelihood of product market survival. Second, my work emphasizes the importance of both ‘what’ firms do as part of resource reconfiguration (corporate scope decisions) and ‘how’ they undertake resource reconfiguration (structural arrangement choices). My work demonstrates that corporate scope decisions and structural arrangement choices are sources of firm heterogeneity that influence product market survival in evolving technology ecosystems.

1.4 CONTRIBUTION AND MANAGERIAL IMPLICATIONS

Two common threads link the three essays of my dissertation. First, each essay contributes to scholarly research at the intersection of corporate strategy and technology ecosystems by employing multiple theoretical lenses situated in strategy and organizational theory (Scott and Davis, 2006).

Essay 1 links the demand side (product level features) of an evolving technology ecosystem characterized by an era of ferment with the supply side (corporate development decisions as knowledge accessing adaptive mechanisms) to develop a theory of product market survival. It provides a knowledge based view (KBV) perspective to the adaptive role of corporate development decisions and their contribution to product market survival in this context.

Essay 2 connects the role of corporate development decisions as agents of exploration and exploitation with the survival enhancing benefits associated with a firm’s growth orientation to develop a theory of firm survival in evolving technology ecosystems. It demonstrates the role of exploration and exploitation and how firms selectively emphasize the two through their corporate development decisions to supplement the growth imperative in these contexts.

Essay 3 links the resource reconfiguring capability of corporate development decisions with the imperative of overcoming the inertia of a legacy technology orientation to develop a theory of product market survival in evolving technology ecosystems. Hence, it introduces a resource reconfiguration perspective to how corporate development decisions mitigate the threat to product market survival during the interplay between legacy and new technologies.

Second, each essay demonstrates the significance of the firm's corporate development function towards addressing and overcoming different types of challenges that managers face in evolving technology ecosystems. An associated message of the dissertation to managers is that corporate longevity and competitive fitness and agility can be inculcated by developing a broad and multifaceted corporate development function. Hence, firms that have the resources, knowledge and capabilities to leverage multiple types of corporate development decisions are more likely to survive in these dynamic and fast-changing environments.

Essay one emphasizes the significance of corporate development decisions as knowledge accessing vehicles that contribute to product reconfiguration and hence enhance the firm's competitive edge in product markets where the dominant product configuration is yet to be determined. Thus, the underlying message to practicing managers is that acknowledging the importance of these knowledge accessing vehicles may well be the difference between survival or exit from relevant product markets.

From essay two, practitioners may note the role of corporate development decisions as growth modes that search for new growth opportunities while consolidating growth related outcomes from existing opportunities to increase the probability of survival in evolving technology ecosystems. Hence, this essay demonstrates the survival enhancing importance of growth modes as tools wherein managers can selectively choose to either identify and access new growth opportunities or develop and leverage a limited subset of growth opportunities.

Finally, essay three demonstrates the importance of corporate development decisions as survival enhancing agents that mitigate the inertia associated with legacy technologies in evolving technology ecosystems by enabling access to new technology resources and capabilities while diverting resources away from legacy technology resources. However, the caveat to managers is that the associated survival enhancing benefits may only materialize when they choose the optimal mode of implementation for these decisions.

In conjunction, the three essays emphasize how corporate development decisions facilitate adaptation at different levels of analysis i.e. product level (essay 1), firm level (essay 2) and transaction level (essay 3) and correspondingly affects survival at different levels i.e. product market level (essays 1 and 3) and firm level (essay 2). In this, my dissertation joins the conversation around corporate development decisions and their increasing relevance in contemporary global technology ecosystems riddled with dynamic and fast-paced change. From a broader and more existential perspective, it demonstrates how the employment of corporate development decisions towards ensuring firm survival in fast-changing and turbulent environments represents a prospective source of firm heterogeneity – a hallmark of scholarly research on strategic management (Rumelt et.al., 1994).

Given the fast-paced and persistently changing landscape of technology ecosystems across the globe, strategic management scholars and practitioners have long acknowledged the survival threatening implications for firms particularly if their adaptive capacity is found to be inadequate for overcoming the challenges of strategizing in these environments (Bettis and Hitt, 1995; Hamel and Prahalad, 1996; Hitt, Keats and DeMarie, 1998). This dissertation complements this conversation with the added insight that firms' corporate development decisions represent a potent tool through which they can improve their adaptability and the possibility of surviving in such environments. For corporate strategy scholars, it emphasizes the importance of research that uncovers theoretical and empirical approaches through which managers can increase the sophistication, robustness and relevance of the corporate development function. For managers, it urges the importance of proactively developing corporate development capabilities aligned to a broad variety of decisions, each of which can contribute positively to firm level outcomes based on the firm's environmental context and resource/capability requirements.

2. ESSAY ONE - SURVIVING THE "LIABILITY OF FERMENT" IN AN ERA OF FERMENT – THE MODERATING ROLE OF CORPORATE SCOPE

2.1 INTRODUCTION

Eras of ferment are periods of technological change affecting the demand and supply sides of product market ecosystems (Adner, 2017; Adner and Kapoor, 2010, 2016; Kapoor and Lee, 2013). On the demand side, changes in customer preferences influence the desirability of a firm's products (Benner and Tripsas, 2012; Benner and Waldfogel, 2016). On the supply side, corporate scope decisions affect the types of product features that a firm offers (Davis, 2016; Kapoor and Lee, 2013). During an era of ferment, firms that do not adopt the features of an evolving product dominant design are disadvantaged and theorized to exit the product market ecosystem (Anderson and Tushman, 1990; Suarez and Utterback, 1995; Tegarden et.al., 1999). I theorize that at any point in an era of ferment, the inability to adopt the features of an evolving product dominant design can be captured as a *'feature implementation gap'* defined as the number of features of the evolving product dominant design that are absent from a given firm's product design poses a threat to its product market survival.

Scholars studying eras of ferment have typically adopted a supply or demand side perspective in explaining firm-related outcomes. On the supply side, scholars have addressed disruptive innovation (Adner and Kapoor, 2016; Anderson and Tushman, 1990); technology selection and readjustment decisions (Eggers, 2016); entry timing effects on firm survival

(Tegarden et.al., 1999) and design competition dynamics (Tushman and Rosenkopf, 1992). Alternatively, demand side perspectives have focused on prior industry affiliation on product design decisions (Benner and Tripsas, 2012); product design introduction/evolution (Martin and Mitchell, 1998) and the emergence of dominant categories and products (Argyres, Bigelow and Nickerson, 2015; Suarez, Grodal and Gotsopoulos, 2015).

However, how demand and supply side decisions jointly affect product market survival in an era of ferment has received limited attention. More specifically, I theorize how firms adapt their corporate scope (supply side) to adopt features of the evolving dominant design (demand side) to improve their likelihood of product market survival. The limited attention to the joint effects of supply and demand side decisions is an important omission in the literature because the number of industries that have witnessed an EOF or are currently experiencing one, indicate that changes in customer preferences for product features require adaptive action on the part of firms.

A few prominent cases of technology ecosystems experiencing an era of ferment include the computerized distribution of music (Burgelman & Grove, 2007), film and video game integration (Brookley, 2010), digital cameras (Benner & Tripsas, 2012), functional foods (Bornkessel, Broring & Omta, 2016) and internet telephony (Hsu & Prescott, 2017; Lee, 2007). The history of these ecosystems is littered with examples of firms that exited their product markets as they were not able to adapt to changes in customer preferences. In the digital camera context of my study, firms implemented an average of two corporate scope decisions (alliances and/or acquisitions) and invested in patenting activity (internal development) to facilitate the adoption of features of the evolving product dominant design. Yet, 48 percent of the firms did not survive the era of ferment and exited their respective digital camera product markets.

The joint effect of demand-side changes in customer preferences for product features and the strategic relevance of supply-side corporate scope decisions as adaptive mechanisms are two strategic issues that have implications for product market survival in eras of ferment. As product market survival determines the winners and losers after the proverbial dust has settled on an era of ferment, understanding how corporate scope decisions enhance the likelihood of product market survival has strategic relevance. The limited scholarly attention accorded to the joint effect of both these factors motivated my research question – *In an era of ferment, how do corporate scope decisions (alliancing, internal development and acquisitions) moderate the relationship between a firm's feature implementation gap and its likelihood of product market survival?*

I approached my research question in two ways. First, adopting a demand side perspective to firm adaptation in an era of ferment, I focused my theoretical and empirical attention at the product level – product features that comprised the evolving dominant design of the digital camera in the product market ecosystem (Benner and Tripsas, 2012; Martin and Mitchell, 1998; Tushman and Murmann, 1998). I theorize that at any point in an era of ferment, a feature implementation gap defined as the number of features of the evolving product dominant design that are absent from a given firm's product design poses a threat to its product market survival.

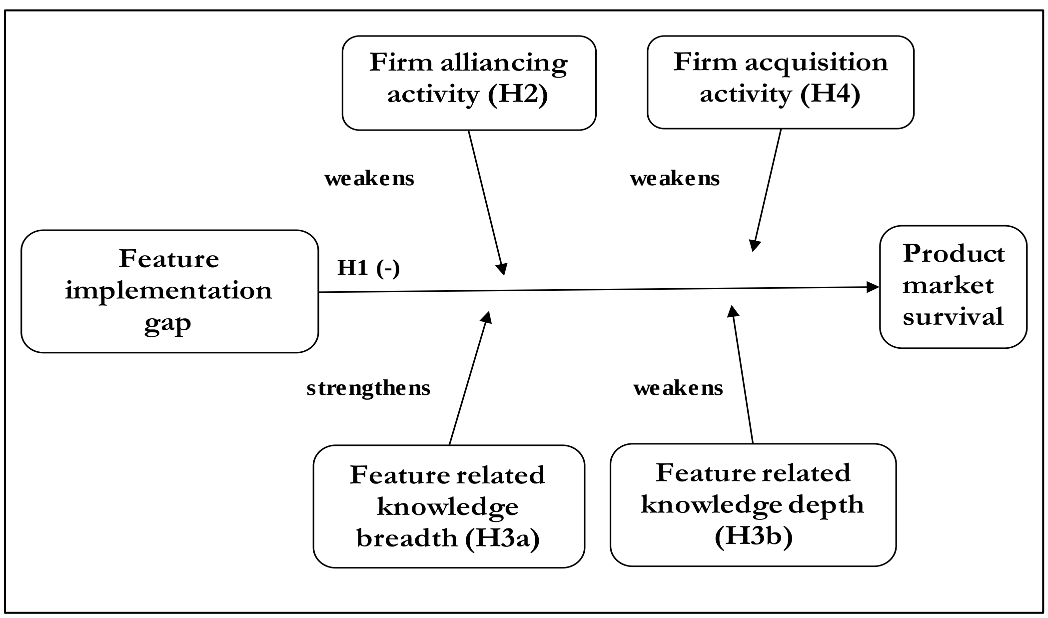
The theoretical grounding for the feature implementation gap hypothesis is consistent with the demand-side logic of a product market ecosystem during an era of ferment wherein product dominant designs evolve in an incremental manner with product features being included in a sequential fashion (Benner and Tripsas, 2012; Martin and Mitchell, 1998; Tushman and Murmann, 1998). The inclusion of features in the evolving product dominant design is a selection process associated with collective strategizing of the product market ecosystem and the social system of institutional stakeholders (Garud and Rappa, 1994; Oliver, 1988; Tushman and Rosenkopf, 1992).

A *'liability of ferment'* mechanism explains the relationship between a firm's feature implementation gap and product market exit. When a firm experiences a feature implementation gap, it faces liabilities - competitive disadvantages in the product market ecosystem (Christensen et.al., 1998; Suarez and Utterback, 1995; Tegarden et.al., 1999) and delegitimization by institutional stakeholders leading to a threat to product market survival (i.e. a liability of ferment) (Aldrich and Fiol, 1994; Baum and Oliver, 1991; Ruef and Scott, 1998). Thus, employing a demand side perspective of the evolving dominant design in an era of ferment facilitates insight into how a feature implementation gap poses a threat to product market survival.

Second, adopting a knowledge-based view (KBV) lens, I theorize that in an era of ferment, corporate scope decisions represent knowledge accessing adaptive mechanisms on the supply side of the product market ecosystem (Capron and Mitchell, 2012; Katila and Ahuja, 2002; Mowery et.al., 1996; Vermeulen and Barkema, 2001). These decisions facilitate access to extramural knowledge (e.g. technological, product, market and customer related knowledge) through alliancing and acquisition activity (Mowery et.al., 1996; Vermeulen and Barkema, 2001) or leveraging knowledge within firm boundaries (i.e., patenting) (Katila and Ahuja, 2002; Rosenkopf and Nerkar, 2001). I theorize that accessing extramural knowledge and leveraging internal knowledge through corporate scope decisions are supply side factors that enable a firm to develop features of the evolving product dominant design that are absent from the firm's evolving product design hence mitigating the negative effect of a feature implementation gap. Thus, my theory development links the supply and demand sides of the product market ecosystem to explain product market survival during an era of ferment.

Using a longitudinal dataset of 843 firm-years involving 62 firms that participated in an era of ferment (1991-2006) in the digital camera product market, I used event history modeling and found that a firm's feature implementation gap had a negative effect on its product market survival (i.e. increased the hazard rate of product market exit). Firms' alliancing and acquisitions activity weakened this negative effect (decreased the hazard rate of product market exit). The moderating effect of feature specific knowledge breadth patenting increased the hazard rate of product market exit but that feature specific knowledge depth patenting had the opposite effect of decreasing the hazard rate of product market exit. Figure 1 below illustrates the theoretical model.

Figure 1. Theoretical model



I make two contributions to era of ferment and corporate scope streams of research. First, I contribute to research on eras of ferment by adopting a demand side perspective (product feature level) and theoretically linking it to product market survival. I demonstrate how the lack of alignment at the feature level between a firm's product design and the evolving dominant design creates a feature implementation gap that imperils product market survival. Through this, I complement research on eras of ferment that takes a product configuration and entry timing perspective (e.g., Benner and Tripsas, 2012; Eggers, 2016; Tegarden et.al., 1999). Second, drawing on the KBV, I add a novel perspective to the era of ferment literature by theorizing on the importance of supply side corporate scope decisions as knowledge accessing adaptive mechanisms that weaken or strengthen the negative affect of a feature implementation gap.

Together, both contributions provide a novel perspective to research on eras of ferment by linking the supply and demand sides of a product market ecosystem during an era of ferment and theorizing how they jointly affect product market survival in heterogeneous ways.

2.2 THEORY AND HYPOTHESES

2.2.1 Feature implementation gap and product market survival

In an era of ferment, a strategic decision for firms concerns the selection of features to introduce as part of their product design (e.g., optical zoom, removable storage as in digital cameras – table 1) (Benner and Tripsas, 2012; Christiansen et.al., 1998; Martin and Mitchell, 1998). Feature related selection decisions are path dependent with respect to a firm's prior industry affiliation (Benner and Tripsas, 2012), technological and market related profile (Christiansen et.al., 1998; Suarez and Utterback, 1995), identity (Tripsas and Gavetti, 2000) and resource dependence on ecosystem stakeholders (Adner and Kapoor, 2010; Kapoor and Furr, 2015). The choice of product features in an era of ferment is heterogeneous across firms (Benner and Tripsas, 2012; Martin and Mitchell, 1998). Therefore, the evolution of a product's dominant design is a process of 'selection' wherein specific features are added to the evolving dominant design in an incremental and sequential manner (Benner and Tripsas, 2012; Garud and Rappa, 1994; Tushman and Murmann, 1998).

Table 1. Dominant design in digital cameras (adopted from Benner & Tripsas, 2012)

Feature	Year of introduction in digital camera models	Model name /Firm	Year of institutionalization (50% or more digital camera models included the feature)
Optical zoom	1992	Fujix PR-2J (Fuji)	2003
Removable storage	1993	FUJI DS-200F (Fuji)	1997
Higher than (>) VGA resolution	1994	Kodak/AP NC2000 (Kodak)	1998
LCD	1995	CASIO QV-10 (Casio)	1997
Video recording	1995	Ricoh RDC-1 (Ricoh)	2000
Digital zoom	1997	EPSON PHOTO PC 600 (Epson)	1999
Full design	1999	Toshiba PDR-M4 – (Toshiba)	2004

The stochastic nature of the evolution of features to the dominant design implies that firms do not have perfect ex ante knowledge of the features that will eventually form the product's dominant design. Hence, the likelihood that a firm's evolving product design will be isomorphic with the evolving product dominant design becomes a key strategic challenge. As both product designs evolve, a firm's product design may not possess the all of features of the evolving product dominant design. I theorize that at any point in an era of ferment, a feature implementation gap defined as 'the number of features of the evolving product dominant design that are absent from a given firm's product design' poses a threat to its product market survival. A mechanism that explains the relationship between a firm's feature implementation gap and product market exit is the 'liability of ferment'. When a firm has a feature implantation gap, it is subject to a liability of ferment due to competitive disadvantages in the product market ecosystem (Christensen et.al., 1998; Suarez and Utterback, 1995; Tegarden et.al., 1999) and delegitimization by institutional stakeholders leading to a threat to product market survival (Aldrich and Fiol, 1994; Baum and Oliver, 1991; Ruef and Scott, 1998).

Scholars theorize that the evolution of a product dominant design is the result of collective strategizing by actors aligned to the product market ecosystem and within the broader social system (Garud and Rappa, 1994; Oliver, 1988; Tushman and Rosenkopf, 1992; Tushman and Murmann, 1998). Thus, features selected into an evolving product dominant design will be those that fulfil relevant competitive and legitimization imperatives.

A competitive imperative involves establishing relationships with ecosystem players including user and their preferences (Baldwin and von Hippel, 2011), upstream and downstream stakeholders (Adner and Kapoor, 2010, 2016; Cohen, Hsu and Dahlin, 2016) and complementary technology providers (Kapoor and Furr, 2015; Roy and Cohen, 2017). A feature implementation gap negatively affects the competitive edge of a firm's product design because diminished attention on the part of lead users and early adopters leads to lower positive network externalities and subsequent technological 'lock out' (Schilling, 1998). When demand-side expectations associated with desired features are not met customers switch to alternative designs that have a greater overlap with the evolving dominant design (Cusumano, Mylonadis and Rosenbloom, 1992). This negatively effects the demand side of a firm's business model limiting the scalability of an installed base (customers) and adversely affecting product market survival (Cusumano et.al., 1992; Schilling, 1998).

A feature implementation gap also hampers the operational compatibility of the product design with supply side ecosystem actors – suppliers, distributors and complementary asset providers. These stakeholders begin collaborating with firms whose designs represent dominant categories or have a greater overlap with the evolving product dominant design (Suarez et.al., 2015). A decrease in operational ties with ecosystem actors leads to resource dependence issues and ecosystem 'lock out' with adverse implications for a firm's business model (Adner and Kapoor, 2010, 2016; Kapoor and Furr, 2015). Hence, a feature implementation gap negatively affects the commercialization potential of a firm's design as early or 'fast' second movers with features of the evolving product dominant design compete for ecosystem partner ties (Argyres et.al, 2015; Eggers, 2016; Tegarden et.al., 1999).

A legitimation imperative involves developing legitimacy with institutional stakeholders including technology standard setting committees/sponsors, socio-political institutional coalitions and governments (Aldrich and Fiol, 1994; Garud and Rappa, 1994; Tushman and Rosenkopf, 1992). In an era of ferment, collective strategizing by institutional stakeholders leads to the development of a new 'negotiated order' (Dokko, Nigam and Rosenkopf, 2012; Garud and Rappa, 1994). These entities proactively support product designs that align with the evolving dominant design and symbolically endow legitimation through memberships in institutional bodies while 'ostracizing' designs with feature implementation gaps (Aldrich and Fiol, 1994; Cusumano et.al., 1992; Garud and Rappa, 1994). Thus, firms with feature implementation gaps have the risk of being isolated from access to important technology and market trends, important product markets and inter-institutional endorsements across the ecosystem. These deficiencies in turn have pernicious effects on product commercialization and ecosystem viability broadly (Cusumano et.al., 1992; Tushman and Murmann, 1998). In sum, for firms with product designs that have a feature implementation gap, competitive disadvantages in the product market ecosystem and the delegitimization by institutional stakeholders has a negative effect on product market survival.

H1: In an era of ferment, a firm's feature implementation gap has a negative effect on product market survival.

2.2.2 The moderating role of corporate scope decisions and the feature implementation gap

When a firm's product design has a feature implementation gap, an approach for increasing the likelihood of product market survival is to 'reverse course' and include the absent evolving product dominant design features into its design (Argyres et.al., 2015; Eggers, 2016; Tegarden et.al., 1999). As per the KBV, I theorize that modifying a firm's knowledge boundaries through accessing or leveraging knowledge assets (e.g. technological, product, market and customer related knowledge) is critical to decisions related to the introduction of features absent from a firm's product design (Grant, 1996a; Kogut and Zander, 1992; Nickerson and Zenger, 2004; Winter, 1987).

I conceptualize the role of corporate scope decisions (alliancing, internal development through patenting and acquisitions) as supply side knowledge accessing adaptive mechanisms that facilitate access to extramural knowledge assets while leveraging knowledge assets within firms (Capron and Mitchell, 2012; Katila and Ahuja, 2002; Mowery et.al., 1996; Vermeulen and Barkema, 2001). In their role as knowledge accessing adaptive mechanisms, these decisions are heterogeneous in terms of their potential to address the demand side issues associated with a feature implementation gap. In the sections below, I theorize on how alliancing, internal development and acquisitions moderate the relationship between feature implementation gap and product market survival in an era of ferment.

2.2.3 Scope expanding decision – Firm alliancing activity

The technological change and KBV literatures conceptualize alliancing activity as an adaptive mechanism that provides access to a broad variety of knowledge assets (Mowery et.al., 1996).

Alliancing facilitates joint development efforts for entering new product markets (Mitchell and Singh, 1992), knowledge transfer through the creation of relational capital (Kale, Singh and Perlmutter, 2000) and provides structural embeddedness and brokerage related benefits of inter-firm networks (Ahuja, 2000; Gulati, 1995). These mechanisms facilitate the mitigation of a feature implementation gap.

Alliancing provides access to extramural knowledge that facilitates joint exploration through recombinant experimentation or new knowledge creation (Davis, 2016; Davis and Eisenhardt, 2011; Grigoriou and Rothaermel, 2017; Rosenkopf and Nerkar, 2001). These processes aid the development of absent feature variants that can effectively replicate an absent feature or proxy it through substituting functionalities (Deeds and Hill, 1996). As firms explore and develop multiple sets of feature variants, collaborative teams increase their commitment to high potential variants to address performance and cost related issues surrounding the absent feature's functionality (Garud and Kumaraswamy, 1995; Noboeka and Cusumano, 1997).

The process of increasing commitment to specific absent feature variants is the result of an interaction between knowledge orchestration and product development alliances that transform absent feature variants to product-compatible features (Rothaermel and Deeds, 2006). Multiple iterations between collaborative teams benefit from 'spill-forward' or 'spill-back' mechanisms thus continually refining the functionality-related performance outcomes of variants of an absent feature (Furr and Snow, 2015; Garud and Nayyar, 1994). These processes lead to the creation of multiple feature-related 'generations' or 'beta versions' to be assimilated within product designs through iterative testing and refinement (Helfat and Raubitschek, 2000; Uzumeri and Sanderson, 1995). Hence, local variants represent 'parallel paths' to implementing absent feature functionality within product designs (Krishnan and Bhattacharya, 2002). As interactions between knowledge orchestration and product development alliances increase, sequential and rapid transfer mechanisms fast track the performance and cost related characteristics of specific local variants hence improving their fit with the overall product design (Garud and Nayyar, 1994; Noboeka and Cusumano, 1997). Apart from their interaction with knowledge orchestration alliances, product development alliances with partners that already possess an absent feature fast track the process of introducing absent feature functionality (Deeds and Hill, 1996). Knowledge orchestration and product development alliances thus decrease the turnaround time associated with incorporating absent features within product designs.

Through collaboration with downstream partners, firms can optimize the degree of co-specialization with downstream assets to ensure that local variants of absent features address product market ecosystem requirements (Kapoor and Furr, 2015; Roy and Cohen, 2017). Ensuring a high level of compatibility with complementary assets also enhances customer experiences and product performance hence speeding up commercialization possibilities (Gans and Stern, 2003). Further, involvement in multi-partner alliances and technological standard consortiums enables collective maneuvering with institutional and social stakeholders through insights into new technology standards, ecosystem and institutional trends, and legitimacy spillovers (Axelrod et.al., 1995; Leiponen, 2008). These benefits increase the probability of developing absent feature functionality. In these ways, alliancing across a product market ecosystem mitigates the feature implementation gap and improve the likelihood of product market survival.

H2: In an era of ferment, alliancing weakens the negative effect of the feature implementation gap on firms' product market survival.

2.2.4 Internal development — Feature specific knowledge breadth

The breadth of a firm's internal knowledge is the result of processes involving exploration, distant search and recombining knowledge assets that have heterogeneous and unrelated scientific and technological origins (Fleming and Sorenson, 2004; Galunic and Rodan, 1998; Nelson and Winter, 1982). Hence, a firm's feature related knowledge breadth refers to the diversity in knowledge assets that underlie the different features in it product design. During eras of ferment, high levels of feature specific knowledge breadth lead to a lack of focus in knowledge orchestration and hinders the development of feature level variants (Fleming, 2001; Siggelkow and Rivkin, 2006). That is, efforts to develop absent feature functionality through knowledge orchestration face significant roadblocks due to incoherent problem-solving approaches, suboptimal problemistic search trajectories and maladaptive search outcomes based on premature satisficing (Haas, Criscuolo and George, 2015; Knudsen and Srikanth, 2014; Nickerson and Zenger, 2004). These processes lead to suboptimal decisions regarding the development of absent feature functionality that 'lock in' inferior feature variants (Schilling, 1998). Thus, commitment to inferior variant development trajectories precludes the benefits of 'real time' approaches to product development and exacerbates the feature implementation gap (Bhattacharya, Krishnan and Mahajan, 1998; Krishnan and Bhattacharya, 2002).

The shortcomings of feature specific knowledge breadth and their orchestration potential are intensified by the heterogeneity of broad knowledge asset portfolios due to stickiness, transferability, context specificity and limits to decomposability thus placing limitations on combinatorial possibilities (Nickerson and Zenger, 2004; Szulanski, 1996; Winter et.al., 2012). This issue overwhelms the bounded rationality of knowledge workers whereby unfamiliarity results in applying inferior approaches to knowledge orchestration leading to inferior recombinant outcomes (Fleming, 2001; Galunic and Rodan, 1998). When knowledge orchestration teams transfer feature related variants to product development teams, negative spillovers and transfer effects compromise the development of absent feature functionality due to the creation of suboptimal local variants of the absent features (Winter et.al., 2012). The probability of developing variants decreases significantly thereby increasing the turnaround time in addressing a feature implementation gap (Krishnan and Bhattacharya, 2002). Both these issues intensify the feature implementation gap and compromise a firm's competitive position within the ecosystem exerting a negative effect on product market survival.

A third issue of feature specific knowledge breadth that adversely affects the development of absent feature functionality is individual and team based heterogeneity in knowledge orchestration environments and learning patterns leading to structural and cognitive embeddedness (Bingham and Davis, 2012; Cardinal et.al., 2011; Reagans, Miron-Spector and Argote, 2016). This compromises the knowledge integration capability of knowledge orchestration and product development teams due to operational shortcomings (Gardener, Gino and Staats, 2012; Grant, 1996b). High decision-making turnaround times, cognitive/behavioral biases in knowledge orchestration and blind spots regarding the potential of 'breakthrough' solutions obstruct progress towards the development of feature related variants undermining the development of absent feature functionality (Bhattacharya et.al., 1998; Krishnan and Bhattacharya, 2002; Tripsas and Gavetti, 2000). These issues emerging from excessive levels of feature related knowledge breadth aggravate the feature implementation gap through slow or maladaptive product design decisions hence increasing the threat to product market survival.

H3a: In an era of ferment, feature specific knowledge breadth strengthens the negative effect of the feature implementation gap on firms' product market survival.

2.2.5 Internal development — Feature specific knowledge depth

Knowledge depth refers to the accumulation of knowledge assets that have related scientific or technological origins and underpin competence enhancing innovation through local search and exploitation (Fleming and Sorenson, 2004; Nelson and Winter, 1982). Hence, feature specific knowledge depth refers to the level of knowledge accumulation regarding a specific product design feature. A firm's knowledge depth evolves through deliberate learning, exploitation and codification through transactive memory systems (Ren and Argote, 2011; Zollo and Winter, 2002). Experience with knowledge assets, absorptive capacity and mindful learning improves knowledge depth through greater clarity on the characteristics of these assets – stickiness, context specificity, decomposability and transferability (Lane and Lubatkin, 1998; Levinthal and Rerup, 2006; Nickerson and Zenger, 2004). Hence, this leads to insights into how the firm's knowledge assets can be redeployed for developing absent feature functionality.

Knowledge orchestration, codification and development of knowledge repositories learning processes ensure that teams and individuals speed up the process developing absent feature functionality in several ways. First, knowledge depth facilitates the processes of searching and selection of knowledge assets for creating feature related variants (Brusoni, Prencipe and Pavitt, 2001; Hansen, 1999). Second, as the turnaround time of variant development decreases, it expedites the selection of high potential variants and transitioning to product development teams (Garud and Kumaraswamy, 1995; Noboeka and Cusumano, 1997). Hence, knowledge orchestration teams can quickly transition to product development efforts aimed at developing absent feature functionality. In turn, product development teams increase commitment to high potential variants avoiding temporal delays (Helfat and Raubitscheck, 2000; Krishnan and Bhattacharya, 2002). Knowledge depth increases the effectiveness and speed of knowledge orchestration and product development processes thereby increasing the likelihood of developing high potential variants that can mirror or substitute for absent feature functionality to address the feature implementation gap.

When product development teams are informed of the possibilities of loose coupling and near-decomposability of knowledge assets, they can leverage the advantages of product design modularity (Brusoni et.al., 2001; Sanchez and Mahoney, 1996). In this case, as teams develop local feature variants drawing on their knowledge depth, they enhance performance and cost related issues through iterative prototyping, testing and 'plug and play' approaches (Staudenmeyer, Tripsas and Tucci, 2005). The creation of increasingly superior and robust variants that improve product design related performance leads to faster turnarounds as performance gaps in absent feature functionality are addressed. Thus, product reconfiguration processes driven by knowledge depth have a higher probability of mitigating the feature implementation gap and improving the likelihood of product market survival (Eggers, 2016).

H3b: In an era of ferment, feature specific knowledge depth weakens the negative effect of the feature implementation gap on firms' product market survival.

2.2.6 Scope expanding decision – Firm acquisition activity

Scholarly work on technological change and the KBV conceptualizes acquisitions as expanding corporate scope by facilitating access to portfolios of related and unrelated knowledge assets that enhance the firms' technological and product development capabilities (Ahuja and Katila, 2001; Haspeslagh and Jemison, 1991; Puranam, Singh and Zollo, 2003; Puranam et.al. 2006). Acquisitions augment a firm's knowledge orchestration and product development capability by altering the development trajectory of product design wherein firms can improve the alignment between their product designs and the evolving dominant designs (Grimpe, 2007).

Acquired knowledge assets that have a high degree of relatedness supplement the firm's knowledge orchestration potential through complementarity or super-additivity in recombinant experimentation or through 'grafting' related outcomes (Kim and Finkelstein, 2009; Puranam et.al., 2003; Sears and Hoetkar, 2014). Since grafting benefits from structural absorption of the target, improved coordination between the acquirer and target knowledge orchestration teams accelerates the development of feature related variants (Puranam et.al., 2003). Hence, the process of variant development is faster as the benefits of time compression and scale and scope in knowledge orchestration are realized. In turn, product development processes are scaled up through a steady input of feature related variants transitioned into local variants that can be included within product designs (Grimpe, 2007). Thus, scale and scope in knowledge orchestration and product development increase the possibility of firms developing absent feature functionality improving the likelihood of addressing the feature implementation gap.

Alternatively, acquisitions with lower degrees of relatedness provide access to knowledge orchestration alternatives that were previously unavailable to the firm (Cassiman et.al.,2005; Lodh and Battaggion, 2015). Employing the twin mechanisms of structural absorption and subsequent collaboration of acquirer-target teams is one approach to knowledge orchestration (Haspeslagh and Jemison, 1991; Puranam et.al. 2006). However, in some cases, target teams are granted autonomy to develop absent feature functionality through leveraging the potential of target resources to generate innovation (Puranam and Srikanth, 2007). This mitigates the possibility of negative spillovers across knowledge orchestration routines that may arise from lower degrees of relatedness (Puranam et.al., 2006) Through autonomous knowledge orchestration, target teams augment the knowledge orchestration efforts of acquirer teams thereby effectively addressing the feature implementation gap (Puranam and Srikanth, 2007). A third approach to developing absent feature functionality involves acquiring firms that have feature functionality absent from the acquirer's evolving product design (Puranam et.al., 2003, 2006). Thus, absent features are directly introduced into the acquirer's product design or alternatively, acquirers may use target product lines to cannibalize their own product lines that are prone to the feature implementation gap.

A parallel advantage of acquisitions lies in their potential as mechanisms of strategic maneuvering wherein acquirers increase their control over technology ecosystems through preemption of upstream and downstream assets (Casciaro and Piskorski, 2005; Drees and Heugens, 2013). Consequently, product designs with newly incorporated absent feature functionality can be protected from competitive pressures as they carve out product market niches. Hence, the prospects of commercialization and strong competitive positioning improve as resource dependence concerns are mitigated (Casciaro and Piskorski, 2005). Acquisitions also improve the visibility of acquirer product designs thereby enhancing their prominence in the ecosystem and the broader institutional environment (Bettinazzi and Zollo, 2017). Thus, they ensure that acquirers gain legitimacy from institutional stakeholders through a process of collective strategizing (Greve and Zhang, 2017). These advantages of acquisitions enable firms to successfully address the feature implementation gap and mitigate the threat to product market survival.

H4: In an era of ferment, acquisition activity weakens the negative effect of the feature implementation gap on firms' product market survival.

2.3 EMPIRICAL CONTEXT, DATA AND METHODOLOGY

2.3.1 Empirical context

The context was the digital camera product market as it witnessed an era of ferment due to the technological convergence of three sets of industries- computing (SIC 3571, 3572, 3577 and 5045), consumer electronics (SIC 5064 and 5065) and photography (SIC 3861 and 5043) (Benner and Tripsas, 2012). Convergence was the consequence of a technological discontinuity in the form of digital photography that enabled computer and consumer electronics firms to develop technological and market related capabilities pertinent to the mass market photography ecosystem (Aoshima and Fukushima, 1998). This triggered an era of ferment that led to the set of features that would comprise the digital photography dominant design. Digital camera products had a high level of modularity indicating that firms had discretion regarding the choice of features to include in their product lines (Benner and Tripsas, 2012; Sanchez and Mahoney, 1996). I chose the years 1991 to 2006 since the first digital camera was released in the U.S. in 1991and in 2007, the iPhone stimulated another round of ferment (Logitech press release, 1991; Digital Camera History website). This period was also the 'coming of age' of the digital photography standard wherein the features of the dominant design evolved from 1992 onwards and the six features comprising the dominant design were institutionalized by 2004 (i.e. when > 50 percent of all digital camera models adopted the features of the dominant design (Benner and Tripsas, 2012) (table 1). This significantly revolutionized the mass market photography ecosystem and shifted the strategic focus of firms and the preferences of customers towards digital cameras.

2.3.2 Data

I used the COMPUSTAT database to collect financial data for public firms in the three industries. The total number of firms in the sample was 62 - 16 computing, 24 consumer electronics and 22 photography firms resulting in 843 firm year observations. I included a firm only if it had introduced a digital camera model with any combination of features of the dominant design (table 1) in the mass market digital camera product market (digital single lens and reflex- DSLR). Hence, SLR and web based cameras were excluded from the analysis. Firm alliancing and acquisition activity data was collected using the Thompson Financial SDC database and through public announcements through Lexis-Nexis. My dataset included 72 alliances and 51 acquisitions formed for accessing knowledge specific to digital photography (technological, upstream or downstream). To determine whether an alliance/acquisition was related to digital photography, I referred to alliancing and acquisition announcements provided in SDC as well as company and industry sources. For internal development (feature specific knowledge breadth and depth), I collected patenting data from the United States Patent and Trademark Office (USPTO) database for feature specific patents using feature and company names. I complemented my dataset by including data corresponding to the patent classes of the digital camera product market as mentioned by Benner and Tripsas (2012).

2.3.3 Dependent variable

Product market survival was a dichotomous variable coded one in the year when a firm exit the digital camera product market and zero otherwise. Using Lexis-Nexis, official company documents and public sources, exit was recorded when a firm ceased operations and/or discontinued production of digital cameras in their product markets (Josefy et.al., 2017). I did not code a firm as having exit if it was taken over and given operational autonomy or was bailed out and ex post it resumed operations related to digital cameras. In my sample, 30 of the 62 firms (48 percent) did not survive and the remaining 32 cases were treated as right censored for empirical analysis (Allison, 1984).

2.3.4 Independent variable

Feature implementation gap – The digital camera's dominant design evolved over the sample period with several features introduced but only six institutionalized as shown by Benner and Tripsas (2012). The operationalization of the feature implementation gap accommodated the introduction and the institutionalization of the features of the product dominant design. A firm experienced a feature implementation gap if it did not introduce an evolving product dominant design feature once it was introduced. The gap intensified after the feature had been institutionalized because if a feature survived the selection window and was institutionalized, it became one of the features of the product dominant design.

Table 1 shows the features comprising the digital camera dominant design, the years each feature was introduced and institutionalized. Benner and Tripsas (2012) defined feature institutionalization as 'the year when 50 percent of the total digital camera products possessed a given feature'. I reconfirmed their findings using several sources (e.g., company websites, trade publications, Future Image Report, PC Photo and digital camera web sites (e.g., dpreview.com, imaging-resource.com, digicamhistory.com and dcviews.com). For each firm, the yearly calculation of the feature implementation gap involved two steps (see Appendix A for an example).

Step 1) Feature level coding: Once a feature of the dominant design was introduced I assigned a 'yearly absent feature score' δpt for each firm ('p' represents a given feature and 't' a specific year). I first ascertained whether a firm implemented a given feature by examining the features of each digital camera model to evaluate whether and when any model had introduced the feature in a given year. I then coded the yearly absent feature score (δ) for feature 'p' for year 't' as follows: if the firm had implemented the feature δpt was coded zero (not absent); if it had not introduced the feature in the year, δpt was coded one (absent). If the firm had not introduced a feature after it was institutionalized, I multiplied δpt by a factor φ (the number of years after institutionalization) to capture the additional threat posed to a firm's product design by an absent feature that was institutionalized. My coding approach was dynamic on a year-by-year basis i.e. if a firm implemented feature 'p' in year 't' (coded as 0), but then removed the feature 'p' from its model in year 't+1', I recoded 'δpt+1' to 1 for 't+1'. Through this, I ensured that the measure was methodologically congruent with the evolving product dominant design (Argyres et.al., 2015; Suarez et.al., 2015).

Step 2) Feature implementation gap score: For each year, I repeated step 1 for each feature (once it had been introduced). I then summed the yearly absent feature scores and divided it by the number of features introduced up to that year to get the firm's product feature implementation gap score for that year. The gap for a given year 't' is thus given by: $\boldsymbol{\delta_{FIGt} = (\sum_{p=1}^{n} \delta pt)/n}$ where δ_{FIGt} is the feature implementation gap score for a given year 't', δpt is the absent feature score for feature 'p' and 'n' takes values from one to six based on how many features had been introduced by year 't'. The gap score had a range between zero and one ($0 \leq gap \leq 1$) where zero implied an absence of a gap (e.g., all six features present) and one implied the maximum gap (e.g., all six features absent). Alternative operationalizations of the feature implementation gap variable are presented in the robustness tests section.

2.3.5 Moderator variables

a) Firm alliancing activity – Operationalized as the sum of all alliances formed by a firm each year. Lagged by one year to control for learning effects (Mowery et.al., 1996).

b) Feature specific knowledge breadth was calculated as the diversity in patenting activity across all features for each firm in each year using a Blau index given as $\boldsymbol{1 - \sum_{i=1}^{n} pi^2}$. Here, pi represents the ratio between the number patents that a firm had with respect to the ith feature and the total number of patents across 'n' features. (Fernhaber and Patel, 2012; Katila and Ahuja, 2002).

c) Feature specific knowledge depth – For a given digital camera feature, for each patent, I counted the number of citations made to other patents based on the given feature (feature specific citations). I then calculated a ratio of the sum of citations made to other patents to the total citations to arrive at the feature specific knowledge depth variable for the given feature (Fernhaber and Patel, 2012; Katila and Ahuja, 2002). I repeated this process for all the patents across all six features for each firm year as shown, $\left[\sum_{i=1}^{x} \sum_{j=1}^{y} \frac{(\text{Feature specific patent citations})\ ji}{(\text{Total citations})\ ji} \right]$ where x = number of features that a firm patented in for each year and y = number of patents (j) that a firm had in a given feature 'i'. Both knowledge breadth and depth were lagged by one year.

d) Firm acquisition activity - Operationalized as the sum of all acquisitions formed by a firm each year. Lagged by one year to control for learning effects (Puranam et.al., 2006).

2.3.6 Control variables

The operationalization and rationale for inclusion of the controls are in table 2. With the exception of product market size, population density, product market/time fixed effects and feature implementation/institutionalization dummy variables, all controls were lagged by one year.

2.3.7 Empirical methodology

I used event history modeling given its ability to handle data with right censoring (Allison, 1984; Cleves, Gould and Marchenko, 2016). For each set of hypotheses, I used a proportional hazards

Table 2. Control variables, operationalization and rationale for inclusion

Control variable	Operationalization	Data source	Reference	Rationale for inclusion
Firm size	Natural logarithm of revenue	COMPUSTAT	NA	Firm size is an important driver of corporate scope as well as a determinant of survival during different types of environmental change
Product market size	Natural logarithm of shipments (millions of units sold)	Standard and Poor Industry Survey Handbooks, Mergent Online, IBIS World	Suarez and Utterback (1995)	Shipment values indicate market demand and are indicators of munificence affecting the likelihood of survival
Product market population density	Natural logarithm of number of firms in product market	Standard and Poor Industry Survey Handbooks, Mergent Online, IBIS World	Suarez and Utterback (1995)	Population may affect firm survival depending on the competitive dynamics in the product market
Entry before dominant design introduction dummy	Dummy variable code 1 if a firm entered the digital camera product market before the year 1999 when the full dominant design (all six features) was introduced; 0 otherwise	Future Image Report, PC Photo and digital camera web sites (e.g., dpreview.com, imaging-resource.com, digicamhistory.com and dcviews.com)	Benner and Tripsas (2012); Suarez and Utterback (1995)	Firms that enter the product market prior to the introduction of the dominant design may have a greater or lower likelihood of survival
Entry before dominant design	Dummy variable code 1 if a firm entered the digital camera product market	Future Image Report, PC Photo and digital camera web sites (e.g.,	Benner and Tripsas (2012);	Firms that enter the product market prior to the institutionalization of the

institutionalization dummy	before the year 2004 when the full dominant design was institutionalized (i.e. >50 percent of digital camera models had all the six features of the dominant design) ; 0 otherwise	dpreview.com, imaging-resource.com, digicamhistory.com and dcviews.com)	Suarez and Utterback (1995)	dominant design may have a greater likelihood of survival
Feature institutionalization dummy	Dummy variable coded 1 for the years between 1997-2004 as features institutionalization began and occurred during this period; 0 otherwise	Future Image Report, PC Photo and digital camera web sites (e.g., dpreview.com, imaging-resource.com, digicamhistory.com and dcviews.com)	Benner and Tripsas (2012)	*Ex post* institutionalization, product market exits increased as shown in panel 1b of figure 1. This variable controls for extraneous factors that may have expedited exit.
Product market fixed effects	Dummy variable code 1 when the firm was present in a photography product market (SIC 5064, 5065); 0 otherwise	NA	NA	The photography product market firms had a higher probability of introducing a greater number of digital camera models compared to the other two product markets
Time fixed effects	Dummy variable code 1 for the year 2001; 0 otherwise	NA	Hsu and Prescott (2017)	The technology crash (dotcom bubble) of 2001 was a significant macroeconomic event affecting the entire technology sector
Corporate diversification intensity	Number of four digit SIC codes that a given firm was present	Standard and Poor Industry Survey Handbooks, Mergent Online, IBIS World	Villalonga (2004)	Diversified firms may have a broader variation of technological and market resources that enable firm survival during the era of ferment
Digital camera product portfolio breadth	Natural logarithm of the cumulative number of digital camera models introduced by a firm	Future Image Report, PC Photo and digital camera web sites (e.g., dpreview.com,	Benner and Tripsas (2012)	Firms having a broader product range of digital camera models may have a higher likelihood of mitigating the feature

		imaging-resource.com, digicamhistory.com and dcviews.com)		implementation gap and improving the likelihood survival
Prior R&D expense	Natural logarithm of (R&D expenditure/Total Revenue) for each firm year	COMPUSTAT	Benner and Ranganathan (2012)	Firms that invest heavily in R&D may have a greater likelihood of addressing and mitigating the feature implementation gap and enhancing the likelihood of survival
Organizational slack	Natural logarithm of (total assets - total liabilities)	COMPUSTAT	Benner and Ranganathan (2012)	Unabsorbed slack contributes to acquisitions in terms of providing resources and precludes the need for liquidity related or performance enhancing divestitures
Prior firm performance	Natural logarithm of (Operating profits/Total assets)	COMPUSTAT	NA	Influences subsequent acquisition and divestiture activity from an aspiration performance gap perspective
Prior alliancing experience	Cumulative number of all the alliances made by a firm for each year	SDC Platinum, Lexis Nexis	Kale et.al. (2000)	Prior alliancing may positively influence future alliancing and hence have greater competence in extramural knowledge orchestration
Prior acquisition experience	Cumulative number of all the acquisitions made by a firm	SDC Platinum, Lexis Nexis	Puranam et.al. (2006)	Past acquisition experience may lead to firms doing more acquisitions in future and hence have greater proficiency in extramural knowledge orchestration

mixed effects Cox regression model. An important benefit of the Cox model is that it does not pose restrictive assumptions about the form of the baseline hazard and permits estimation using time-varying covariates (Cleves et.al., 2016).

Each firm has a unique hazard function $h_t(t) = h_0(t) \exp(\beta X [t])$; where 't' is the time at which a firm exit, $h_0(t)$ is the baseline hazard function, X[t] is a matrix of covariates at time 't' and β is a vector of modeled coefficients. I used a mixed effects specification (frailty) for the model using the shared option in STATA 14.1 to control for time dependence in individual firm observations and unobserved heterogeneity across firms (Allison, 1984; Cleves et.al., 2016). I estimated the hazard rate of product market exit as the 'event' of interest given the main effect of the feature implementation gap and the moderating effects of the corporate scope variables.

2.3.8 Endogeneity concerns

The study may be prone to external drivers or omitted variables that lead to endogeneity regarding how firms may have self-selected into implementing an evolving dominant design feature to address the feature implementation gap and improve the likelihood of product market survival (Benner and Tripsas, 2012). In this, firms that introduced features *ex post* institutionalization displayed endogeneity through adapting behavior while those that did so *ex ante* did so through endogeneity in experimentation intended to shape the evolution of the dominant design (Eggers, 2016). The limitation of endogeneity also affects corporate scope decisions as they represent knowledge accessing adaptive mechanisms that can address the feature implementation gap (Capron and Mitchell, 2012; Katila and Ahuja, 2002).

To address this potential limitation, I controlled for endogeneity in feature introduction and corporate scope decisions using a two-stage procedure (Hamilton and Nickerson, 2003). First, for each firm year, I determined whether a firm was an 'adapter' (coded 0) or a 'shaper' (coded 1) by calculating the ratio between the number of features introduced *ex ante* and *ex post* institutionalization (a value > 1 implied a proclivity to shape while one < 1 implied a proclivity to adapt). For the corporate scope variables, I evaluated the likelihood that a firm used alliancing, patenting or acquisitions (coded as zero, one and two respectively) or a combination of the three (coded as 3) to address the feature implementation gap. I developed two instrumental variables – *feature introduction proclivity* (natural log of the absolute value of the difference between the number of 'shapers' and 'adapters') and *corporate scope activity* (natural log of the total firms in a year that used any of the three corporate scope decisions).

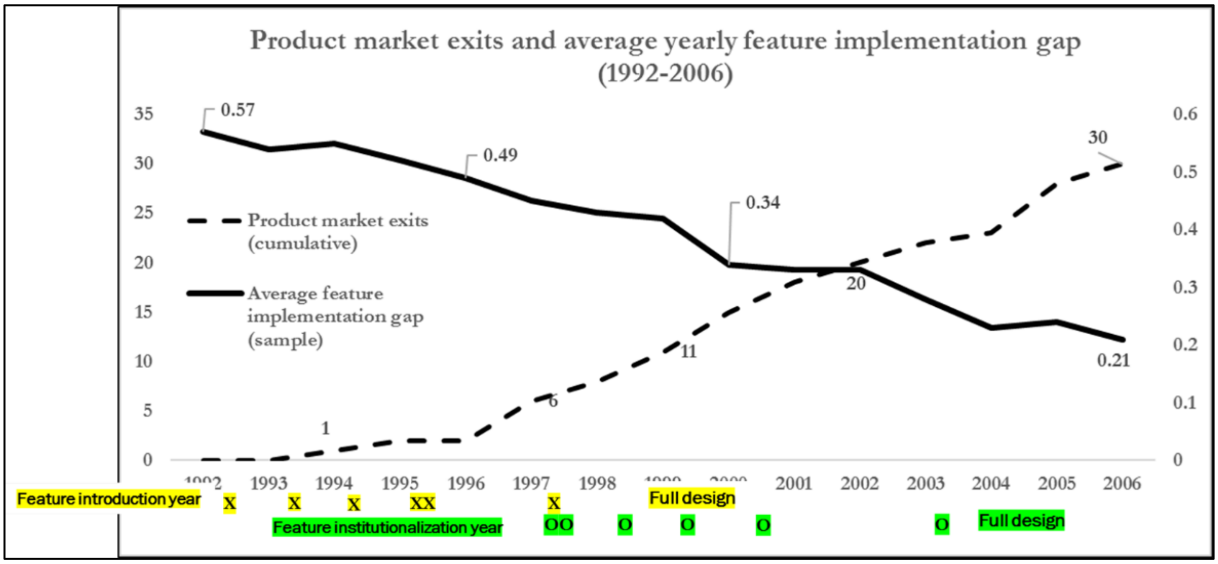
Empirically, I observed that the null hypothesis of regressor exogeneity was rejected ($p< 0.05$) indicating that endogeneity was an issue. I found that the null hypothesis of the Hansen J statistic $\chi2$ test was rejected ($p> 0.1$) justifying the validity of the instruments. I ran two first stage probit models to predict the likelihood of feature introduction and making corporate scope decisions using my variables and the respective instruments. I used the *predict* procedure to save the predicted values of the residuals (inverse Mills ratios) for both equations and included them in the second stage model to control for endogeneity.

2.4 RESULTS

Correlations and descriptive statistics are shown in table 3. Multi-collinearity was not a concern since the mean variance inflation factor (VIF) was 1.80 with individual variable values < 3 (Berry, 1993). The mean of the feature implementation gap variable was 0.38 indicating that on average, about two features were absent from a firm design over the sample period. Table 4 contains the endogeneity adjusted mixed effects Cox proportional hazards regression results. A negative coefficient for a variable indicates a *lower* hazard of product market exit (higher likelihood of product market survival) while a positive coefficient indicates a *higher* hazard of product market exit (lower likelihood of product market survival) (Allison, 1984; Cleves et.al., 2016).

Figure 2 shows the empirical context underpinning the era of ferment for the digital camera product market ecosystem. Over the sample period, the feature implementation gap decreased by over 50 percent (solid line) indicating that firms with product designs that had a high gap value exited the product market over time (broken line) showcasing a 'selection' effect. The timelines for feature introduction and feature institutionalization are at the bottom of the graph. Twenty-two of the 30-product market exits (73 percent) occurred during the period of institutionalization (1997-2004). The timeline of feature introduction and institutionalization are shown where 'X' and 'O' indicate features introduced and institutionalized in a given year respectively.

Figure 2. Empirical context



The empirical results are shown in table 4. The controls (model 1 in table 4) offered important insights. Alliance and acquisition experience were significant and positively related to product market survival because they provide access to external knowledge (Mowery et.al., 1996; Vermeulen and Barkema, 2001). Fixed time effects had a negative effect on product market survival and product market size had a positive effect consistent with the concept of munificence (Suarez and Utterback, 1995). Corporate diversification had a positive and significant effect on product market survival as firms could redeploy resources towards the digital camera business unit to improve adaptive capability (Helfat and Eisenhardt, 2004).

Table 3. Correlations and descriptive statistics

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Firm size	1												
2. Product market size	0.15	1											
3. Population density	-0.14	0.61	1										
4. Dominant design. intro-duction	0.02	0.00	0.01	1									
5. Dominant. design. institutionalization	-0.03	0.03	-0.03	0.02	1								
6. Feature institutionalization	0.38	0.04	-0.06	-0.01	0.06	1							
7. Product. market fixed effects	0.31	0.01	-0.02	0.07	-0.02	0.35	1						
8. Time fixed effects	0.06	0.43	-0.08	-0.01	0.04	0.01	-0.01	1					
9. Diversification	0.38	0.30	-0.28	0.01	0.08	0.79	0.23	0.09	1				
10. Product portfolio breadth	-0.01	-0.08	0.14	-0.02	0.03	-0.02	0.01	0.03	-0.03	1			
11. R&D expense	0.28	0.02	0.03	0.03	-0.00	0.00	0.01	0.02	0.03	-0.01	1		
12. Organizational Slack	0.68	0.16	-0.15	-0.01	-0.06	0.08	0.16	0.01	0.14	0.00	-0.05	1	
13. ROA	0.21	-0.01	-0.05	-0.04	-0.03	0.03	-0.00	0.00	-0.00	0.01	-0.14	0.09	1
14. Alliance experience	0.27	0.01	-0.03	0.08	-0.04	0.30	0.48	0.01	0.23	0.04	0.02	0.06	0.03
15. Acquisition experience	0.11	0.35	-0.32	-0.02	0.07	0.25	0.07	0.12	0.47	-0.00	0.03	0.07	-0.00
16. Feature gap	-0.10	-0.40	0.39	0.02	-0.01	-0.17	0.03	-0.11	-0.11	0.05	0.03	-0.13	-0.07
17. Alliancing activity	0.39	0.04	-0.02	-0.00	-0.01	0.15	0.28	0.00	0.29	0.05	0.02	0.33	0.04
18. Knowledge breadth	-0.20	0.02	0.03	0.01	0.11	0.09	-0.16	0.03	-0.01	-0.00	0.07	-0.22	-0.07
19. Knowledge depth	0.36	0.34	-0.41	-0.03	-0.02	0.21	0.12	0.02	0.26	-0.04	-0.05	0.28	0.04
20. Acquisition activity	-0.11	-0.35	0.32	0.02	-0.07	-0.09	-0.07	-0.12	-0.47	0.00	0.00	-0.07	0.00
21. Product market survival	-0.09	0.08	-0.03	0.07	-0.04	-0.25	-0.00	0.06	-0.03	0.03	0.03	-0.00	-0.22
Mean	2.47	2.10	3.97	0.05	0.04	0.44	0.14	0.24	0.65	0.48	0.56	0.87	0.08
Standard deviation	1.04	1.16	0.21	0.06	0.04	0.71	0.35	0.43	1.33	0.29	1.11	1.27	0.58
Maximum	4.97	3.31	4.22	1	1	1	1	1	5	0.99	1.81	7.04	1.82
Minimum	0.54	0.24	3.37	0	0	0	0	0	0	0.01	0.00	2.69	0.13

N= 843 firm year observations. All values ≥0.10 and ≤ -0.10 are significant at $p<0.05$.

Table 3. (continued)

Variable	14	15	16	17	18	19	20	21
14. Alliance experience	1							
15. Acquisition experience	0.01	1						
16. Feature gap	0.02	0.02	1					
17. Alliancing activity	0.26	0.28	-0.00	1				
18. Knowledge breadth	-0.10	-0.11	0.03	-0.15	1			
19. Knowledge depth	0.35	0.09	-0.17	0.34	-0.20	1		
20. Acquisition activity	-0.01	-0.25	0.17	-0.16	-0.09	-0.21	1	
21. Product market survival	-0.01	-0.07	-0.01	-0.04	0.10	-0.04	-0.09	1
Mean	1.44	1.23	0.38	0.88	0.86	0.60	0.06	0.06
Standard deviation	3.09	1.89	0.21	2.59	0.18	0.14	0.24	0.24
Maximum	19	9	1.00	9	1	0.98	4	1
Minimum	0	0	0.00	0	0	0	0	0

N= 843 firm year observations. All values ≥0.10 and ≤ -0.10 are significant at $p<0.05$.

Hypothesis 1 proposed that the feature implementation gap had a negative effect on product market survival. It was supported in model 2 of table 4 ($\beta = 0.62$, $p < 0.05$). When all six features of the digital camera dominant design were absent from a firm's product design, the hazard rate of product market exit increased by 86 percent (exp (1*0.62) = 1.86 or (1.86-1) *100). This result was materially supported as firms that exit the digital camera product market had an average feature implementation gap of 58 percent (~ 2-3 absent features) while those that survived the sample period had a gap of 22 percent (~ 1 absent feature). Also, as 48 percent of the sample firms exited the product market, the gap was an important driver of product market exit.

Hypothesis 2 proposed that firms' alliancing activity had a weakening effect on the negative relationship between the feature implementation gap and product market survival. It was supported in model 3 of table 4 ($\beta = -0.58$, $p < 0.05$). As the feature implementation gap increased by one feature, for each additional alliance formed, the hazard rate of product market exit decreased by ($\exp^{(0.17* -0.58)}$ = 0.91 or (1-0.91) *100) or 9 percent. Panel 3a of figure 3 shows the moderation effect . As the gap decreased, the hazard rate of product market exit for firms with low levels of alliancing activity (broken line) decreased exponentially relative to firms with high levels of alliancing activity (solid line) for whom the decrease in hazard rate was relative flatter. Firms with low alliancing activity were ~ four times more likely to exit the product market than those with high alliancing activity when all six features were absent from their camera models. This difference in relative hazard of exit decreased as the gap decreased (i.e. as firms adopted more features of the evolving dominant design). Low alliancing activity firms were only twice more likely to exit compared to high alliancing activity firms when one feature was absent. Thus, alliancing was a survival enhancing strategy particularly when firms had higher values of the gap

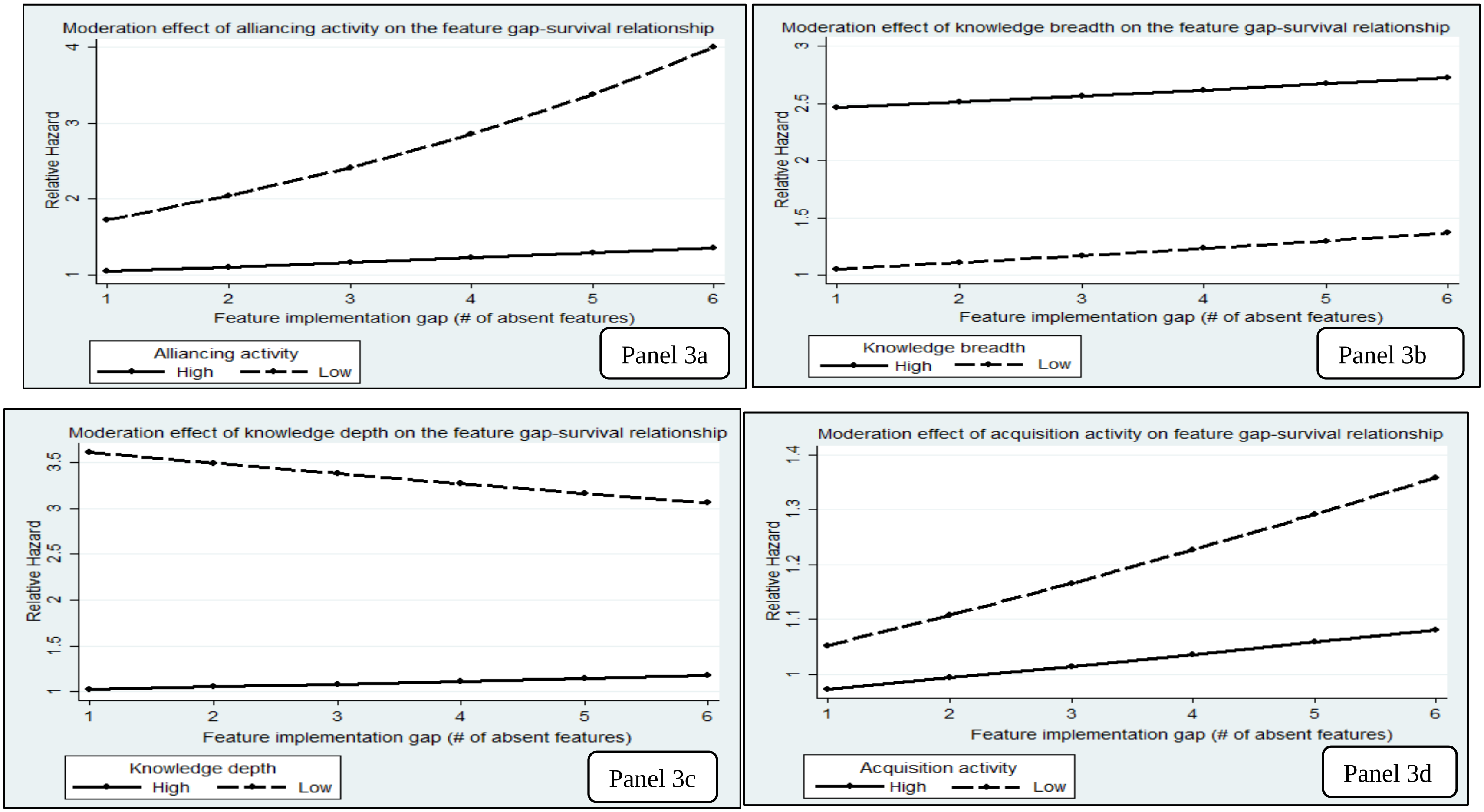
Table 4. Event history modeling results (endogeneity adjusted estimates)

Control variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Firm size	-0.78* (0.36)	-1.11**(0.45)	-1.44** (0.44)	-0.68 (0.53)	-0.63** (0.24)	-0.43 (0.50)
Product market size	-0.38**(0.07)	-0.39**(0.08)	-0.42 (0.89)	-0.72** (0.18)	-0.21** (0.05)	-0.11** (0.02)
Product market population density	0.20 (0.17)	0.65 (1.91)	0.41* (0.19)	0.53 (2.61)	0.32** (0.09)	-0.17 (0.29)
Entry before dominant design introduction dummy	0.36 (0.63)	0.16 (0.63)	0.02 (0.58)	0.76 (0.78)	0.46 (1.09)	0.68 (0.84)
Entry before dominant design institutionalization dummy	-0.66 (0.48)	-1.02 (0.56)	-1.07^{+} (0.58)	-1.37^{+} (0.74)	0.49* (0.02)	-0.34 (0.77)
Feature institutionalization dummy	0.66^{+} (0.36)	0.56 (0.57)	0.82* (0.39)	0.10 (0.56)	0.71** (0.22)	0.66 (0.53)
Product market fixed effects	-1.30 (0.94)	-0.77 (1.01)	-0.25* (0.11)	-0.71 (1.60)	0.21** (0.06)	0.45 (1.77)
Time fixed effects	0.25** (0.08)	0.32** (0.09)	0.21* (0.09)	0.42* (0.16)	0.22** (0.06)	0.55** (0.19)
Corporate diversification	-1.71**(0.48)	-1.54*(0.76)	-1.64**(0.50)	-1.91* (0.96)	-3.01 (2.19)	-3.52* (1.31)
Digital camera portfolio breadth	-1.48 (0.96)	-0.78 (0.94)	-0.29 (0.95)	-0.23 (0.15)	-0.16** (0.05)	-0.39* (0.19)
Prior R&D expense	0.16^{+} (0.09)	0.09 (0.10)	0.07 (1.11)	0.01 (1.25)	0.24** (0.07)	0.21^{+} (0.12)
Organizational slack	-0.03 (0.35)	-0.11 (0.11)	0.70^{+} (0.40)	1.27 (0.84)	-1.02 (1.11)	-0.11 (0.59)
Prior firm performance (ROA)	-0.09 (0.10)	0.05 (0.13)	0.39** (0.15)	0.21 (0.23)	-0.12** (0.04)	0.23 (0.29)
Prior alliancing experience	-0.27**(0.09)	-0.04 (0.19)	-0.24 (0.08)	-0.03 (0.27)	-0.11* (0.04)	-0.32(0.28)
Prior acquisition experience	-0.61^{+} (0.36)	-0.44 (0.39)	-0.68^{+} (0.38)	-0.27 (0.56)	-0.59** (0.20)	-0.26* (0.13)
H1: Feature implementation gap		**0.62* (0.32)**	1.04** (0.28)	3.77 (2.56)	0.48** (0.14)	0.07^{+} (0.04)
H2: Gap * Firm alliancing activity			**-0.58* (0.22)**	-0.89* (0.33)	-0.27** (0.09)	-0.99** (0.34)

Table 4. (continued)						
Firm alliancing activity			-0.10 (0.09)	-0.20 (0.12)	-0.13** (0.04)	-0.17 (0.14)
H3a: Gap * Feature related knowledge breadth				**0.46^{+} (0.25)**	0.50** (0.14)	0.75* (0.36)
Feature related knowledge breadth				-0.64 (0.92)	-0.15** (0.04)	-0.13 (0.12)
H3b: Gap * Feature related knowledge depth					**-0.35** (0.12)**	-0.96* (0.47)
Feature related knowledge depth					-0.21* (0.09)	-0.27 (0.21)
H4: Gap * Firm acquisition activity						**-0.97** (0.34)**
Firm acquisition activity						-0.10* (0.04)
Inverse Mills Ratio – Feature introduction proclivity	0.34 (0.62)	-0.12 (0.09)	-1.47^{+} (0.82)	-0.11 (0.09)	0.02 (0.32)	0.51 (1.32)
Inverse Mills Ratio – Corporate scope activity	0.05 (0.14)	-0.06 (0.16)	0.17 (0.17)	0.46 (0.34)	1.01* (0.37)	0.32 (0.47)
Over-dispersion (frailty) (θ)	0.66	0.32	0.86	1.61	1.38	1.30
LR test (χ2) of θ (p-value)	0.01 (0.99)	0.04(0.49)	0.05(0.50)	0.01(0.99)	0.01 (0.99)	0.01 (0.99)
# of events (product market exits)	30	30	30	30	30	30
Firm year observations	843	843	843	843	843	843
Log likelihood	4.14	7.67	14.42	16.88	22.46	23.79
Likelihood ratio test χ2 (df)	105.80 (17)	110.44(18)	126.35(20)	126.16(22)	133.29(24)	140.34(26)

Notes for table 4: a) n= 62 firms with 843 firm year observations.
b) The first value for each variable in each model is the regression coefficient. The value in brackets is the standard error calculated through the concept of shared frailty that accounts for dependence between observations and unobserved heterogeneity.
c) ** p<0.01, * p< 0.05 and + p< 0.1.
d) Bold values refer to the hypotheses results.
e) When the LR test of theta is not significant, unobserved heterogeneity (frailty) is accounted for in the model.

Figure 3. Graphical representation of moderation effect hypotheses



(i.e. more absent features). This result was materially supported as I found that firms that survived the era of ferment made 48 of the 72 alliances (67 percent) in my sample.

Hypothesis 3a proposed that the breadth in feature related knowledge had a strengthening effect on the negative relationship between the feature implementation and product market survival. From model 4 in table 4, hypothesis 3a received partial support ($\beta = 0.46$, $p < 0.1$). For a firm with all six features absent from its design, patenting in any one of the features would increase the hazard rate of product market exit by 8 percent. Panel 3b of figure 3 shows the moderation effect wherein the relative hazard rate of exit for firms with high levels of knowledge breadth (solid line) was ~ two times that of firms with low levels of knowledge breadth (broken line) irrespective of the gap. Also, for firms with low levels of breadth, the hazard rate of exit decreased marginally as the gap decreased (i.e. firms adopted features of the evolving dominant design). This finding implies that lower levels of breadth may have been particularly beneficial for product market survival when only a few features were absent. This result was materially supported as firms that did not survive the era of ferment had an average knowledge breadth of 86 percent implying that their patenting activity spanned at least five of the six features of the evolving dominant design.

Hypothesis 3b proposed that the depth in feature related knowledge had a weakening effect on the negative relationship between the feature implementation gap and product market survival. From model 5 in table 4, hypothesis 3b was supported ($\beta = -0.35$, $p < 0.01$). For a firm that had all six features absent from its design, a 10 percent increase in knowledge depth in any one feature decreased the hazard rate of product market exit by six percent. Panel 3c of figure 3 shows the moderation effect wherein the relative hazard rate of exit for firms with low levels of knowledge depth (broken line) was ~ three times that of firms with high levels of knowledge depth (solid line). This difference in relative hazard of exit increased with a decrease in the gap (i.e. as firms adopted more features of the evolving dominant design). For instance, firms with low knowledge depth were > three times likely to exit compared to high knowledge depth firms when one feature was absent. This finding implies that low levels of depth had negative implications for product market survival particularly when only a few features were absent. This result was materially supported wherein survivors had an average knowledge depth of 62 percent. On average, 62 percent of survivors' patent citations for a given feature were to patents that were based on that feature.

Hypothesis 4 proposed that firms' acquisition activity had a weakening effect on the negative relationship between the feature implementation gap and product market survival. From model 6 in table 4, hypothesis 4 was supported ($\beta = -0.97$, $p < 0.01$). As the feature implementation gap increased by one feature, for each additional acquisition, the hazard rate of product market exit decreased by 15 percent. Panel 3d of figure 3 shows the moderation effect wherein the relative hazard rate of exit for firms with low acquisition activity (broken line) was ~ one and half times that of firms with high acquisition activity (solid line) irrespective of the gap. This difference in relative hazard of exit decreased as the gap decreased (i.e. as firms adopted more features of the evolving dominant design). Low acquisition activity firms were only 20 percent more likely to exit compared to high acquisition activity firms when one feature was absent. Thus, when the gap was low, acquisitions did not significantly exert a survival enhancing effect for firms. This result was materially supported with firms that survived making 45 of the 51 acquisitions (90 percent).

2.4.1 Robustness checks

To assess the robustness of the feature implementation gap variable, I created a *'design proximity'* variable to measure how close a firm's design was to the evolving dominant design in terms of features. I operationalized the variable by subtracting the original gap variable in each firm year from one. If a firm's product design had a low (high) value on the feature implementation gap, the inverse design proximity variable would indicate a high (low) level of proximity with the evolving product design. I expected the proximity variable to exert a positive effect on product market survival because it measured the overlap or similarity between a firm's product design and the evolving dominant design. The proximity variable was marginally significant (β= -0.39, $p< 0.1$) with the negative sign indicating a decrease in the hazard rate of product market exit). This result showed that my findings were consistent with the technological evolution literature on dominant designs wherein a high degree of similarity with the evolving dominant design implies a higher likelihood of product market survival (Argyres et.al., 2015; Eggers, 2016; Tegarden et.al., 1999).

A case could be made that the feature implementation gap should be measured only when features became institutionalized to address the question of how could a firm have *ex ante* knowledge of which features to implement. My theory does not rest on this assumption because it centers on how firms used corporate scope decisions to address a gap regardless of whether they were aware or unaware of the features of evolving product dominant design. However, I empirically addressed this issue through two approaches. First, I divided the sample into two periods; (1) from the beginning of the sample period until the first feature had been institutionalized (1991 – 1997) and (2) from when the first feature had been institutionalized until the end of the sample period (1997 – 2006). I re-ran the main effect model with these truncated samples and in both cases, the main effect of the feature implementation gap was significant ($p< 0.01$ and $p< 0.05$ respectively) indicating that the gap negatively affected product market survival irrespective of whether a firm had *ex ante* knowledge of what features to implement.

Second, I lagged the gap measure by one, two and three years and used it as a dependent variable in fixed effects regression models that used the corporate scope decisions as independent variables. I observed that firm alliancing and acquisition activity had a negative effect on the gap (decreased the gap) that was significant in the models using the two and three year lagged gap variable. Depth in feature knowledge (patenting) had a negative effect on the gap in the model using the one year lagged gap variable. I tested the above models over the entire sample period. The results indicated that corporate scope decisions were knowledge accessing mechanisms that enabled firms to introduce features in their product designs *ex ante* to the introduction and institutionalization of the evolving product dominant design (1991-1997) and facilitated firms in addressing the feature implementation gap (adaptation) *ex post* to the introduction and institutionalization of the evolving product dominant design (1997-2004).

In the operationalization of the feature implementation gap variable, if a firm implemented a specific feature, the yearly absence score was coded as zero and if the firm had not implemented the feature, it was coded as a one. While I controlled for firm diversification, the operationalization did not provide for the possibility that diversified firms could share technology across businesses. That is, if a diversified firm had the capability for a given feature in other business units, it could share it with the digital camera business unit. For example, the presence of a video recording option in Canon Inc.'s camcorder business unit meant that the capability could be transferred to digital cameras unit (Helfat and Eisenhardt, 2004). To control for the possibility of capability transfer through economies of scope, I re-operationalized the feature implementation variable using an additional coding of 0.5 for firms that had the capability to implement a given feature in their digital camera models (by measuring firm patenting in the concerned feature) but had not done so as of the specific year in the sample period. I ran the models using this variable and the main effect of the revised feature implementation gap variable was marginally significant and slightly lower than the original variable indicating that fungibility of feature related capabilities in a firm was an important mechanism that benefited product market survival ($\beta = 0.46$, $p < 0.1$).

Finally, as a counterfactual argument to the hazard rate assumption, I tested for a monotonically increasing or decreasing hazard rate using piecewise exponential, Weibull and Gompertz specifications that allow for such a trend in the hazard rate (Allison, 1984; Cleves *et.al.*, 2016). The results were robust but the model fit was superior for the Weibull specification over a Gompertz specification. The Wald test of STATA 14.1 indicated that a piecewise exponential assumption was not suitable. I also tested for a parametric distribution that allowed for a non-monotonic hazard rate (lognormal) and the model fit was inferior indicating a lack of support for using a non-monotonic hazard rate assumption. The results were also not robust to a lognormal specification (that allows for a non-monotonic trend of hazard rate) with inferior fit indicating that my assumption of a non-monotonic hazard rate was appropriate.

2.5 DISCUSSION

I motivated this paper with the observation that eras of ferment are increasingly common in technology ecosystems and their negative effect on firms' product market survival is undeniable.

One of the primary antecedents explaining the negative effect on firms' product market survival is demand side change, especially changes in the features of an evolving product dominant design arising from changing customer preferences for products. I theorized that during an era of ferment firms that did not introduce features of the evolving product dominant design faced a feature implementation gap that increased their likelihood of product market exit.

Given demand side changes and the need for firms to minimize a feature implementation gap, I asked a strategically important question: during an era of ferment, how do corporate scope decisions (alliancing, internal development and acquisitions) acting as knowledge accessing adaptive mechanisms at the supply-side to moderate the feature implementation gap-product market survival relationship. I found that alliancing, acquisitions and feature specific knowledge depth in patenting weakened the negative effect of a feature implementation gap increasing the likelihood of product market survival. However, feature specific knowledge breadth in patenting strengthened the negative effect of a feature implementation gap and decreased the likelihood of survival. In an era of ferment, supply side corporate scope decisions matter because they affect the selection of demand side product features aligned with the evolving product dominant design thus increasing the likelihood of product market survival in the evolving technology ecosystem.

2.5.1 Contribution

Eras of ferment are periods of change for technology ecosystems affecting both their demand and supply sides (Adner and Kapoor, 2010; Kapoor and Lee, 2013). From a demand side perspective, changes in customer preferences for product features influence the desirability of a firm's products

(Benner and Tripsas, 2012; Benner and Waldfogel, 2016). From a supply side perspective, corporate scope decisions and their access to different types of knowledge affect the types of product features that a firm offers in the changing ecosystem (Capron and Mitchell, 2012). Thus, during an era of ferment, both demand and supply changes to an ecosystem have important consequences for firms' product market survival (Adner and Kapoor, 2010, 2016). My contributions to the era of ferment and corporate scope streams of research build on this insight.

My first contribution informs era of ferment research by clarifying why adopting a demand side perspective explains product market survival. I do this by focusing theoretical and empirical attention at the product level – product features that comprise the evolving dominant design of the digital camera. By conceptualizing a feature implementation gap as the absence of features of the evolving product dominant design in a firm's product design, I demonstrate how taking a demand side perspective to eras of ferment reveals a threat to a firm's product market survival. Conversely, my work shows how evolving demand side dynamics in terms of customer preferences for specific product level features pose supply side firm adaptation imperatives in an era of ferment. For example, in 1994, the Apple Quick Take 100 was one of the earliest digital camera models but it did not include an optical zoom feature while their external storage feature only permitted transfer of images to an Apple Mac computer (Kaplan and Segan, 2008). Both features were part of the evolving digital camera dominant design. Their absence from the Quick Take 100 design created a feature implementation gap. The model exited the product market in 1997 due to a lack of enthusiasm from non-Apple users and those that preferred an optical zoom feature (Kaplan and Segan, 2008).

This work also identified a liability of ferment mechanism that theoretically explains the negative relationship between a feature implementation gap and product market survival. The liability of ferment mechanism explains the threat posed to product market survival arising from competitive disadvantages in the product market ecosystem and delegitimization by institutional stakeholders in the social system (Tegarden et.al., 1999; Tushman and Rosenkopf, 1992). The lack of alignment of a firm's product design with the evolving product dominant design threatens product market survival as customers and ecosystem players withdraw their endorsement and de-legitimize the firm. For example, panel 2 in figure 2 shows that the average yearly feature implementation gap decreased over time as firms exit their respective product market. This supports a selection effect as firms with lower values of the feature implementation gap limited their liability of ferment and survived.

Analogous to research that has applied the 'liability' mechanism to firm age (Henderson, 1999), geographic origin (Edman, 2016) and location (Un, 2016), applying the liability of ferment mechanism to firm idiosyncratic attributes generates novel insights into how firms become susceptible to an era of ferment. While my work focused at the product level, I propose that cognitive limitations (individual level), resource and capability limitations (capability level) and firms' structural and cultural limitations (firm level) also create feature implementation gaps. Additionally, as per the principle of mechanism *'concatenation'* the various levels are mutually reinforcing (Gambetta, 1998). Hence, era of ferment scholarly work would benefit from research within and across the levels of analysis.

My second contribution is theoretically identifying supply side corporate scope decisions as moderators of the relationship between the demand side feature implementation gap and product market survival. Corporate scope decisions act as knowledge accessing adaptive mechanism that can mitigate or attenuate the negative effect of a feature implementation gap. *Ex-ante* to the institutionalization of the evolving product dominant design, to remain competitive firms choose features that form their product design. These choices are contingent on knowledge assets within a firm's boundaries along with relevant technological and product market resources and capabilities that the firm can access externally (Benner and Tripsas, 2012; Martin and Mitchell, 1998). However, given the stochastic way a product dominant design evolves, a feature implementation gap manifests due to the knowledge orchestration of a firms' *ex-ante* corporate scope decisions. In my sample, Ricoh Co Ltd. faced a high feature implementation gap until 1995 as it had not introduced the optical zoom, removable storage and greater than VGA resolution features that were part of the evolving digital camera dominant design. However, it leveraged internal R&D through patents at its R&D facility in California to not only introduce these features but also pioneer the introduction and institutionalization of the video recording feature through breakthrough innovation in color image compression (Ricoh Company History, 2016).

Scholarly research on eras of ferment typically focus on a supply side (Argyres et.al., 2015; Eggers, 2016; Suarez et.al., 2015; Tegarden et.al., 1999) or a demand side perspective (Benner and Tripsas, 2012; Martin and Mitchell, 1998). I provide a novel perspective by theorizing how the interaction of demand and supply side decisions (i.e., features and corporate scope) affect product market survival. The linking of the supply and demand side of the product market ecosystem, my work suggests that embracing a product market ecosystem perspective during eras of ferment will develop additional theoretical insights of era of ferment dynamics. Through both my contributions, I add to scholarly research on eras of ferment by highlighting how threats to product market survival arise and how they can be mitigated.

2.5.2 Managerial implications

For practicing managers, my study provides two implications of note. First, I demonstrated that strategic renewal of organizational knowledge and the features selected to comprise a firm's evolving product design during periods of technological change are important predictors of product market survival (Capron and Mitchell, 2012). Thus, my work draws managers' attention to the importance of continually renewing their knowledge base through external venturing and internal development while also developing knowledge integration capabilities and reconfiguring knowledge orchestration routines (Grant, 1996a, b; Helfat et.al., 2007; Winter, 1987; Zollo and Winter, 2002). At the same time, the conceptualization of the feature implementation gap captures the threat posed to product market survival due to the misalignment of product configurations with the evolving dominant design driven by a distillation of ecosystem and institutional expectations. Augmenting the knowledge base within a firm's boundary by improving the depth of existing knowledge while expanding its knowledge base through alliances and acquisitions facilitate establishing the competitive robustness and the legitimacy of firms in evolving technology ecosystems experiencing design competition. My work also exhorts the importance of experimentation and recombination in knowledge work as a key driver of breakthrough innovation wherein the roles of scientists, R&D personnel and owners of organizational knowhow take initiatives that inculcate and preserve a culture of knowledge driven product innovation.

Second, my work emphasizes the importance of managing the diversity (Harrison and Klein, 2007) of a firm's corporate development portfolio to facilitate the strategic renewal of organizational knowledge and its product portfolio during an era of ferment. For instance, I focused on two approaches to managing the diversity of a corporate development portfolio -

expansion (through alliancing and acquisitions) and *sustenance* (through internal development of feature specific knowledge breadth and depth). Each approach has different effects in terms of augmenting a firm's knowledge and affecting its product market survival. Further, the importance of leveraging multiple knowledge sourcing options in the corporate development function is evident through my theory development of how knowledge orchestration and product development are linked as the firm's product portfolio evolves in response to ecosystem and technological change. Hence, managers who leverage a diverse range of corporate scope decisions during periods of technological change have a greater chance of improving the likelihood of product market survival. For example, Eastman Kodak used patenting to pioneer the greater than VGA resolution feature within the digital camera dominant design while acquiring several targets that had capabilities in digital imaging (Digital Camera Museum). It formed alliances with Adaptive Solutions Inc. and IBM to improve digital imaging and external storage capabilities for digital cameras (Kodak Company History).

These findings suggest that the management of diversity in corporate development decisions can be a crucial managerial capability that facilitates the creation, modification and renewal of firm knowledge in a manner that help managers minimize the threat to product market survival during eras of ferment (Adner and Kapoor, 2010; Helfat et.al., 2007).

2.5.3 Limitations and future research directions

I based the operationalizations of the four corporate scope decisions on archival data. Thus, a future research opportunity is to use field-based research designs (Edmondson and McManus, 2007) to identify and operationalize fine grain, processes and process-oriented variables of how firms choose to develop their corporate development portfolio while shaping or adapting to eras of ferment. An interesting dilemma for most firms is the trade-offs between and coordination of making sequentially versus simultaneously corporate scope decisions. For example, a firm with high levels of knowledge depth face a dilemma of whether and when to leverage internal knowledge or expand corporate scope through accessing extramural knowledge. I suggest that unpacking process-related aspects of corporate scope decisions would not only enlighten strategy scholars on how firms adapt their corporate scope in eras of ferment but also provide insight into the evolution and management of a firm's corporate scope over time.

For the development of feature related variants, I limited my theory development on the moderation effects to the transition between knowledge orchestration teams and product development teams. Thus, I did not articulate the practices through which such intra-firm collaboration takes place. Further, since I operationalized knowledge breadth and depth through patenting, the internal development variable was limited to 'upstream' knowledge orchestration thereby limiting its scope. Future research should include alternative internal development practices such as R&D innovation processes, corporate ventures and product development dynamics. I propose that a practice theory lens for understanding when, why and how firms use a 'go it alone' approach and intra-firm collaboration to adapt to eras of ferment would shed light on the role of management preferences, organizational routines and firm artifacts (Feldman and Worline, 2016).

My conceptualization of corporate scope as knowledge accessing mechanisms is an adaptation oriented approach to managing in an era of ferment (Child, 1997). Thus, a boundary condition is that I did not focus on how firms shaped the era of ferment through feature introduction and strategic maneuvering to institutionalize features in the evolving dominant design. For example, through strategic and institutional maneuvering with ecosystem actors, a firm could proactively influence the evolution of the dominant design *ex ante* thereby minimizing exposure to the liability of ferment (Garud and Rappa, 1994; Tushman and Rosenkopf, 1992). Scholarly research on how firms shape an era of ferment through strategic and institutional maneuvering would complement adaptation perspectives and would yield rich theory.

Finally, a limitation of my dataset involved the absence of private firms for whom control variables, performance measures and corporate scope decision data was limited or unavailable. Benner and Tripsas' (2012) research on how prior industry affiliation affected feature introduction included 40 private firms in the digital camera product market. To assess if the exclusion of the 40 private firms affected my findings, I collected data on product market survival and calculated the feature implementation gap for these firms. I found that 9 of the private firms (22 percent) exited their product market during the era of ferment with an average feature implementation gap of 0.51 (~three absent features). For the 31 survivors, the feature implementation gap was 0.26 (~two absent features). These results align with hypothesis 1that a feature gap has a negative effect on product market survival.

2.6 CONCLUSION

Highlighting the importance of a feature implementation gap that threatens product market survival during eras of ferment and the adaptive role of corporate scope decisions, my study emphasized the importance of linking demand-side and supply side perspectives to increase understanding of product market survival. A liability of ferment mechanism explains the demand side threat that a feature implementation gap poses to survival because it creates competitive disadvantages in the product market ecosystem and delegitimization by institutional stakeholders in the broader social system. On the supply side, corporate scope decisions provide access to diverse sets of extramural knowledge while leveraging internal knowledge facilitating the development of product designs that improve the likelihood of survival during eras of ferment.

Developing and testing theory that links the era of ferment and corporate scope streams of research will provide novel insights as to how and why ecosystems change, the role of corporate scope in shaping or adapting to ecosystem change and how their interaction affects firms' product market survival. Given the increasing number of industries that have witnessed an era of ferment or are currently experiencing one, the time is ripe for engaging managers and scholars alike to the joint effects of the demand and supply sides of the changing ecosystem during eras of ferment.

3. ESSAY TWO - "PROLIFERATE AND MOBILIZE" – HOW FIRMS EXPLORE AND EXPLOIT THROUGH GROWTH MODES TO SURVIVE IN EVOLVING TECHNOLOGY ECOSYSTEMS

3.1 INTRODUCTION

Firm growth is an important cornerstone of corporate strategy research (DeSantola and Gulati, 2017; Gulati, 2004; Penrose, 1959). Scholars have addressed the antecedents of growth (Greve, 2008; Kotha and Nair, 1995), effect of technological innovation regimes (Stuart, 2000), effect on firm survival (Audretsch, 1995), interplay with corporate investment and profitability (Prescott, Kohli and Venkatraman, 1986; Yu et.al., 2017), strategic approaches to achieving growth outcomes (Chen, Williams and Agarwal, 2012; Favaro et.al., 2012), how firms formulate and implement growth initiatives (Lechner and Kreutzer, 2010) and corporate development decisions (internal development, alliances, acquisitions and divestitures) as 'growth modes' (McKelvie and Wiklund, 2010). However, notwithstanding the importance accorded to corporate development decisions as drivers of growth strategies by scholars and managers, how these decisions influence the relationship between firm growth and survival in changing technology ecosystems has not been addressed in scholarly work on firm growth or corporate strategy.

Technological change in product market ecosystems adversely impacts firm survival due to the threat of technological substitution and obsolescence (Adner and Kapoor, 2016; Christensen et.al., 1998). A firm's *growth orientation* increases its likelihood of surviving technological change as it is an adaptive response to technological change (Favaro et.al., 2012; Gulati, 2004; Penrose, 1959). Growth orientation is defined as 'the relative emphasis placed on the investment of firm resources towards increasing revenue and market share'. It is based on identifying and accessing new growth opportunities for increasing revenue and market share (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993). It also entails committing resources to develop and leverage a limited subset of growth opportunities while diverting resources away from less attractive growth opportunities (Helfat and Eisenhardt, 2004; Chakrabarti et.al., 2011; Kaul, 2012). Thus, a firm's growth orientation decreases the threat of failure in evolving technology ecosystems as it involves searching and selecting opportunities for increasing revenue and market share.

A firm's corporate development decisions - internal development, alliances, acquisition and divestitures represent growth modes that drive the revenue and market share growth imperatives of firms (Capron and Mitchell, 2012; Dyer et.al., 2004). Firm growth modes can be viewed as adaptive mechanisms that influence the relationship between growth orientation and the likelihood of firm failure through their ability to support the survival enhancing benefits of a growth orientation (Chakrabarti et.al., 2011; Kim, Haleblian and Finkelstein, 2011; Singh and Mitchell, 2005). As a constantly evolving technology ecosystem environment is increasingly complex and unpredictable for firms to maneuver, growth mode decisions represent a strategic alternative for managers through which they can adapt to the rapidly changing ecosystem environment and avoid the possibility of failure.

For instance, in my empirical context of technological change in the telecommunication equipment and computer networking product market ecosystems, firms assumed a modest growth orientation on average and chose over 14 different growth mode decisions to adapt to and survive technological change. Notwithstanding these efforts, 49 percent of the firms did not survive the sample period. As firm failure is an outcome of unsuccessful adaptation to environmental change (Barnett and Hansen, 1996; Christensen et.al., 1998; Josefy et.al., 2017), how growth modes act as adaptive mechanisms that affect the growth orientation-firm failure relationship is a strategic issue that merits scholarly and managerial attention. However, the current lack of scholarly insight on the adaptive and survival enhancing role of growth modes during technological change blurs clarity on how they contribute to corporate longevity. The importance of this issue for managers and the lack of scholarly insight on it motivated my research question – *'In evolving technology ecosystems, how do growth modes - internal development, alliances, acquisitions and divestitures moderate the relationship between growth orientation and the likelihood of firm failure?'*

To address this research question, I borrow from the continuum perspective offered by exploration/exploitation scholars (Gupta, Smith and Shalley, 2006; Lavie, Stettner and Tushman, 2010; March, 1991). I propose that growth modes represent domains through which firms selectively determine the *degree of exploration and exploitation* - the relative emphasis on exploratory or exploitative corporate development decisions aligned to a given growth mode (Lavie and Rosenkopf, 2006; Lavie et.al., 2011; Parmigiani and Rivera-Santos, 2011; Stettner and Lavie, 2014). A high degree of exploration within a growth mode implies a focus on distant search and technological variation - entering new product markets to identify and access opportunities for revenue and market share growth (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993). A high degree of exploitation within a growth mode implies local search or selection - committing resources to develop and leverage a limited subset of opportunities and diverting resources away from less attractive growth opportunities for achieving growth related outcomes (Helfat and Eisenhardt, 2004; Chakrabarti et.al., 2011; Kaul, 2012). As growth modes allow firms to selectively modify the relative emphasis on exploration or exploitation, they represent adaptive mechanisms that support the benefits of a growth orientation and decrease the likelihood of firm failure.

I theorize that the degree of exploration and exploitation in growth modes moderates the relationship between growth orientation and the likelihood of firm failure during technological change. To study this moderation effect, I theorized on the degree of exploration within two growth modes– internal development and alliance activity (Lavie and Rosenkopf, 2006; Stettner and Lavie, 2014). I borrow from extant research that emphasizes the survival enhancing potential of exploration in both modes (Dowell and Swaminathan, 2006; Mitchell and Singh, 1993; Reuer and Tong, 2010). I also theorized on degree of exploitation in two alternative growth modes – acquisition activity and divestiture activity (Moschieri and Mair, 2017; Stettner and Lavie, 2014). I borrow from extant research that emphasizes the importance of exploitation in both modes towards positive influencing firm survival (Kaul, 2012; Kuusela, Keil and Maula, 2017; Vidal and Mitchell, 2015). For this, I captured the relative emphasis on exploration within the internal development and alliance activity growth modes and the relative emphasis on exploitation within the acquisition and divestiture activity growth modes. I then developed and tested hypotheses for the moderation effect of each of the four growth modes on the relationship between growth orientation and firm failure.

My empirical context is a salient case of technological change involving the convergence between the equipment and networking product market ecosystems during 1989-2003 (Hsu and Prescott, 2017; Lee, 2007). The threat of firm failure and the importance of developing a growth orientation resulted from growth opportunities springing up due to technological convergence between both sets of product markets (Greenstein and Khanna, 1997; Seaberg et.al., 1997). Using a sample of 3,327 growth mode decisions made by firms across sets of product markets, I examined my hypotheses using event history modeling. First, I found that maintaining a growth orientation had a negative effect on the likelihood of firm failure. Subsequently, I found that a high degree of exploration in the internal development and alliance activity growth modes exerted a *'growth proliferation effect'* that strengthened the negative effect of growth orientation on firm failure. The growth proliferation effect enabled firms to identify and access opportunities for increasing revenue and market share thereby mitigating the threat of firm failure (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993).

Finally, I found that a high degree of exploitation in the acquisition and divestiture activity growth modes exerted a *'growth mobilization effect'* that strengthened the negative effect of growth orientation on firm failure. A growth mobilization effect enabled firms to commit resources to develop and leverage a limited subset of growth opportunities while diverting resources away from declining markets thus decreasing the likelihood of firm failure (Chakrabarti et.al., 2011; Kaul, 2012; Kuusela et.al., 2017). Thus, my findings indicate that firms that selectively emphasized exploration in certain growth modes i.e. internal development and alliance activity while emphasizing exploitation in alternative growth modes i.e. acquisition and divestiture activity were less likely to fail. This is attributed to their ability to manage the twin imperatives of search and selection with their growth modes for superior adaptability to a changing technology ecosystem.

This paper makes two contributions to strategy research. First, I contribute to scholarly research at the intersection of corporate strategy and firm growth by demonstrating how firm growth modes serve as adaptive mechanisms during change in technology ecosystems. By theorizing on the growth proliferation and growth mobilization effects, I demonstrate that a plausible driver of firm heterogeneity refers to the differences in firm growth mode choices and their influence on the relationship between growth orientation and survival during technological change. Second, I contribute to scholarly work on exploration/exploitation by showing the role of exploration and exploitation towards firm growth – a theoretical link that has received scant attention (cf. Raisch, 2008). By theorizing and finding support for the two effects, I extend research at the intersection of corporate strategy and exploration/exploitation by showing how selectively modifying the relative emphasis on exploration and exploitation in a firm's growth modes improved the adaptive capability of the firm thus increasing its likelihood of survival in evolving technology ecosystems.

3.2 THEORY AND HYPOTHESES

3.2.1 Growth orientation, technological change and firm failure

Technological change requires firms to adapt their growth strategies or face the threat of failure due to technological substitution and obsolescence (Adner and Kapoor, 2016; Christensen et.al., 1998; Tripsas and Gavetti, 2000). Rapidly evolving technology ecosystems are characterized by the emergence of new product markets (growth markets) underpinning opportunities for increasing revenue and market share (Luksha, 2008; Navis and Glynn, 2010; Woolley, 2010). Firms that realign their revenue and market share enhancement strategies around growth markets are more likely to survive as they can overcome the threats of technological substitution and obsolescence (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993).

In this context, a firm's growth orientation - 'the relative emphasis placed on the investment of firm resources towards increasing revenue and market share' assumes importance as it enables adaptation to the changing technology ecosystem by realigning its revenue and market share generation logic (Favaro et.al., 2012; Gulati, 2004; Penrose, 1959). Maintaining a growth orientation equips firms to access opportunities for increasing revenue and market share while exiting product markets vulnerable to technological substitution and obsolescence (Chakrabarti et.al., 2011; Helfat and Eisenhardt, 2004; Kaul, 2012). Technological/product market diversification underpins the benefits of distant search and exploration across growth markets leading to a proliferation of opportunities for increasing revenue and market share (Dowell and Swaminathan, 2006; Mitchell and Singh, 1993). However, as the revenue generation potential of opportunities may not be evident *ex ante* (Luksha, 2008; Schilling, 2015), adopting a growth orientation encourages firms to develop broad sets of growth opportunities across several ecosystem niches (Reuer and Tong, 2010; Vassolo, Anand and Folta, 2004). Growth opportunity sets enable firms to record modest increases in revenue and market share in growth markets thereby shifting and grounding revenue and market share generation strategies around these avenues (Folta and Miller, 2002; Rindova et.al., 2012). Hence, a growth orientation decreases exposure to technological substitution and obsolescence thus decreasing the likelihood of failure.

A parallel outcome of a firm's growth orientation involves expansion programs that commit resources for developing and leveraging a limited subset of opportunities for broader and more substantial increase in revenue and market share (Folta and Miller, 2002; Ghemawat, 1991; Maritan, 2001). To facilitate this, *de novo* or *de alio* entry form two key underpinnings of growth strategies that contribute to higher scale and scope across multiple growth markets (Bercovitz and Mitchell, 2007; Henderson and Cockburn, 1996; Penrose, 1959). Both approaches lead to 'speed capabilities' through early mover advantages in growth markets (Hawk, Pacheco-de-Almeida and Yeung, 2013). These include raising entry barriers by developing significant revenue streams and market share through minimum efficient scale (Ghemawat, 1991), network effects (Schilling, 2002), process innovation (Benner and Tushman, 2003) and exclusivity in access to complementary assets (Roy and Cohen, 2017). To support these expansion programs, exit from declining markets allows for the possibility of slack availability and resource redeployment for greater control over growth markets (Anand and Singh, 1997; Capron et.al., 2001; Kaul, 2012). As firms appropriate revenues and market share in growth markets, positional advantages accruing from market dominance further decrease their vulnerability to failure in the product market ecosystem (Barnett, Greve and Park, 1994; Mitchell, 1989; Mitchell and Singh, 1993).

Finally, proactively communicating a growth orientation to the broader technology ecosystem leads to legitimacy spillovers from ecosystem and institutional actors (Benner and Ranganathan, 2013; Lev, Petrovits and Radhakrishnan, 2010; Ozcan and Gurses, in press). Symbolic attributions of institutional legitimacy through socially constructed categories enhance the visibility of firms with a growth orientation (Zajac and Westphal, 2004). Ecosystem wide endorsements decrease the possibility of resource dependence issues that create roadblocks to the quest for growth outcomes (Cascario and Piskorski, 2005; Zheng, Singh and Mitchell, 2015; Greve and Zhang, 2017). Thus, firms adopting a growth orientation proactively reconfigure their revenue and market share generation logic thus mitigating the possibility of firm failure. Hence:

H1: Growth orientation will have a negative effect on the likelihood of firm failure in evolving technology ecosystems.

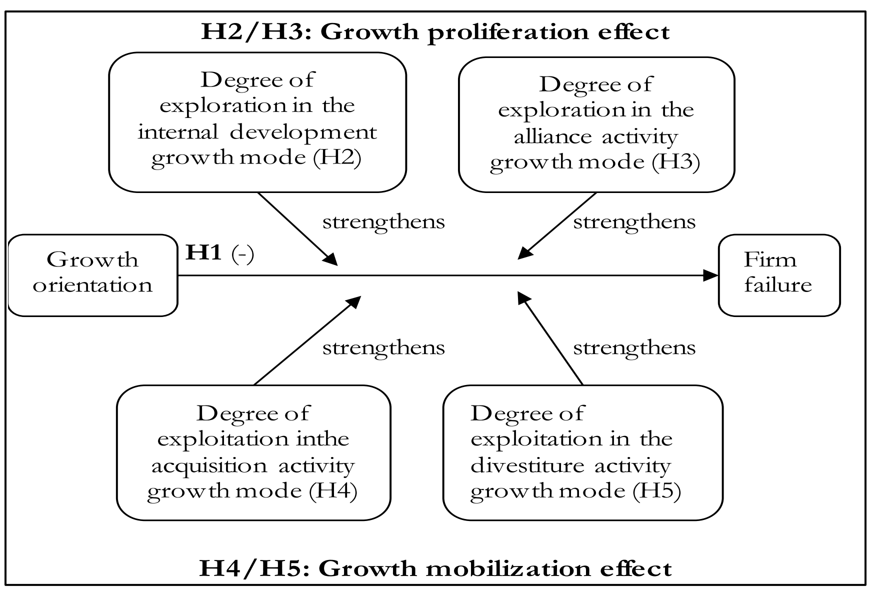
3.2.2 Corporate development decisions as exploratory and exploitative growth modes

Given the importance of a growth orientation as technology ecosystems change, how firms choose to identify, access and commit resources to opportunities for increasing revenue and market share is a key strategic issue. To theoretically address this, I borrow from the continuum perspective of the exploration exploitation lens (Gupta et.al., 2006; Lavie et.al., 2010; March, 1991). I propose that a firm's growth modes – internal development, alliances, acquisitions and divestitures (Capron and Mitchell, 2012; Dyer et.al., 2004) serve as domains that permit firms to selectively determine the degree of exploration and exploitation (Choi and McNamara, 2018; Lavie and Rosenkopf, 2006; Lavie et.al., 2011; Stettner and Lavie, 2014). Through this, growth modes serve as adaptive mechanisms that facilitate identifying, accessing and committing resources to opportunities for increasing revenues and market share.

I propose that by enabling firms to selectively emphasize exploration over exploitation or *vice versa*, growth modes can either strengthen or weaken the effect of growth orientation on firm failure. A high degree of exploration within a growth mode indicates a high relative emphasis on distant search and variation in terms of new product market entry and experimentation with new technologies and product lines to identify and access opportunities that can contribute to revenue and market share growth (Lavie and Rosenkopf, 2006; Lavie et.al., 2011; Stettner and Lavie, 2014). A high degree of exploitation within a growth mode implies a high relative emphasis on local search or selection - committing resources to develop and leverage a limited subset of opportunities and diverting resources away from less attractive opportunities to achieve the above-mentioned growth outcomes (Parmigiani and Rivera-Santos, 2011; Stettner and Lavie, 2014).

In line with existing research, I defined the degree of exploration as the ratio of the total number of exploratory decisions made within a specific growth mode to the total number of decisions made within it. I defined the degree of exploration as the ratio of the total number of exploratory decisions made within a specific growth mode to the total number of decisions made within it (Choi and McNamara, 2018; Lavie and Rosenkopf, 2006; Lavie et.al., 2011; Stettner and Lavie, 2014). Next, I develop hypotheses theorizing that a high degree of exploration in the internal development and alliance activity growth modes and a high degree of exploitation in the acquisition and divestiture growth modes will strengthen the negative effect of growth orientation on firm failure during technological change. The full model is shown in figure 4 below.

Figure 4. Theoretical model



3.2.3 The internal development growth mode

The internal development growth mode encompasses the autonomous decisions of firms to achieve growth related outcomes (Capron and Mitchell, 2012; Favaro et.al., 2012; Penrose, 1959). *De novo* exploration enables firms to evaluate and devote resources to opportunities for increasing revenue and market share via greenfield establishments, incubators and new ventures (Ahuja and Lampert, 2001; Day, 1994; Raisch and Tushman, 2016). These exploratory forms benefit from autonomous charters that encourage distant search and experimentation (Galunic and Eisenhardt, 2001; Fang, Lee and Schilling, 2010). They increase the possibility of developing technology/product related breakthroughs and new business models aligned to a new revenue generation logic (Chesborough and Rosenbloom, 2002; Luksha, 2008). As commercialization possibilities, market penetration and ecosystem actor buy-in become feasible, the innovative output of *de novo* organizational forms initiates nascent revenue streams that allow firms to sustain and build on strategic positions in multiple growth markets (Fosfuri, Giarratana and Roca, 2016; Zimmerman and Zeitz, 2002).

Alternatively, *de alio* entry into growth markets involves diversified expansion to access opportunities for increasing revenue and market share (Montgomery and Hariharan, 1991). Contingent on the degree of relatedness between existing resources and growth opportunities, *de alio* entry corresponds to separate product market diversification initiatives or through resource redeployment driven economies of scope (Dowell and Swaminathan, 2006; Helfat and Eisenhardt, 2004). Due to the strategic focus on exploration, the temporal spans involving new resource development, commitment driven allocation and scale can be avoided thereby leading to positional advantages across multiple growth markets (Barnett et.al., 1994; Greve, 2008; Hawk et.al., 2013).

Hence, *de novo* and *de alio* approaches permit firms to identify and access opportunities that contribute revenue and market share enhancement thereby invoking a growth proliferation effect. Through these approaches, exploration in the internal development growth mode decreases exposure to declining markets thus alleviating the prospective threat of firm failure due to exposure in declining markets (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993).

From the above, firms that maintain a high degree of exploration in the internal development growth mode have a greater probability of overcoming the threat of failure. As firms choose to de-emphasize exploration, they decrease the relative emphasis on identifying and accessing opportunities for increasing revenue and market share. The resulting tradeoff requires them to increase the relative emphasis on committing resources to further develop and leverage a limited subset of opportunities while eliminating low potential opportunities (Gupta et.al., 2006; Lavie et.al., 2010; March, 1991). This decrease in emphasis on exploration involves a concomitant increase in resource allocation/redeployment (Helfat and Eisenhardt, 2004), incurring capital expenditure (Maritan, 2001) and develop operational scale and scope as part of a commitment driven strategy (Bercovitz and Mitchell, 2007; Henderson and Cockburn, 1996; Penrose, 1959).

As these decisions are associated with the complex dynamics of intra-organizational ecology (Burgelman, 1991; Lovas and Ghoshal, 2000), they can be characterized as infrequent events involving irreversible degrees of commitment without the benefit of prior heuristics (Ghemawat, 1991; Noda and Bower, 1996; Souder et.al. 2016). Thus, firms are less likely to resort to this category of commitment oriented decisions due to a significant opportunity cost of the exploration/exploitation tradeoff that arises from de-emphasizing exploration. When these decisions are taken *ex ante* to the growth proliferation effect, the lack of strategic insight into the true revenue and market share growth potential of opportunities mandates early or premature resource commitment and leads to positional disadvantages and high opportunity costs due to the irreversibility of such investment (Folta and Miller, 2002; Ghemawat, 1991).

Also, *ex-ante* resource commitment may be vulnerable to competency traps, resource rigidity and cognitive embeddedness in declining markets (Barnett and Hansen, 1996; Fang and Levinthal, 2009; Tripsas and Gavetti, 2000). Both these possibilities are likely to compromise the firm's growth orientation due to the opportunity cost being locked out of alternative opportunities with higher revenue generation potential. If the above-mentioned decisions are taken *ex post* the growth proliferation effect, they can contribute to tangible growth-related outcomes as firms develop strategic insights into the true potential of growth opportunities *ex ante* to resource commitment (Barnett, 2008; Folta and Miller, 2002).

In either case, the survival enhancing potential of the internal development growth mode requires that firms maintain a high degree of exploration for the growth proliferation effect. This allows them to identify and access opportunities for increasing revenue and market share in growth markets and alleviates the threat of firm failure. Hence:

H2/Growth proliferation effect: In evolving technology ecosystems, a high degree of exploration in the internal development growth mode will strengthen the negative effect of growth orientation on the likelihood of firm failure.

3.2.4 The alliance activity growth mode

The alliance activity growth mode involves the use of collaborative arrangements with external partners in technology ecosystems (Davis, 2016; Lee, 2007). Collaborative exploration facilitates the joint identification and access to opportunities for increasing revenue and market share in growth markets thus leading to the development of growth opportunity sets (Reuer and Tong, 2010; Rindova et.al., 2012; Vassolo et.al., 2004). A significant advantage of this is linked to lower levels of resource commitment, decreased turnaround times and higher flexibility regarding the identification and development of opportunities for increasing revenues and market share (Barnett, 2008; Folta and Miller, 2002; Rindova et.al. 2012). Alternatively, equity based alliances or joint ventures contribute to the reconfiguration of growth strategies through greater resource commitment and deeper levels of collaborative exploration arising from relational embeddedness between partners (Dyer and Singh, 1998). Focused exploration in these agreements allows partners to develop revolutionary technology breakthroughs and novel product lines thus enabling them to jointly appropriate growth opportunities over time (Luo, 2002a, b; Singh and Mitchell, 2005; Stuart, 2000). In other instances of interfirm collaboration in technology ecosystems, product redeployment through cross-selling, complementarity based bundling or cross licensing help develop to new revenue streams across growth markets (Arora, Fosfuri and Gambardella, 2004).

Exploratory alliancing also contributes to relational ties with high status ecosystem actors, R&D and standard setting consortia and institutional entities hence leading to legitimacy spillovers through the development of relational and social capital (Axelrod et.al., 1995; Doz, Olk and Ring, 2000; Koka and Prescott, 2002). This relieves resource dependence concerns ensuring that growth outcomes are not hindered by ecosystem or institutional level mandates (Lev et.al., 2010; Zheng, et.al., 2015). Through the above-mentioned outcomes of exploratory collaboration, the alliance activity growth mode contributes to the growth proliferation effect through the joint identification and development of revenue and market share growth opportunities. In this, it directs strategic focus towards the more attractive niches to the evolving technology ecosystem (Davis and Eisenhardt, 2011; Davis, 2016; Stuart, 2000).

Thus, maintaining a high degree of exploration is more likely to be favored in the alliance activity growth mode to attenuate the likelihood of firm failure. As the uncertainty associated with evolving growth markets and niches recedes, firms with a high degree of exploration are better positioned to identify and access opportunities that have a high revenue and market share growth potential through the growth proliferation effect (Folta and Miller, 2002; Reuer and Tong, 2010; Rindova et.al., 2012). This leads to lower turnaround times in achieving growth outcomes as firms benefit from a broad range of exploratory ties at the technology, operational, functional and value chain levels of the ecosystem (Dussauge, Garrette and Mitchell, 2004; Lavie and Rosenkopf, 2006; Luo, 2002b; Roy and Cohen, 2017). Thus, firms with a high degree of exploration in the alliance activity growth mode are more likely to achieve the tangible increments in revenue and market share as they are gain a greater degree of strategic insight into the true growth potential of different types of opportunities across the evolving technology ecosystem.

Conversely, firms that proactively maintain a low degree of exploration or de-emphasize exploration may be vulnerable to failure. De-emphasizing exploration arises from a persistence with repeat alliancing with existing partners over legacy technologies and product lines . Hence, it may reinforce the inertia of structural and positional embeddedness in existing interfirm ties (Madhavan, Koka and Prescott, 1998). The concomitant mechanisms of collaborative myopia, over-socialization in pre-existing alliance networks and negative transfers from exploitation also undermine the growth proliferation effect as they privilege commitment to existing interfirm ties over the creation of new linkages (Jiang et.al., 2018; Knudsen and Srikanth, 2014; Lumineau and Oliveira, 2018). From a growth opportunity perspective, a low degree of exploration compromises the need for requisite variation in alliance portfolios leading to redundancies and sub-additive outcomes that undermine the mandate of a growth orientation (Vassolo et.al. 2004). These dynamics pose significant opportunity costs to the growth proliferation effect and preclude the likelihood of identifying new growth opportunities through collaborative exploration.

Finally, firms that choose to de-emphasize exploration must adhere to the accompanying tradeoff requiring higher resource commitment and managerial attention for developing and leveraging a limited subset of growth opportunities and collaborative arrangements that have a high revenue and market share growth potential (Lavie and Rosenkopf, 2006; Lavie et.al., 2010, 2011). However, this approach can only contribute to tangible survival enhancing growth related outcomes *ex post* the growth proliferation effect that yields strategic insights into the revenue and market share generation potential of growth opportunity sets and collaborative arrangements (Folta and Miller, 2002; Ghemawat, 1991). Thus, firms that maintain a high degree of exploration in the alliance activity growth mode are strategically positioned to secure the benefits of the growth proliferation effect and decrease the likelihood of failure. Hence:

H3/Growth proliferation effect: In evolving technology ecosystems, a high degree of exploration in the alliance activity growth mode will strengthen the negative effect of growth orientation on the likelihood of firm failure.

3.2.5 The acquisition activity growth mode

The acquisition activity growth mode involves the purchase of new technology targets, start-ups or assets across the broader technology and product market ecosystems (Ahuja and Katila, 2001; Puranam et.al., 2003, 2006). Exploration in the acquisition activity growth mode de-contextualizes strategic focus around declining product markets through the discontinuous and path-breaking nature of acquisitions (Barkema and Schjiven, 2008; Karim and Mitchell, 2000;

Vermeulen and Barkema, 2001). When targets are integrated within firm boundaries, recombinant outcomes with existing resources interrupt the momentum of legacy operations in declining product markets by creating opportunities for diversification across growth markets (Barkema and Schjiven, 2008; Graebner, 2004; Karim and Mitchell, 2000). These outcomes of acquisitions enable firms to increase revenue and market share through greater control over growth opportunities hence decreasing the likelihood of failure.

However, these failure mitigating benefits of exploration in the acquisition activity growth mode are most likely to be achieved when the relative emphasis on exploration is low. As agents of discontinuous and path-breaking change, exploratory acquisitions are survival enhancing to the extent that they enable firms to realign their growth strategies around opportunities for increasing revenue and market share (Graebner, 2004; Vermeulen and Barkema, 2001). A high degree of exploration causes frequent recalibrations of the firm's strategic direction that decreases coherence in growth strategy thereby undermining growth-related outcomes (Teece et.al., 1994). A key driver of this is the persistently unstable organizational context that emerges due to complexity and unpredictability injected by the lack of relatedness of exploratory targets with legacy resources leading to significant burden on managerial sense-making (Hannan, Polos and Carroll, 2003; March, Sproull and Tamuz, 1991). Operationally, this translates into decreased clarity over integration approaches (Puranam et.al., 2006; Stahl and Voigt, 2008), negative synergies due to target unfamiliarity (Harrison et.al., 1991) employee demotivation (Buono and Bowditch, 1989), time compression diseconomies (Vermeulen and Barkema, 2002), inertia arising from established power equations (Ganz, 2018) and expectation misalignment across management levels (Vuori, Vuori and Huy, 2018). These downsides of exploration detract from the primary aim of increasing revenue and market share in growth markets decreasing the survival enhancing potential of the acquisition activity growth mode. Over time, the broader context of technological change in the ecosystem is lost to firms as the myopia of acquisition integration compromises strategic focus.

Firms that manage the tradeoff posed by the continuum perspective of exploration/exploitation in the acquisition activity growth mode are more likely to decrease the threat of failure (Choi and McNamara, 2018; Stettner and Lavie, 2014). In this, while a low degree of exploration is beneficial for realigning growth strategies, the corresponding tradeoff requiring a high degree of exploitation allows firms to commit resources to develop and leverage a specific subset of growth opportunities (Choi and McNamara, 2018; Stettner and Lavie, 2014). Thus, a high degree of exploitation reinforces the path-breaking and discontinuous growth trajectory set by exploration through broader and more comprehensive growth-related outcomes through a growth mobilization effect. Through the growth mobilization effect, exploitation in the acquisition activity growth mode contributes to survival enhancing outcomes such as focused resource commitment or redeployment to develop scale and scope across multiple ecosystem niches (Capron et.al., 1998; Seth, 1990), increased product portfolio breadth and line depth to preserve and develop revenue streams (Kaul and Wu, 2016; Puranam et.al., 2003) and consolidation around declining product markets to tap residual revenue and market share possibilities (Anand and Singh, 1997). Alternatively, exploitation also mitigates resource dependence through vertical integration and strategic maneuvering (Cascario and Piskorski, 2005; Greve and Zhang, 2017).

Building on the relatedness and coherence imperatives of exploitation, the growth mobilization effect can be magnified through acquisition programs that increase the firm's capability in developing and leveraging growth opportunities in multiple growth markets (Chatterjee, 2009; Laamanen and Keil, 2008). Acquisition programs mitigate the causal ambiguity and 'rareness' inherent to acquisitions through learning outcomes that mitigate negative transfer effects, superstitious learning and incoherent implementation approaches (Puranam et.al., 2006; Zollo and Singh, 2004; Zollo, 2009). Thus, exploitation in the acquisition activity growth mode creates a virtuous cycle as frequent acquisitions contribute to learning and experience spillovers that underpin subsequent acquisitions (Laamanen and Keil, 2008; Zollo and Singh, 2004). Consequently, firms that de-emphasize exploration and adhere to the resultant tradeoff of increasing the relative emphasis on exploitation in the acquisition activity growth mode can effectively realign the firm's growth orientation around revenue and market share enhancement opportunities and subsequently develop a growth mobilization effect. As a result, these firms will have a lower likelihood of failure leading to the following hypothesis:

H4/Growth mobilization effect: In evolving technology ecosystems, a high degree of exploitation in the acquisition activity growth mode will strengthen the negative effect of growth orientation on the likelihood of firm failure.

3.2.6 The divestiture activity growth mode

The divestiture activity growth mode involves the elimination or spinoff of business units and strategic assets from firm boundaries (Lee and Madhavan, 2010). Spinoffs allow firms to segregate exploratory innovation aimed at developing breakthrough technologies and product lines within isolated organizational forms (Chesborough and Rosenbloom, 2002; Cirillo, Brusoni and Valentini, 2014; Galunic and Eisenhardt, 2001). Structural and contextual differentiation and positive spillovers from parental affiliation optimize the probability of developing nascent revenue streams in growth markets thus decreasing vulnerability in declining product markets (Argyres and Mostafa, 2016; Fang, Lee and Schilling, 2010; Ito, 1995). Alternatively, exploration also manifests through discontinuous restructuring targeted towards developing and leveraging opportunities for revenue and market share growth while eliminating the inefficiencies of declining product markets (Girod and Whittington, 2015; Wiersema and Liebeskind, 1995).

However, these failure mitigating benefits of the acquisition activity growth mode are most likely to be achieved when the relative emphasis on exploration is low. Exploratory initiatives lead to a prolonged context of outcome related uncertainty, cognitive and behavioral biases arising from entrepreneurial attitudes and operational re-alignment in spinoffs and restructuring initiatives lead to complexity and unpredictability in the firm's growth strategy (Hannan et.al., 2003; Lampel, Shamsie and Shapira, 2009). Thus, irregular and continuous re-alignment arising from disruptions in activity systems, intra-firm structural and relational patterns (DeWitt, 1993; Shah, 2000), employee mobility (Buono and Bowditch, 1989) and stakeholder demotivation (Gopinath and Becker, 2000) subvert the achievement of growth related outcomes. To address these disruptions, strategic resources and managerial attention get re-directed towards the tactical aspects of the transformation process that assumes a 'life of its own' instead of the strategic imperative of growth (McKendrick and Wade, 2010). These drawbacks associated with a high degree of exploration indicate that it is likely to be survival enhancing only when used sporadically i.e. for introducing strategic and contextual discontinuities that persuade managerial incumbents to reconfigure growth strategies for avoiding failure.

Thus, firms that manage the tradeoff posed by the continuum perspective of exploration/exploitation in the divestiture activity growth mode are more likely to decrease the threat of failure (Lee and Madhavan, 2010; Moschieri and Mair, 2017). In this, while a low degree of exploration is beneficial for realigning growth strategies, the corresponding tradeoff requiring a high degree of exploitation allows firms to effectively divert resources away from declining markets through redeployment or asset retrenchment (Anand and Singh, 1997; Kaul, 2012; Kuusela et.al., 2017). For instance, asset retrenchment or selloff exerts a selection effect as it rationalizes the growth opportunity sets aligned to the growth proliferation effect thus limiting focus towards high potential growth opportunities for subsequent resource commitment (Mitchell, 1994; Ozcan, 2018; Vassolo et.al., 2004). This decreases the cognitive and information processing burden on managers over resource allocation decisions, temporal commitment and attention (Barnett, 2008; Bennett and Feldman, 2017). At the firm level, exploitative divestiture refines the firm's asset utilization capability by eliminating legacy resources posing opportunity costs to the growth mobilization effect or compromising it due to high aspiration-performance gaps (Feldman, 2014; Kaul, 2012). In this, exploitation also assumes a resource 'liberating' role as it increases the degree of organizational slack available for redeployment towards growth opportunities (Kuusela et.al., 2017; Vidal and Mitchell, 2015). Hence, divestiture calibrates resource allocation decisions in support of growth opportunities thereby supplementing the resource mobilization effect.

A second advantage of exploitation in the divestiture activity growth mode lies in its contribution to the growth mobilization effect through the elimination of redeployment of acquired resources (Capron et.al., 1998, 2001). These decisions rationalize the asset base of the acquirer thereby improving its revenue and market share generation potential in growth markets while 'milking' declining markets through consolidation strategies (Anand and Singh, 1997; Capron et.al., 2001; Helfat and Eisenhardt, 2004). The presence of a divestment capability increases the risk appetite of firms regarding acquisition decisions in growth markets thus inculcating a survival enhancing virtuous cycle of resource reconfiguration through both growth modes to achieve broader outcomes of revenue and market share growth (Barkema and Schjiven, 2008; Chakrabarti et.al., 2011; Kaul, 2012). Thus, firms that de-emphasize exploration in the divestiture activity growth mode while adhering to the corresponding tradeoff of a high degree of exploitation will have a lower likelihood of failure leading to the following hypothesis:

H5/ Growth mobilization effect: In evolving technology ecosystems, a high degree of exploitation in the divestiture activity growth mode will strengthen the negative effect of growth orientation on the likelihood of firm failure.

3.3 EMPIRICAL CONTEXT, DATA AND METHODOLOGY

3.3.1 Empirical context

My empirical context involves an era of technological convergence in the equipment (SICs 3661, 3663, and 3669) and networking (SIC 3576) product market ecosystems from 1989-2003 established in strategy research as a period of technological change (Hsu and Prescott, 2017; Lee, 2007). The equipment ecosystem was based on the legacy technology of circuit switching for voice calling across a 'dedicated' communication channel while the networking ecosystem was based on packet switching technologies that facilitated data transmission (Greenstein and Khanna, 1997; Eugsters, Besio and Hawn, 1998). Over time, the packet switching technologies developed by networking firms developed technological capabilities in voice calling through the transmission of voice signals in data packets (Bhise et.al.,1999; Eugsters et.al., 1998). While it was superior for voice calling, circuit switching was not optimal for data transmission. Thus, firms in the equipment ecosystem faced the threat of failure as packet switching encompassed voice calling capabilities leading to circuit switching becoming redundant (Bhise et.al., 1999; Seaberg et.al., 1997).

Due of the high growth potential of networking product markets, equipment firms began entering networking product markets to access growth opportunities and establish operations to tap into new sources of revenues while developing market share (Lee, 2007). These entry decisions led to convergence between both sets of product markets underpinning structural changes that led to an evolving new technology ecosystem (Bhise et.al., 1999; Greenstein and Khanna, 1998; Hsu and Prescott, 2017). As convergence increased, firms developed integrated voice and data solutions requiring voice calling and data transmission capabilities aligned with circuit and packet switching technologies respectively (Eugsters et.al., 1998; Lee, 2007; Seaberg et.al., 1997). In this context, a growth orientation underpinning a focus on increasing revenue and market share was imperative to ensure firm survival. This was because the growth potential of product markets shifted from packet switching product markets to niches based on integrated voice and data product lines (Bhise et.al., 1999; Seaberg et.al., 1997).

Thus, networking firms began to explore circuit switching based equipment product markets while simultaneously exploiting packet switching technologies. Equipment firms retained their initial growth strategy of exploring networking product-markets while exploiting circuit switching to develop integrated product lines. These decisions had implications for the choice of growth modes in both sets of product markets regarding their relative emphasis on exploration or exploitation (Eugsters et.al., 1998; Greenstein and Khanna, 1997). This context is hence suitable to study how firms in both product markets used exploratory and exploitative growth modes to decrease the possibility of failure in a converging technology ecosystem. The empirical context of the paper is hence significantly fluid as firms had to adapt to a shift from circuit switching to packet switching and subsequently to a focus around integrated product lines involving voice and data capabilities (Bhise et.al., 1999; Eugsters et.al., 1998; Seaberg et.al., 1997).

3.3.2 Data

I used the COMPUSTAT database to identify firms in both sets of product markets. The beginning of the sample period was 1989 when the first networking product was introduced (Lee, 2007). The total number of sample firms was 231 with 4,200 firm years (147 equipment; 84 networking firms). I included a firm if it had a product offering in either circuit switching (voice) or packet switching (data) technologies. I collected data two years prior to (1986-1988) and after (2003-2005) my sample frame to capture any significant shift in contextual or firm related measures *ex ante* to and *ex post* the chosen sample period. Performance and control variable data was collected from COMPUSTAT. Data on alliance, acquisition and divestiture activity was collected using the Thompson Financial Securities & Data Commission Platinum database (Kaul, 2012). Data on firms' growth orientation was obtained from COMPUSTAT and the Center for Research in Security Prices (CRSP) Survivor-Bias-Free US Mutual Fund Database (Benner and Ranganathan, 2013). Data on internal development (product-market entry) was collected using the CORPTECH Database (Hsu and Prescott, 2017; Lee, 2007). The total number of growth mode decisions in my sample was 3,327 for the four growth modes.

3.3.3 Dependent variable

I used the multi-dimensional conceptualization proposed by Josefy et.al. (2017) to operationalize *firm failure*. I estimated this by recording failure through three modes during the sample period (Josefy et.al., 2017). The variable was coded as one in the year firms ceased operations and/or discontinued production of voice or data related product lines (operations related failure), the year when a firm was acquired and integrated within the operations of the acquirer and ceased to operate as an autonomous entity (ownership related failure) or the year when a firm was dissolved or filed for bankrupt (solvency related failure). Otherwise, the variable was coded as zero. I used Lexis-Nexis and public sources of data to ascertain the year and underlying driver of firm failure. Of the 231 sample firms, 111 firms (48%) did not survive the sample period with the remaining 120 cases treated as right censored (Allison, 1984).

3.3.4 Independent variable

Growth orientation was operationalized using a structural equation model comprising two measures of a firm's prior performance outcomes – financial ratio indicators and mutual fund ratings by security analysts. Extant research at the intersection of corporate strategy and corporate finance proposes two approaches to estimating a firm's strategic focus on increasing revenue and market share– its intrinsic performance outcomes (financial ratio indicators) and outcomes aligned to the external perception of institutional investors (mutual fund analyst ratings) (Benner and Ranganathan, 2013; Lakonishok, Shleifer and Vishny, 1994; Koller, Goedhart and Wessels, 2010).

First, I obtained data on three market performance related financial ratio indicators (stock price/earnings ratio, market/book ratio and stock price/cashflow ratio) and three accounting performance related financial ratio indicators (revenue growth, capital gains/dividend ratio and retained earnings as percentage of revenue). A high value on these six ratio indicators for a firm implies that it has a high growth orientation in terms of a focus on revenue and market share growth (Lakonishok et.al., 1994; Koller et.al., 2010). For each firm year, I calculated percentiles for each indicator and then calculated an aggregate indicator percentile score - the arithmetic means of the percentiles for all the six financial ratio indicators (Lakonishok et.al., 1994).

Second, the ratings of mutual fund analysts on mutual funds comprising a firm's securities (e.g. stocks/bonds) also provide insight into strategic focus on revenue and market share growth through categorization of financial securities (Benner and Ranganathan, 2013). To measure this, I used the approach employed by Benner and Ranganathan (2013). I developed investor profile percentile scores for each firm year using a weighted measure of the different types of mutual funds (growth, value or mixed) that held a firm's stock multiplied by ratio of the number of securities held in each mutual fund and the total number of outstanding securities. A high value on these this score for a firm indicated a high growth orientation. Using this approach, I ensured that the operationalization was congruent with the theory development around a firm's growth orientation (Koller et.al., 2010).

I performed confirmatory factor analysis using structural equation modeling (sembuilder option in STATA 14.1) to estimate the measurement model (Kline, 2011). The standardized factor loading of both percentile measures onto the composite independent variable (growth orientation) was significant at $p<0.01$. The goodness of fit statistics were within the range as per Kline (2011) (RMSEA = 0.04, Tucker Lewis Index = 0.96, Comparative fit index = 0.99). Detailed results are available from the author. The Cronbach alpha for the composite variable was 0.88 and the individual measure alphas were > 0.72. I calculated the growth orientation for each firm year as a weighted sum of the product of both percentile measures (aggregate indicator percentile score and investor profile percentile score) and their respective standardized factor loadings as $\sum_{i=1}^{2} wixi$, where wi refers to the loading of the i^{th} variable and xi refers to the value of the i^{th} variable. Hence, the growth orientation was expressed as an overall percentile rank. If a firm had a high growth orientation, it was ranked in a higher percentile and vice versa. I lagged this variable by one year.

3.3.5 Moderator variables

a) Internal development growth mode: For each firm year, I conceptualized decisions aligned to the internal development growth mode using data on the number of product markets that firms entered through autonomous operation. Product-market entry data was collected from the 'Who makes What' section of the CORPTECH Database that records 37 networking product-markets and 28 equipment product-markets (Hsu and Prescott, 2017; Lee, 2007). For each firm year, I subtracted the entries made into product-markets through alliances and acquisitions (from SDC) from the total entries (from CORPTECH) to arrive at the number of product-markets enter through internal development. An internal development growth mode decision was coded as exploratory if a firm entered a product-market based on a new technology (e.g. an equipment firm entering a packet switching based data product market) for the first time.

I excluded cases where a firm entered a product-market based on a familiar technology, if a firm re-entered a product-market that it had exit earlier or if an entry decision was based on augmenting existing operations in a product market as these decisions were exploitative. Thus, ADC Telecommunication Inc.'s entry into the local area network (LAN) product market in 1993 (a networking product market as per Corp Tech) was coded 'exploratory' as its prior operations were based around voice technologies or data technologies different from LAN.

b) Alliance activity growth mode: I coded an alliance activity growth mode decision as exploratory if it provided a license or access to a new technology, involved a technological knowledge creating R&D agreement (e.g. a packet switching technology alliance made by an equipment firm) or provided access to a new technology product market through a joint venture (Arora et.al., 2004; Lavie and Rosenkopf, 2006; Luo, 2002a, b). I excluded alliances and joint ventures aimed at enhancing the scale and scope of prior collaborations between partners or based on developing process improvements (e.g. an alliance between networking firms to decrease the cost of networking solutions or accessing complementary assets). For instance, Ericsson Business Communication's alliance with Network Equipment Technology in 1993 for developing the next-generation of asynchronous transfer mode (ATM) switching equipment was coded 'exploratory' because its prior alliances were based on developing incremental variants of voice technologies or data technologies that did not include ATM.

Next, for each of these two growth modes, the *degree of exploration* was operationalized as the ratio of the total exploratory decisions in a growth mode (internal development or alliance activity) and the total of all decision in that growth mode for a given firm year (Lavie and Rosenkopf, 2006; Stettner and Lavie, 2014).

c) Acquisition activity growth mode: I coded an acquisition activity growth mode decision as exploitative if it was based on augmenting the firm's existing resources/capabilities in a familiar technology or entering product markets based on a familiar technology to achieve scale or expand technological scope (e.g. a networking firm acquiring another firm to increase scale in operation) (Seth, 1990). I excluded acquisitions where the target provided access to new technology resources/capabilities (e.g. a networking firm acquiring the patent portfolio of an equipment firm) or if the target provided the acquirer with an alternative to explore new product markets (Puranam et.al., 2003, 2006). Hence, Cisco Inc.'s acquisition of Kalpana Inc., in 1994 was coded as 'exploitative' since Cisco had existing technological capabilities in Ethernet switching and the acquisition of Kalpana was aimed at gaining market leadership in the Ethernet switching product market (New York Times, 1994).

d) Divestiture activity growth mode: A divestiture activity growth mode decision was coded as exploitative in two instances – a) if it involved exiting product markets, selling business units or eliminating technology and product market resources intended to increase revenue generation through greater operational efficiency (Vidal and Mitchell, 2015) and b) when it facilitated the release of organizational resources that could be redeployed in alternative product markets (Anand and Singh, 1997). I excluded exploration based spinoffs or carveouts (e.g. subsidiaries created to support new technology exploration in growth markets (Cirillo et.al., 2014). Thus, Lucent Inc.'s sale of its voice technology based computer telephony assets in 1998 was coded 'exploitative' as it increased strategic focus on computer networking by exiting voice related product markets (ResponseSource, 1998)

Next, for each of these two growth modes, the *degree of exploitation* was operationalized as the ratio of the total exploitative decisions in a growth mode (acquisition or divestiture activity) and the total of all decision in that growth mode for a given firm year (Choi and McNamara, 2018; Stettner and Lavie, 2014).

This approach to operationalization measures the relative emphasis placed on exploration or exploitation as per the continuum perspective of the exploration/exploitation lens (Gupta et.al., 2006; Lavie et.al., 2010).

3.3.6 Control variables

The operationalization and rationale for inclusion of control variables are in table 5. Apart from the product market growth, product market/time fixed effects and degree of product market convergence variables, controls were operationalized at the firm level. All controls were lagged by one year unless mentioned otherwise.

3.3.7 Empirical methodology

I used event history modeling for given its ability to handle data with right censoring (Allison, 1984; Cleves et.al., 2016). For testing each hypothesis, I used a proportional hazards mixed effects Cox regression model. A key advantage of the Cox model is that it does not pose restrictions on the form of the baseline hazard and permits estimation using time-varying covariates (Allison, 1984; Cleves et.al., 2016). Each firm had a unique hazard function $ht(t) = h0(t) \exp(\beta X[t])$; where 't' is the year of firm failure (time to event), $h0(t)$ is the baseline hazard function, $X[t]$ is a matrix of covariates at time 't' and β is a vector of modeled coefficients. I used a mixed effect specification (frailty) for the model using the shared option in STATA 14.1 to control for time dependence in individual firm observations and unobserved heterogeneity across firms (Cleves et.al., 2016). I estimated the hazard rate of firm failure as the 'event' under the main effect of a firm's growth orientation (H1) and the moderating effects of the four growth modes (H2-H5).

3.3.8 Endogeneity concerns

My study may be prone to external drivers or omitted variables that lead to endogeneity in firms regarding their growth orientation (Gulati, 2004; Favaro et.al., 2012; Penrose, 1959). A firm's focus on maintaining or augmenting a growth orientation may be also be an approach to avoiding failure during environmental change (Chakrabarti et.al., 2011; Kuusela et.al., 2017). The limitation of endogeneity also affects growth mode decisions as established by Shaver (1998). Firms employ growth modes when their respective product markets have a prior record of such activity or to leverage the advantages of a growth orientation to avoid firm failure during technological change (Anand and Singh, 1997; Kaul, 2012; Singh and Mitchell, 2005).

I controlled for endogeneity in growth orientation and growth mode decisions using a two-stage procedure (Hamilton and Nickerson, 2003). First, for each year, I evaluated the likelihood of either the aggregate indicator percentile score or the investor profile percentile score or both scores increasing (coded zero, one and two respectively). For the growth mode variables, I evaluated the likelihood that a firm made an exploratory internal development decision/alliance or an exploitative acquisition/divestiture (coded zero and one respectively) or a combination of both (coded two). I developed two instrumental variables – i) *growth focus* as the natural log of the total number of firms that recorded an increase in either or both scores and ii) *growth mode activity* as the natural log of the total number of firms that used any combination of the both sets of exploratory and exploitative growth mode decisions. Empirically, I observed that the null hypothesis of regressor exogeneity was rejected ($p < 0.05$) indicating that endogeneity was an issue. I found that the null hypothesis of the Hansen J statistic $\chi 2$ test was rejected ($p > 0.1$) justifying the validity of my instruments. I ran two first stage probit models to predict the likelihood of percentile

Table 5. Control variables, operationalization and rationale for inclusion

Control variable	Operationalization	Data Source	Reference	Rational for inclusion
Firm size	Natural log of revenue	COMPUSTAT	NA	Size influences a firm's growth orientation as well as its corporate strategy in terms of exploration and exploitation in corporate scope decisions
Firm age	Natural log of the difference between current year and founding year	COMPUSTAT	NA	Older firms may have a higher proclivity for exploitation while younger firms may have a higher proclivity for exploration using corporate scope decisions
Product market revenue growth	% year on year growth in revenue for both product markets	Standard and Poor industry reports	Mitchell and Singh (1993)	High growth product markets provided a more munificent context for growth orientation in firms
Product market fixed effects - equipment	Dummy variable code 1 if SIC code is 3661/63/69, 0 otherwise	NA	Lee (2007)	The equipment product markets faced a threat of substitution from packet switching and hence were likely to endogenously choose specific exploratory/exploitative corporate scope decisions over others for adaptation

Product market fixed effects - networking	Dummy variable coded 1 if SIC code is 3576, 0 otherwise	NA	Lee (2007)	The networking product market was a source of disruption for equipment product markets and hence firms were likely to choose different corporate scope decisions from equipment firms.
Time fixed effects	Dummy variable- coded 1 if year was 2001; 0 otherwise	NA	Hsu and Prescott (2017)	The technology crash of 1999-2001 was a significant macroeconomic event that adversely impacted firm growth as well as the decision to explore and exploit
Degree of product market convergence		CORPTECH	Hsu and Prescott (2017)	The degree of product market convergence is a measure of cross product market diversification that proxies the intensity of technological change in the equipment and networking product markets. In the denominator of the formula, 1036 is calculated as 37*28 as there were 37 networking product markets (j) and 28 equipment product markets (i). r_{ij} is the number of firms that were present in a specific product market pair ij concurrently.

Tobin's Q	Ratio of the market value of a company's assets (as measured by the market value of its outstanding stock and debt) divided by the replacement cost of the company's assets (book value)	COMPUSTAT	Koller et.al. (2010)	Past market performance reinforces the growth orientation of a firm and affects what type of corporate scope decisions will be implemented.
Prior performance (ROA)	Natural log of (Operating profits/Total assets)	COMPUSTAT	Harrison et.al. (1991)	Influences subsequent corporate scope activity from an aspiration performance gap perspective
R&D intensity	Natural log of (R&D expenditure/Total Revenue)	COMPUSTAT	Harrison et.al. (1991)	Diversified firms may have greater R&D expenditure committed to internal development that precludes the need for alliances acquisitions and divestitures.
Debt to equity ratio	Ratio of market value of equity and total debt (long term liabilities + short term liabilities+ current liabilities)	COMPUSTAT	Harrison et.al. (1991)	Greater debt to equity ratios may represent an alternative explanation of exit due to insolvency
Patent portfolio diversity	Blau index of digital technology patents vis a vis the total of analog and digital photography patents	United States Patent and Trademark Office	Katila and Ahuja (2002)	Patenting is viewed as a proxy to internal development that could substitute for acquisitions and legacy divestitures
Capital expenditure	Natural log of capital expenditure	COMPUSTAT	Benner and Ranganathan (2012)	Capital expenditure represents an alternative form of internal development and maintaining a growth orientation as opposed to

				alliances, acquisitions and divestitures
Unabsorbed slack	Natural log of (total assets - total liabilities)	COMPUSTAT	Benner and Ranganathan (2012)	Firms can deploy slack resources to maintain or develop a growth orientation or invest in corporate scope decisions
Prior alliance experience	Cumulative number of all the alliances made by a firm	SDC Platinum, Lexis Nexis	Kale and Singh (2007)	Prior alliancing may positively influence future alliancing to generate growth options
Prior acquisition experience	Cumulative number of all the acquisitions made by a firm	SDC Platinum, Lexis Nexis	Puranam et.al. (2006)	Past acquisition experience may lead to firms doing more acquisitions in future.
Prior divestiture experience	Cumulative number of all the divestitures made by a firm	SDC Platinum, Lexis Nexis	Vidal and Mitchell (2015)	Past divestiture experience may lead to firms doing more divestitures in future
Prior product market entry experience	Cumulative number of exploratory and exploitative internal product market entry moves	CORPTECH	NA	Firms that enter a larger number of product markets using internal development may prefer to use the same mode in the future
Dividend payout decision	Dummy variable coded 1 for the year the firm announced a dividend, 0 otherwise	COMPUSTAT	Koller et.al. (2010)	Firms with high growth orientation may choose not to pay out dividends while firms with a low orientation are stable in dividend payouts
Stock repurchase decision	Dummy variable - coded 1 if firm made a repurchase announcement in a given year; 0 otherwise	SDC Platinum, Lexis Nexis	Benner and Ranganathan (2012)	Firms use stock repurchases when they have a low growth orientation and may not find suitable avenues of investment

score increase and growth mode decisions using my variables and the respective instrument. I used the predict procedure to save the predicted values of the residuals (inverse Mills ratios) for both equations and included them in the second stage model to control for endogeneity.

3.4 RESULTS

Panels 5a-b of figure 5 show the empirical context of this study. Panel 5a shows revenue growth for the equipment and networking product markets. It can be observed that between 1996-2003, the growth in revenue for the networking product market increased relative to the equipment product market and was ~five times higher (on average) than that of the equipment product markets that recorded modest growth in revenue over the entire sample period. Panel 5b shows the pattern of firm entry into both product markets. After 1991, the cumulative number of firms entering the networking product were greater than those entering into the equipment product market with the trend persisting throughout the sample period.

Table 6 shows the descriptive statistics and correlations. The mean growth orientation percentile scores for survivor and non-survivor firms was 0.57 and 0.39 respectively i.e. on average, survivors and non-survivors had growth orientation percentile ranks of 57 and 39 respectively. This difference was significant ($p< 0.01$) as indicated by a two-sample t-test. This shows that the relative emphasis on increasing revenue and market share was 46 percent higher for survivors than non-survivors. Table 7 presents the mixed effects proportional hazards Cox model results. Assumptions for event history modeling were met and multicollinearity was not an issue (full model VIF = 2.33; individual variables maximum. VIF = 2.64).

Figure 5. Empirical context and material effects

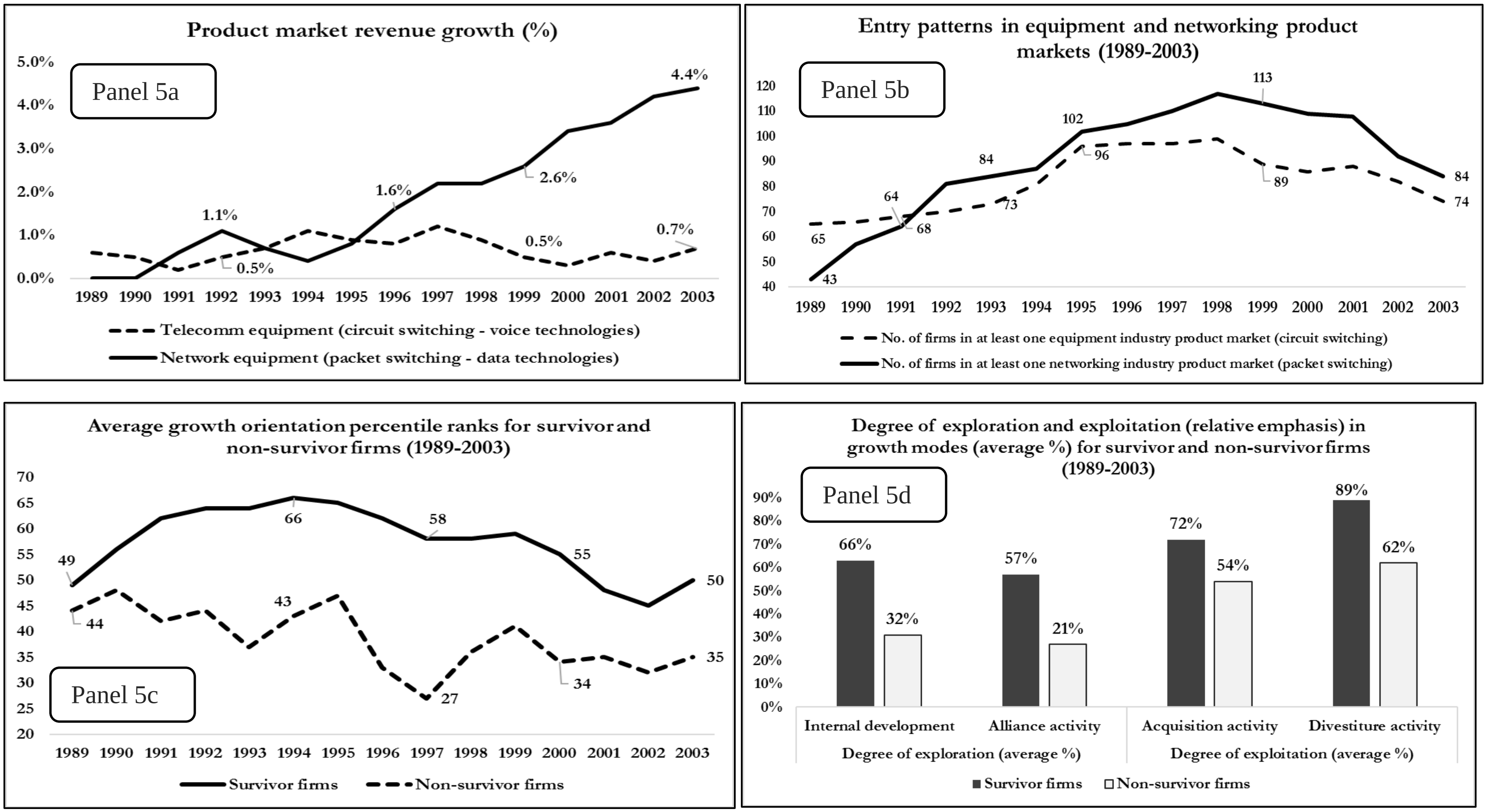


Table 6. Correlations and descriptive statistics

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1) Firm size	1												
2) Firm age	0.16	1											
3) Market growth	0.04	-0.10	1										
4) Equipment fixed effect	0.10	0.24	0.00	1									
5) Networking fixed effect	0.16	0.02	0.12	-0.00	1								
6) Time fixed effect	0.04	0.18	0.01	0.45	-0.00	1							
7) Market convergence	0.24	0.00	-0.09	-0.01	0.58	-0.01	1						
8) Tobin's Q	0.22	0.19	0.06	0.12	0.14	0.05	0.22	1					
9) Prior performance (ROA)	0.42	0.09	0.02	-0.05	0.06	-0.00	0.12	0.43	1				
10) R&D intensity	0.31	0.05	-0.02	-0.03	0.09	-0.03	0.08	0.30	0.28	1			
11) Debt equity ratio	0.34	0.25	-0.02	0.01	0.02	-0.05	0.10	0.22	0.25	0.18	1		
12) Patent diversity	0.43	0.09	-0.06	-0.05	0.09	-0.01	0.08	0.33	0.55	0.40	0.27	1	
13) Capital expenditure	0.96	0.26	-0.05	-0.02	0.06	0.01	0.02	0.42	0.31	0.21	0.10	0.63	1
14) Unabsorbed slack	0.32	0.22	-0.08	0.04	0.13	-0.02	0.23	0.32	0.24	0.26	0.17	0.46	0.46
15) Prior alliance exp.	0.36	0.22	-0.05	-0.02	0.05	-0.01	0.05	0.35	0.44	0.36	0.23	0.32	0.60
16) Prior acquisition exp.	0.32	0.22	-0.08	0.02	0.02	0.00	0.01	0.31	0.26	0.34	0.31	0.25	0.38
17) Prior divestiture exp.	0.29	0.25	-0.07	0.07	0.01	0.03	0.00	0.28	0.20	0.22	0.15	0.15	0.32
18) Prior entry exp.	0.46	0.16	-0.09	0.02	0.24	-0.01	0.38	0.45	0.28	0.26	0.25	0.41	0.27
19) Dividend decision	0.11	-0.03	-0.03	0.01	0.04	0.06	0.03	0.11	0.26	0.05	0.14	0.13	0.16
20) Repurchase	0.19	0.00	-0.02	-0.00	0.09	-0.01	0.13	0.18	0.09	0.06	0.10	0.10	0.06
21) Growth orientation	0.39	-0.21	0.24	-0.05	-0.02	-0.06	0.05	0.38	0.24	0.10	0.16	0.13	0.04
22) Internal dev. – explore	0.17	0.11	-0.08	0.09	0.06	0.04	0.13	0.16	0.10	0.09	0.13	0.18	0.11
23) Alliance – explore	0.01	0.01	-0.01	0.02	0.01	0.03	0.02	0.01	-0.06	-0.00	-0.04	-0.02	-0.06
24) Acquisition – exploit	0.24	0.02	-0.07	0.05	-0.06	0.10	-0.06	-0.23	-0.22	-0.15	-0.52	-0.23	-0.13
25) Divestiture - exploit	0.30	0.24	-0.14	0.07	0.06	-0.01	0.19	0.30	0.11	0.24	0.10	0.42	0.46
26) Firm failure	-0.15	-0.02	-0.03	-0.02	0.10	-0.02	0.13	-0.13	0.06	-0.02	0.06	0.03	0.02
Mean	1.06	0.18	0.14	0.64	0.27	0.26	0.23	0.24	0.75	0.08	0.34	0.36	0.33
S.D.	1.13	0.16	0.19	0.48	0.44	0.44	0.17	0.26	1.56	0.60	1.14	2.91	1.29
Minimum value	0.68	0.13	-0.17	0	0	0	0	-0.51	0.01	-2.83	0.00	0.00	0.00
Maximum value	4.72	0.52	0.85	1	1	1	0.49	1.06	1.60	7.26	1.18	0.53	2.22

N= 4200 firm year observations. All values ≥0.20 and ≤ -0.20 are significant at p< 0.05.

Table 6. (continued)

Variable	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
14) Unabsorbed slack	1												
15) Prior alliance exp.	0.42	1											
16) Prior acqn. exp	0.39	0.73	1										
17) Prior div. exp	0.36	0.50	0.45	1									
18) Prior prod. mkt exp	0.72	0.37	0.40	0.31	1								
19) Dividend decision	0.08	0.16	0.09	0.06	0.11	1							
20) Repurchase	0.08	0.08	0.08	0.03	0.14	0.04	1						
21) Growth orientation	0.05	0.08	0.06	0.05	0.13	0.03	0.10	1					
22) Int dev. – explore	0.20	0.17	0.19	0.15	0.41	0.13	0.03	0.02	1				
23) Alliance – explore	-0.00	-0.15	-0.01	-0.00	-0.00	-0.42	0.01	0.02	-0.16	**1**			
24) Acqn – exploit	-0.17	-0.20	-0.23	-0.16	-0.26	-0.06	-0.07	-0.12	-0.14	-0.00	1		
25) Divest - exploit	0.89	0.44	0.48	0.54	0.65	0.09	0.04	-0.04	0.18	-0.06	-0.14	1	
26) Firm failure	0.07	0.03	0.02	0.03	0.10	0.04	-0.04	-0.05	-0.03	0.00	-0.05	0.02	1
Mean	2.97	1.14	0.26	1.16	0.20	0.09	0.21	0.47	0.22	0.52	0.32	0.44	0.03
S.D.	0.11	0.49	0.14	2.54	0.62	0.28	0.53	0.29	0.22	0.16	0.78	0.31	0.16
Minimum value	0.00	0.00	0.00	0.00	0	0	0	0.00	0.00	0.00	0.00	0.00	0
Maximum value	127	97	24	27	1	1	1	0.99	0.50	0.83	0.77	0.64	1

N= 4200 firm year observations. All values ≥ 0.20 and ≤ -0.20 are significant at $p < 0.05$.

Table 7. Event history modeling results (endogeneity adjusted estimates)

Control variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Firm size	-0.84**(0.17)	-0.83** (0.18)	-0.77**(0.15)	-0.82** (0.14)	-0.78**(0.13)	-0.86**(0.18)
Firm age	-0.09**(0.02)	-0.07** (0.02)	-0.19 (0.18)	-0.13 (0.18)	-0.27 (0.18)	-0.79 (0.82)
Product market revenue growth	-0.32* (0.14)	-1.33 (1.39)	-0.99 (1.40)	-1.09 (1.40)	-1.75 (1.39)	-1.91 (1.19)
Product market fixed effect 1 (equipment)	0.79* (0.33)	0.11** (0.03)	0.72* (0.31)	0.76* (0.32)	0.76* (0.30)	0.53* (0.27)
Product market fixed effect 2 (networking)	-0.23 (0.42)	-0.10 (0.38)	-0.72* (0.04)	-0.55 (0.36)	-0.42 (0.36)	-0.34 (0.31)
Degree of product market convergence	0.26** (0.05)	0.22** (0.05)	0.21** (0.04)	0.20**(0.05)	0.25**(0.05)	0.31**(0.04)
Time fixed effect	-0.28 (0.49)	-0.29 (0.49)	-0.38 (0.36)	-0.37 (0.48)	-0.12 (0.48)	-0.23 (0.38)
Tobin’s Q	-0.39^{+} (0.23)	-0.28** (0.05)	-0.26**(0.05)	-0.11 (0.07)	-0.12^{+} (0.07)	-0.26 (0.18)
Prior performance (ROA)	-0.27* (0.13)	-0.15(0.13)	-0.30*(0.14)	-0.11(0.13)	-0.15 (0.09)	-0.16 (0.11)
R&D intensity	-1.00 (1.08)	-1.19 (1.12)	-0.83 (1.37)	-0.87 (1.42)	-0.56 (1.28)	-0.37 (1.09)
Debt equity ratio	0.59 (0.61)	0.57 (0.64)	0.65 (0.71)	0.21^{+} (0.12)	0.22^{+} (0.13)	0.44 (0.55)
Patent portfolio diversity	0.07 (1.04)	-0.13 (0.10)	0.05 (0.11)	-0.06 (0.09)	-0.04 (0.08)	-0.20**(0.08)
Capital expenditure	-0.31**(0.14)	-0.36** (0.10)	-0.44*(0.10)	-0.43** (0.10)	-0.28**(0.09)	-0.13(0.10)
Unabsorbed slack	-0.14 (0.10)	-0.04 (0.09)	-0.11 (0.12)	-0.19^{+} (0.11)	-0.23* (0.11)	-0.27^{+} (0.15)
Prior alliance experience	-0.02 (0.12)	-0.17 (0.13)	-0.06 (0.15)	-0.03 (0.13)	-0.07 (0.13)	-0.15 (0.11)
Prior acquisition experience	-0.11 (0.29)	-0.02 (0.10)	-0.05 (0.09)	-0.02 (0.09)	-0.06 (0.09)	-0.03(0.08)
Prior divestiture experience	-0.73 (0.45)	-0.30 (0.38)	-0.45 (0.46)	-0.41 (0.45)	-0.43 (0.48)	-0.39 (0.43)
Prior product market entry experience	-0.20**(0.07)	-0.18**(0.07)	-0.18**(0.06)	-0.16*(0.06)	-0.20**(0.06)	-0.19**(0.05)

Table 7. (continued)						
Dividend payout decision	0.20 (0.26)	0.23 (0.26)	0.28 (0.22)	0.05 (0.25)	0.05 (0.24)	0.08 (0.23)
Stock repurchase decision	-0.21**(0.08)	-0.20**(0.07)	-0.24** (0.08)	-0.21**(0.07)	-0.20**(0.08)	-0.15**(0.06)
H1: Growth orientation (main effect)		**-0.09**(0.02)**	-0.10**(0.02)	-0.11**(0.02)	-0.08**(0.02)	-0.11**(0.02)
H2: Growth orientation * Degree of exploration in internal development			**-6.95*(2.97)**	-7.47**(2.90)	10.35**(2.69)	-12.42**(2.6)
Degree of exploration in internal development			-1.26(1.22)	-1.23(1.23)	-1.48(1.24)	-2.87**(1.08)
H3: Growth orientation * Degree of exploration in alliance activity				**-3.44*(1.76)**	-3.05^{+}(1.75)	-3.75*(1.97)
Degree of exploration in alliance activity				-1.10(1.10)	-0.69(1.01)	-1.09(1.03)
H4: Growth orientation * Degree of exploitation in acquisition activity					**-5.24**(1.37)**	-5.99**(1.43)
Degree of exploration in acquisition activity					-1.73*(0.74)	-3.26**(1.27)
H5: Growth orientation * Degree of exploitation in divestiture activity						**-1.58*(0.68)**
Degree of exploration in divestiture activity						-0.23(0.22)
Inverse Mills ratio 1 – Growth focus	0.18(0.22)	0.13(0.19)	-0.05(0.22)	-0.13(0.22)	-0.02(0.08)	-0.11(0.24)
Inverse Mills ratio 2 – Growth mode activity	0.00(0.09)	-0.12(0.14)	0.05(0.29)	0.01(0.14)	-0.18(0.24)	0.05(0.11)
Over-dispersion (frailty) (θ)	0.41	0.11	0.12	0.11	0.11	0.10
LR test (χ^2) of θ (p-value)	2.67 (0.05)	0.98(0.50)	0.67(0.49)	0.69(0.49)	0.16(0.49)	0.12 (0.49)
Log likelihood	-356.73	-335.66	-334.12	-333.29	-330.99	-328.90
Wald χ^2 (df)	141.06 (22)	157.37 (23)	167.69 (25)	173.43 (27)	173.59(29)	208.81 (31)

Notes for table 7: a) n= 231 firms with 3200 firm year observations.
b) The first value for each variable in each model is the regression coefficient. The value in brackets is the standard error calculated through the concept of shared frailty that accounts for dependence between observations and unobserved heterogeneity.
c) ** p<0.01, * p< 0.05 and + p< 0.1.
d) Bold values refer to the hypotheses results.
e) When the LR test of theta is not significant, unobserved heterogeneity (frailty) is accounted for in the model.

A positive (negative) coefficient for a variable indicates that it increases (decreases) the hazard rate of firm failure thus decreasing (increasing) the likelihood of survival (Allison, 1984).

The controls in model 1 of table 7 reveal important insights. Product market revenue growth and firm size had a negative and significant effect on the likelihood of firm failure. Equipment firms had a higher likelihood of failure compared to those in the networking product market as shown by the opposite signs of both product market fixed effect variables. The product market convergence variable captures the intensity of technological change (see table 5) and has a positive relationship with the likelihood of firm failure indicating that convergence had survival threatening implications regardless of the firm's product market presence. Prior performance (ROA) and a firm's capital expenditure decision decreased the likelihood of failure. Of the growth mode decision experience variables, prior experience in entering product markets (internal development) had a negative and significant effect on firm failure while prior experience in alliances, acquisitions and divestitures had negative effects that were not significant.

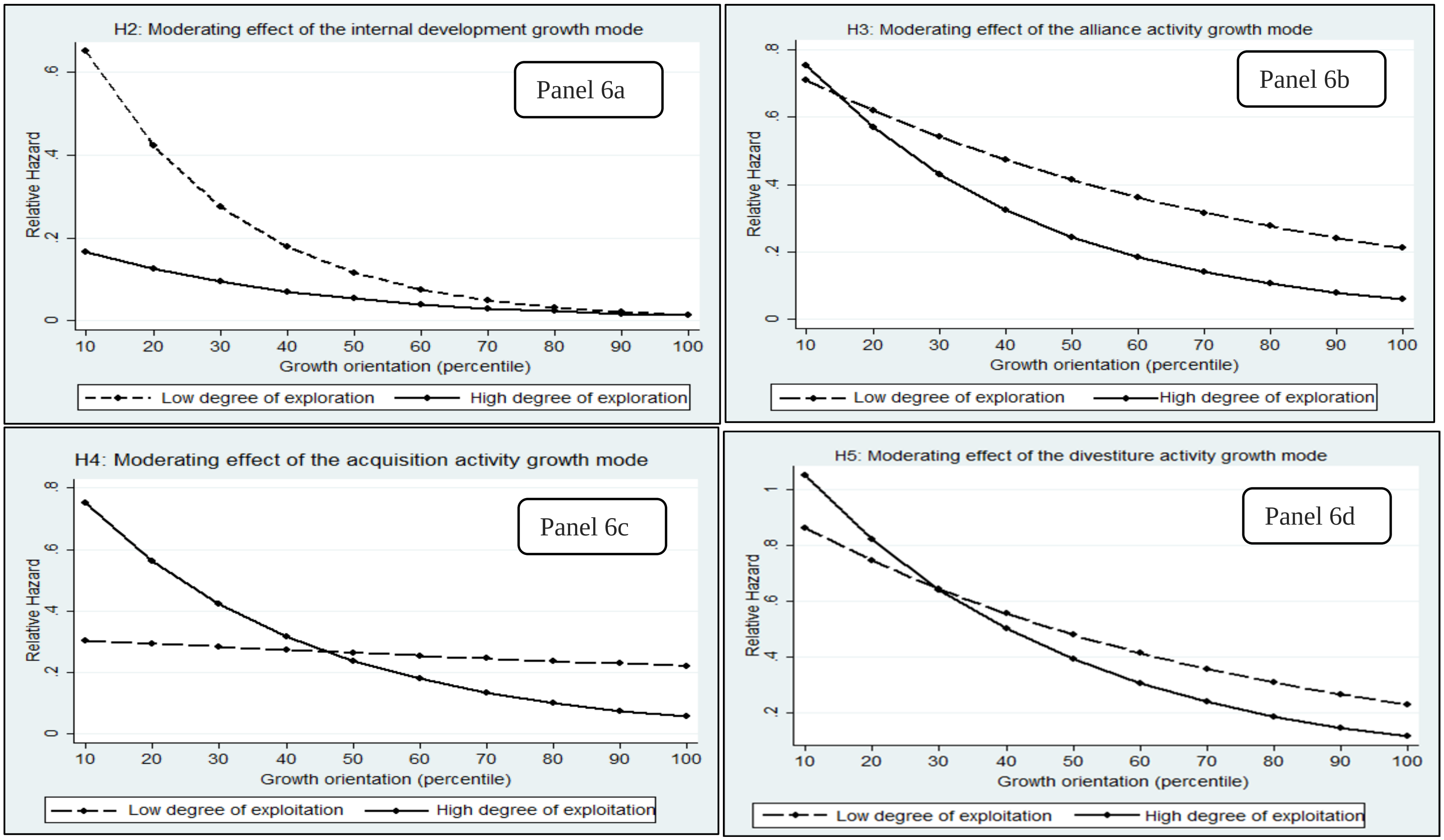
Hypothesis 1 proposed that growth orientation had a negative effect on its likelihood of firm failure in evolving technology ecosystems. It was supported (table 7, model 2: $\beta = -0.09$, $p < 0.01$). For a unit increase in a firm's growth orientation percentile rank, the hazard rate of firm failure in the convergence driven evolving technological ecosystem decreased by nine percent (1-(exp (0.1 * - 0.09) =0.09). The result was materially significant as on average, survivor firms were ranked in the 57th percentile compared to non-survivor firms that were ranked in the 39th percentile in terms of having a growth orientation i.e. survivors had a 46 percent greater emphasis on increasing revenue and market share across the ecosystem as compared to non-survivors. In panel 5c of figure 5, it is observed that surviving firms had a higher average growth orientation percentile rank compared to non-survivor firms over the sample period hence indicating material support for hypotheses 1.

Hypothesis 2 proposed that in evolving technology ecosystems, a high degree of exploration in the internal development growth mode strengthened the negative effect of growth orientation on the likelihood of firm failure. This was supported (table 7, model 3: β= - 6.95, p< 0.05). For a unit increase in a firm's growth orientation percentile rank, increasing the relative emphasis on exploration by 10 percent decreased the hazard rate of firm failure by 49 percent (1-(exp (0.1 * - 6.95) =0.49). Panel 6a of figure 6 shows that the hazard rate of failure for firms with a high degree of exploration (solid line) was consistently lower relative to the hazard rate for firms with a low degree of exploration (broken line). However, this difference was negligible for firms that had a very high growth orientation percentile rank (> 87). Beyond this threshold rank, the relative hazard was zero (i.e. firm failure was unlikely) irrespective of the relative emphasis on exploration. Thus, for the internal development growth mode, de-emphasizing exploration did not pose a tangible threat to firm survival after the threshold rank of 87 was passed. This result was materially supported in panel 5d of figure 5 as the average degree of exploration was 66 percent for survivors and 32 percent for non-survivors for the internal development growth mode (i.e. survivors had > two times higher emphasis on exploration).

Hypothesis 3 proposed that in evolving technology ecosystems, a high degree of exploration in the alliance activity growth mode strengthened the negative effect of growth orientation on the likelihood of firm failure. It was supported (table 7, model 4: β= - 3.44, p< 0.05). For a unit increase in a firm's growth orientation percentile rank, increasing the relative emphasis on exploration by 10 percent decreased the hazard rate of firm failure by 29 percent. Panel 6b of figure 6 shows that the lines of high and low degrees of exploration intersect at a growth orientation percentile rank of 14. For the alliance activity growth mode, a high degree of exploration was a failure mitigating strategy for firms that had a growth orientation percentile > 14. When firms ranked below this threshold placed a higher emphasis on exploration, they actually *exacerbated* their risk of failure instead of mitigating it. This result was materially supported in panel 5d of figure 5 as the average degree of exploration in the alliance activity growth mode was 57 percent for survivors but 21 percent for non-survivors (i.e. survivors had ~ three times greater emphasis on exploration).

Hypothesis 4 proposed that in evolving technology ecosystems, a high degree of exploitation in the acquisition activity growth mode strengthened the negative effect of growth orientation on the likelihood of firm failure. The hypothesis was supported (table 7, model 5: β= -5.24, $p< 0.01$). For a unit increase in a firm's growth orientation percentile rank, increasing the relative emphasis on exploitation by 10 percent decreased the hazard rate of firm failure by 41 percent. Panel 6c of figure 6 shows that the lines corresponding to high and low degrees of exploitation intersect at a growth orientation percentile rank of 46. Thus, for the acquisition activity growth mode, increasing the emphasis on exploitation was a survival enhancing strategy *only* when firms had a growth orientation percentile rank > 46. Prior to this threshold rank, emphasizing exploration in the acquisition activity growth mode was more likely to decrease the hazard rate of failure. This result was materially supported in panel 5d of figure 5 as the average degree of exploitation in the acquisition activity growth mode was 72 percent for survivors but 54 percent for non-survivors (i.e. survivors had a 33 percent greater emphasis on exploitation).

Figure 6. Graphical representation of moderation effect hypotheses



Hypothesis 5 proposed that in evolving technology ecosystems, a high degree of exploitation in the divestiture activity growth mode strengthened the negative effect of growth orientation on the likelihood of firm failure. It was supported (table 7, model 6: $\beta = -1.58$, $p < 0.05$). For a unit increase in a firm's growth orientation percentile rank, increasing the relative emphasis on exploitation by 10 percent decreased the hazard rate of firm failure by 15 percent. Panel 6d of figure 6 shows that the lines corresponding to high and low degrees of exploitation intersect at a growth orientation percentile rank of 28. Thus, for the divestiture activity growth mode, increasing the emphasis on exploitation was a survival enhancing strategy *only* when firms had a growth orientation percentile rank > 28. Prior to this threshold rank, switching emphasis in favor of exploration decreased the hazard rate of failure. This result was materially supported in panel 5d of figure 5 as the average degree of exploitation in the acquisition activity growth mode was 89 percent for survivors but 62 percent for non-survivors (i.e. survivors had a 43 percent greater emphasis on exploitation).

3.4.1 Supplementary analyses

The results of H3, H4 and H5 also indicate that firms that chose to emphasize exploration and exploitation in the alliance, acquisition and divestiture activity growth modes selectively and *contingent* to their growth orientation percentile ranks were less likely to fail. For instance, for the alliance activity growth mode, increasing the degree of exploration at very low growth orientation percentile ranks (< 14) was likely to increase the hazard rate of firm failure – an outcome that can be linked to complex adaptation issues arising from attempting to transition to exploration from a prior posture of exploitation (Swift, 2016). However, for firms that managed this transition and persisted with emphasizing exploration beyond the percentile rank of 14, the corresponding decrease in the hazard rate may be linked to learning outcomes inculcating absorptive capacity and the development of alliance management capabilities that were supportive of exploration through alliancing (Davis, 2016; Kale and Singh, 2007; Lane et.al., 2001; Schildt et.al., 2012).

Conversely, for H4 and H5, at low to intermediate growth orientation percentile ranks, firms that chose to emphasize exploration in the acquisition and divestiture activity growth modes had lower hazard rates of failure. While this is a result contrary to my hypotheses, it indicates that a low percentile rank values, a high degree of exploration through the acquisition and divestiture growth modes was a mechanism that decreased inertia arising from exposure to declining product markets and introduced path breaking and discontinuous change (Girod and Whittington, 2015; Karim and Mitchell, 2000; Vermeulen and Barkema, 2001). However, as firms surpassed the requisite growth orientation percentile rank thresholds (46 and 28 for acquisitions and divestiture activity growth modes respectively), a high degree of exploitation decreased the hazard rate of failure as it allowed firms to develop and leverage growth opportunities aligned to the growth trajectories developed by exploration while exiting declining markets through asset retrenchment and resource redeployment (Anand and Singh, 1997; Capron et.al., 1998, 2001).

From an exploration/exploitation standpoint, these results demonstrate the importance of ambidexterity within growth modes wherein the capability to explore and exploit at different junctures contingent to the firm's growth orientation could be instrumental to ensuring firm survival in evolving technology ecosystems - a result consistent with the work of Lavie and colleagues.

3.4.2 Robustness checks

I used several robustness checks to ensure the validity and consistency of the results. First, the individual effects of the aggregate indicator and investor profile percentile scores may be conflated within the structural model constructed to create the independent variable (Kline, 2011). This may lead to overestimation or underestimation of the hypotheses testing results. To avoid this, I used each individual measure as an estimate of a firm's growth orientation and re-ran all models. While the results of table 7 were supported in both cases, the models comprising the aggregate indicator percentile score as the independent variable had superior fit compared to the models that used the investor profile percentile score. This may imply that the intrinsic performance of a firm is a better measure of its focus on increasing revenue and market share as opposed to the extrinsic perception of mutual fund analysts through security ratings (Koller et.al., 2010).

Second, how firms choose their growth orientation may include the effect of different mechanisms contingent on the intensity of technological change that may have varied over time. This issue also affects the growth mode variables and their effect on the growth orientation- firm failure relationship. That is, at what point in time firms choose to explore or exploit and which growth mode decisions they choose to explore or exploit is likely to affect how firms' growth orientation influences its likelihood of surviving technological change. To control for this, I included a time trend variable (1 for 1989....14 for 2003) to control for alternative mechanisms that may have influenced a firm's growth orientation and their choice to explore or exploit using specific growth mode decisions (Hsu and Prescott, 2017). My results were robust to this variable.

Third, I created a more conservative measure of the degree of exploration and exploitation in the moderator variables by re-evaluating whether firms made growth mode decisions that had a mixed emphasis on both exploration and exploitation. Of the 3327 growth mode decisions in my sample, about 623 decisions could arguably have had a mixed emphasis on exploration and exploitation in terms of technology, product lines or value chain activity (Stettner and Lavie, 2014). Since this figure was ~ 20 percent of the total number, I re-ran all models using the re-calculated moderator variables. While my results were robust, the model fit values were inferior to the models in table 7. Hence, it is likely that firms did not place a mixed emphasis on exploration or exploitation in any given growth mode decision but used different decisions to explore and exploit in entirety - a result congruent with Stettner and Lavie (2014).

Fourth, from panel 5c of figure 5, it can be observed that there is a temporal trend in the average growth orientation percentile rank of surviving firms over the sample period. There is a consistent decrease in the average rank between 1994 and 2003. To avoid this trend biasing my results, I re-ran each model for a truncated sample comprising firm years between 1994 and 2003. The results were robust to this check but were weaker than the results presented in table 7, an outcome that can be attributed to the declining average growth orientation percentile rank in the truncated sample.

Fifth, there were instances in my sample where firms with a high average growth orientation percentile rank did not survive (e.g. 3Com Inc.'s acquisition of Chipcom in 1996) or where firms choosing growth modes hypothesized to be survival enhancing by my theoretical model did not survive (e.g. Bay Network Inc.'s acquisition by Northern Telecom in 1999). As this aspect of the data did not conform to my hypotheses, I re-ran my models by eliminating these firms from my sample to observe whether my empirical results were stronger in the absence of these outlier firms. My results were supported but there were not noticeably stronger indicating that the above-mentioned firms may not have survived due to the competing risks inherent to the environmental context (Allison, 1984; Cleves et.al., 2016).

Finally, I tested the developed model using alternative distributional assumptions - proportional hazards Weibull and Gompertz specification (both allowing for monotonically increasing/decreasing hazard functions). The results were supported but model fit was poor compared to the Cox model in table 3 (Cleves et.al., 2016). We tested for the piecewise exponential distribution (a special case of the Weibull distribution when the scale parameter = 1) and found results in favor of the Weibull model. We also ran a fixed effects model with robust standard errors clustered on individual firms to which our results were robust.

3.5 DISCUSSION

Drawing on the exploration/exploitation lens, I asked the following research question - During technological change, how do corporate development decisions or growth modes (i.e. internal development, alliances, acquisitions and divestitures) moderate the relationship between growth orientation and the likelihood of firm failure? I motivated my research question by stressing the significance of a growth orientation and the role of growth modes as adaptive mechanisms in mitigating the threat of firm failure in evolving technology ecosystems. I found that a firm's growth orientation decreased the likelihood of firm failure. The growth proliferation effect facilitated firms in identifying and accessing opportunities for increasing revenue and market share in growth markets. The growth mobilization effect allowed firms to develop and leverage a specific subset of opportunities for achieving these growth outcomes while strategically exiting declining markets. The growth proliferation and mobilization effects are mechanisms that explain the moderation effect of firm growth modes on the growth orientation-firm failure relationship.

3.5.1 Contribution

Firms maintain a corporate level focus on growth through several approaches - top management agendas (Gulati, 2004), structural arrangements (Favaro et.al., 2012), entrepreneurial orientation (Yu et.al., 2018), growth modes (Capron and Mitchell, 2012; Dyer et.al., 2004) and resource development tradeoffs (Tushman and O'Reilly, 1996). By introducing the theoretical construct of growth orientation, I demonstrate that the imperative of increasing revenue and market share in growth markets is a central aspect of firms' growth strategies. Moreover, I show that conceptualizing a firm's growth orientation as a strategic focus around increasing revenue and market share has survival enhancing implications during technological change. By theorizing on and testing the growth proliferation and growth mobilization effects, I unpack their role as adaptive mechanisms that strengthen the negative effect of growth orientation on firm failure. In this, I contribute to scholarly research on growth modes by demonstrating how they align with the broader imperative of a firm's growth orientation (Capron and Mitchell, 2012; McKelvie and Wiklund, 2010). Firms that used the internal development and alliance activity growth modes for identifying and accessing opportunities in growth markets (exploration) while employing the acquisition and divestiture activity growth modes to develop and leverage specific subsets of growth opportunities were less likely to fail. These findings indicate that how firms choose growth modes as adaptive mechanisms and the diverse effects of these choices on firm survival represent two prospective drivers of firm heterogeneity (Rumelt et.al., 1994).

My findings also complement scholarly research on the exploration/exploitation lens with a firm growth perspective – a theoretical link that has received scant attention (cf. Raisch, 2008). I highlight the importance of exploration and exploitation for growth related outcomes in firms. They provide exploration/exploitation scholars with initial insights into this novel theoretical link that can be refined and expanded through subsequent theoretical and empirical efforts.

Extant research on product market entry (Dowell and Swaminathan, 2006; Mitchell, 1989; Mitchell and Singh, 1993) and strategic alliances (Davis, 2016; Lee, 2007; Luo, 2002a) has established the importance of exploration as a survival enhancing mechanism during environmental change. Through the growth proliferation effect, I show that increasing the relative emphasis on exploration in both these growth modes enabled firms to identify and access opportunities for increasing revenue and market share in growth markets. This strengthened the negative effect of growth orientation on the likelihood of firm failure. The growth proliferation effect was thus a mechanism that depicted the survival enhancing nature of maintaining a high degree of exploration in both these growth modes.

Scholarly work on firm growth has stressed the importance of exploitation as a critical mechanism that improves the likelihood of firm survival during technological change (Bercovitz and Mitchell, 2007; Benner and Tushman, 2003). Through the growth mobilization effect, I show that de-emphasizing exploration by appreciating the tradeoff requiring a high degree of exploitation in the acquisition and divestiture activity growth modes enabled firms to increase resource commitment to a specific subset of growth opportunities while diverting resources away from low potential opportunities. This strengthened the negative effect of growth orientation on the likelihood of firm failure. The growth mobilization effect was thus a mechanism that showed the survival enhancing nature of a high degree of exploitation in both these growth modes.

Finally, my work has implications for scholarly research at the intersection of exploration/exploitation and corporate strategy (Choi and McNamara, 2018; Lavie and Rosenkopf, 2006; Lavie et.al., 2011; Stettner and Lavie, 2014). For instance, the statistical and material results aligned to the growth proliferation and growth mobilization effects stress the importance of an ambidextrous posture across a firm's growth mode choices but not within them – a result supporting that of Stettner and Lavie (2014). These results substantiate an approach to how ambidexterity can be woven across growth mode choices i.e. by increasing the relative emphasis on exploration in the internal development and alliance activity growth modes and exploitation in the acquisition and divestiture activity growth modes. Thus, the broader implications are that ambidexterity across a firm's growth modes enabled firms to leverage the advantages of a growth orientation, improve their adaptive capability and lower the likelihood of firm failure. However, this was only likely when firms selectively and decisively chose to emphasize exploration or exploitation within a specific growth mode. My results indicate a prospective avenue through which firms can develop ambidexterity as a dynamic capability within a firm's corporate strategy (Lavie et.al., 2010; Tushman and O'Reilly, 1996).

3.5.2 Managerial implications

My work offers two insights for checking the growth imperative 'box' on managerial agendas (Gulati, 2004). First, my conceptualization and measurement of growth orientation as a percentile rank is grounded in tangible growth outcomes - financial indicator ratios and mutual fund analyst ratings (Benner and Ranganathan, 2013; Koller et.al., 2010). As a significant portion of this data is publicly accessible, business analysts can replicate this measure or customize it to help managers benchmark their company's growth orientation against that of competitors and alternative ecosystem actors. This may not only reveal the robustness of a firm's revenue and market share growth strategies but also highlight its strategic positioning vis-à-vis key rivals (Prescott, 2001).

Second, as growth orientation imperatives are socially constructed, they cannot be grounded solely around numerical 'targets' of revenue and market share but must be woven into top management rhetoric, board agendas, executive cognition and corporate narratives for corporate coherence (Alexander, Fennel and Halpern, 1993; Dweck, 2016; Teece et.al., 1994; Zajac and Westphal, 2004). While my work did not address these factors, top management teams may be advised to proactively communicate the growth imperative across the firm and to external actors to demonstrate a proactive corporate level focus on growth.

A final message of note to managers from my work refers to the strategic management of the corporate development decision/growth mode portfolio (see Appendix B). The theoretical formulation of this paper indicates that growth modes can be used to search for new revenue and market share growth opportunities or commit corporate resources to leverage a subset of opportunities for growth. However, as shown by the statistical and material results, managers need to be circumspect in matching the choice of growth mode with the intended outcome associated with its deployment. In this, two key challenges may have to be addressed. First, the growth mode portfolio of the firm needs to be broader in terms of the decisions available for administering the growth imperative (Capron and Mitchell, 2012). In my sample, companies with broader portfolios comprising four diverse growth mode decisions (‘build’, ‘borrow’, ‘buy’ ‘sell’) for achieving revenue and market share related outcomes were more likely to successfully navigate the choppy waters of technological change. Hence, proactively developing decision level and portfolio level capabilities could survival enhancing factors in environmental adversities (Kale and Singh, 2007; Zollo and Singh, 2004).

Second, managers may note the importance of developing agility in shifting strategic focus from the flexibility of experimenting with multiple growth opportunities (exploration - growth proliferation effect) to the commitment oriented stability required for leveraging specific subsets of opportunities (exploitation - growth mobilization effect). This is particularly important when managers must implement particularly types of growth mode decisions that require fast switching capabilities when a certain growth threshold has been passed (panels 3 b, c, d). The flexibility/stability tradeoff is well established in strategy research (Benner and Tushman, 2003) and managerial practice (Haanes, Reeves and Wurlord, 2018; Reeves et.al., 2013). My findings expand it to the strategic realm of a firm’s growth mode portfolio. However, the associated caveat for managers concerns the company’s capability to create structures, processes and cultures that enable these transitions within and across growth mode choices (Fang et.al., 2010; Ghoshal, 1997).

3.5.3 Limitations and future research directions

The limitations of this paper indicate several interesting opportunities for future research. *First,* the operationalization of the independent variable employs an implicit working assumption of efficient markets where evolutionary dynamics are assumed away (Benner and Ranganathan, 2013; Koller et.al., 2010). Thus, a lack of consideration for alternative factors driving firms' growth strategies - environmental imperatives (Lev et.al., 2010), intra-organizational ecology (Lovas and Ghoshal, 2000), executive cognition (Dweck, 2016), resource and capability profiles (Tushman and O'Reilly, 1996) and tradeoff with other outcomes (Prescott et.al., 1986) limits the richness of the developed theory. In acknowledgement of the scholarly challenges associated with developing a middle range theory on firm growth (Shephard and Wiklund, 2009), my work invites scholarly effort into this area of corporate strategy research.

Second, a limitation of the moderator variables lies in their being operationalized using archival data. In this, the internal development growth mode may be under-represented due to the restriction posed by product market entry data. Hence, theoretical and empirical insights on the importance of greenfield units, new ventures, incubators and spinoffs is limited due to a lack of granularity in my data sample (Ahuja and Lampert, 2001; Day, 1994; Raisch and Tushman, 2016). Also, process related insights into how growth modes were selected and how the relative emphasis on exploration/exploitation was altered for the growth proliferation and growth mobilization effects do not emerge from my work. In a similar vein, the statistical and material aspects of my results indicate that in three growth modes, there was a threshold growth orientation percentile rank that required firms to switch between a high degree of exploitation to a high degree of exploration (alliances) or vice versa (acquisitions and divestitures) (panels 3 b, c, d). However, the empirical approach of deductive theory testing through regression models poses the limitation of a precision paradox (Dubin, 1978). Thus, how managers implemented the switch from exploration to exploitation or vice versa in the three growth modes cannot be ascertained or explained from the empirical results of H3-H5. This limitation of my study emphasizes the importance of recent progress made on how firms switch between exploration and exploitation (Swift, 2016) and vice versa thus suggesting that further scholarly effort in this topic are of organizational ambidexterity is required (Lavie et.al., 2010).

Finally, the moderator variables represent isolated system states in the empirical model (Dubin, 1978). Hence, controlling for the effect of one growth mode while testing hypotheses aligned to alternative modes precludes theory development around how the interaction between different growth modes affected the growth orientation- firm failure relationship. For instance, extant research on growth modes has provided scholarly insight into the interaction between internal development/alliances (Hoang and Rothaermel, 2010), alliances/acquisitions (Hsu and Prescott, 2017), acquisitions/divestitures (Kaul, 2012) and internal development/acquisitions (Karim and Mitchell, 2000). However, theory development around growth mode portfolios and implications of how interactions between modes affect portfolio evolution and firm outcomes need to be uncovered. I suggest that a prospective research stream of interest to scholars of firm growth is the study of how different growth modes interact with each other to influence relevant growth outcomes. This can be a first step in a broader research agenda addressing richer theory development and managerial insights into the role of growth mode decisions and portfolios towards corporate level outcomes.

3.6 CONCLUSION

This study demonstrates that during technological change, a growth orientation along with the growth proliferation and growth mobilization effects exerted by firm growth mode choices decrease the likelihood of firm failure. For corporate strategy scholars, my work emphasizes the role of a growth orientation and growth modes that enable firms to improve their adaptability and likelihood of survival in evolving technology ecosystems. For managers, it demonstrates the need to maintain robust growth strategies and supplement these through appropriate growth mode decisions as part of their firms' corporate strategies to ensure firm survival during technological change. For both, it demonstrates the importance of developing a corporate development capability in firms that can espouse strategic decisions to serve as growth modes in dynamic, fast-paced environments characterized by technological change.

4. ESSAY THREE - "REINFORCE, ATTENUATE, RECONCILE" – HOW RESOURCE RECONFIGURATION THROUGH CORPORATE SCOPE DECISIONS OVERCOMES THE INERTIA OF A LEGACY TECHNOLOGY ORIENTATION

4.1 INTRODUCTION

Resource reconfiguration - the addition, subtraction, redeployment and recombination of firm resources is a topic of growing interest in corporate strategy research (Folta et.al., 2016; Galunic and Rodan, 1998; Karim and Capron, 2016). Scholars have studied its antecedents (Folta et.al., 2016; Galunic and Rodan, 1998), role as an environment alignment mechanism (Chakrabarti et.al., 2011); effect on technological innovation (Kaul, 2012), heterogeneity in reconfiguration approaches (Lavie, 2006), how multi-business firms reconfigure their businesses (Eisenhardt and Brown, 1999) and corporate scope decisions (acquisitions and divestitures) as modes of reconfiguration (Kaul, 2012; Kuusela, et.al., 2017). However, during technological change, a key challenge for firms in legacy technology ecosystems is to address the inertia arising from legacy technology oriented business units to adapt to the threat posed by a new technology (Ahuja and Lampert, 2001; Tripsas and Gavetti, 2000).

In evolving technology ecosystems, resource reconfiguration is an important adaptive mechanism when the emergence of a new technology poses a threat to firms that exhibit inertia due to a *’legacy technology orientation’* – ‘a firm’s relative emphasis on technological knowledge and products aligned to an incumbent technology’. To improve the likelihood of product market survival, resource reconfiguration involves reconciling the tension between the inertia of a legacy technology orientation and adaptation to the new technology so that firm survival can be salvaged in evolving technology ecosystems (Adner and Snow, 2010; Albert, Kreutzer and Lechner, 2015).

Corporate scope decisions and their associated structural arrangement choices are central to the reconciliation of the tension between legacy and new technologies (Puranam et.al., 2006, 2009; Puranam and Srikanth, 2007). Corporate scope decisions enable firms to acquire new technology resources or divest legacy technology resources to enhance their adaptability in evolving technology ecosystems (Ahuja and Katila, 2001; Haspeslagh and Jemison, 1991; Feldman, 2014). The choice of structural arrangement associated with acquisitions/divestitures affects whether firms can jointly deploy resources that have a high potential for reconfiguration (i.e., capacity for redeployment, recombination and complementarity) from the legacy and the new technology while isolating resources that have low reconfiguration potential (Capron et.al., 1998, 2001; Schweizer, 2005). Structural arrangement choices develop a ‘common ground’ when they leverage resources from both technologies that reconcile the tension between inertia and adaptation thus improving the likelihood of product market survival (Moschieri and Mair, 2017; Puranam et.al., 2009; Schweizer, 2005).

An increasing number of firms in product markets aligned to legacy technology ecosystems currently face threats to survival from a new technology - internet television (Dowling, Lechner and Thielman, 1998), integrated banking and insurance (Cummins and Weiss, 2009), functional foods (Bornkessel et.al., 2016) and film and video game integration (Brookley, 2010). In this context, the role of corporate scope decisions and their structural arrangement choices as agents of resource reconfiguration to address the inertia of a legacy technology orientation warrants theoretical attention due to its significant relevance for scholars and managers alike.

For instance, in my empirical context of the mass market photography ecosystem, firms had a significant legacy technology orientation (derived from a commitment to analog photography) and on average, made over three corporate scope decisions as part of resource reconfiguration to adapt to the challenge posed by a new technology (digital photography). However, 48 percent of the firms did not survive the sample period and exit their product markets. As product market survival is an outcome of successful adaptation to changing environments (Barnett and Hansen, 1996; Christensen et.al., 1998), understanding how resource reconfiguration through corporate scope decisions and their structural arrangement choices enables firms to reconcile the inertia of a legacy technology orientation with a new technology and improve the likelihood of product market survival is a strategic issue. The lack of theoretical insight into this issue and its relevance for managers motivated my research question – *'For firms with a legacy technology orientation, how does resource reconfiguration through corporate scope decisions and their structural arrangement choices affect the likelihood of product market survival in evolving technology ecosystems?'*

I approach this research question in three stages. First, I theorize that a legacy technology orientation exerts a *'legacy reinforcement effect'* that decreases the likelihood of resource reconfiguration through scope expanding new technology acquisitions and scope reducing legacy technology divestitures. A legacy reinforcement effect is driven by inertia arising from relatedness and coherence narratives arising from a legacy technology orientation (Chatterjee and Wernerfelt, 1991; Teece et.al., 1994). Second, I theorize that new technology alliance experience induces a *'legacy attenuation effect'* that weakens the negative effect of a legacy technology orientation and increases the likelihood of acquisitions and legacy divestitures. Alliance experience, a knowledge accessing mechanism, enhances absorptive capacity in the new technology and directs managerial attention towards its potential to substitute the legacy technology or contribute to its obsolescence (Lane et.al., 2001; Maula et.al., 2013; Schildt et.al., 2012).

Third, I theorize that in the event of new technology acquisitions or legacy technology divestitures, firms that choose hybrid structural arrangements (i.e., partial integration for acquisitions and partial selloffs for legacy divestitures) over pure structural arrangements (i.e., full integration or selloffs) have a higher likelihood of product market survival due to a *'legacy reconciliation effect'*. Hybrid structural arrangements involve the joint deployment of legacy and new technology resources that have a high reconfiguration potential while isolating resources with low potential (Moschieri and Mair, 2017; Schweizer, 2005; Zaheer et.al., 2013). These arrangements facilitate new resource creation or legacy resource renewal and harmonize the inertia associated with a legacy technology orientation context and the emerging new technology context by developing a 'common ground' between both technologies (Kale et.al., 2009; Puranam et.al., 2009; Schweizer, 2005). Thus, they improve the likelihood of product market survival.

Using a longitudinal dataset of 843 firm-years and 62 digital camera firms during a period of technological change in the mass market photography ecosystem, I found that a legacy technology orientation (linked to analog photography) exerted inertia and decreased the likelihood of new technology acquisitions (digital photography) and legacy technology divestitures while new technology alliance experience weakened this effect. Further, firms were more likely to survive when they made new technology acquisitions and legacy technology divestitures and chose hybrid structural arrangements over pure arrangements.

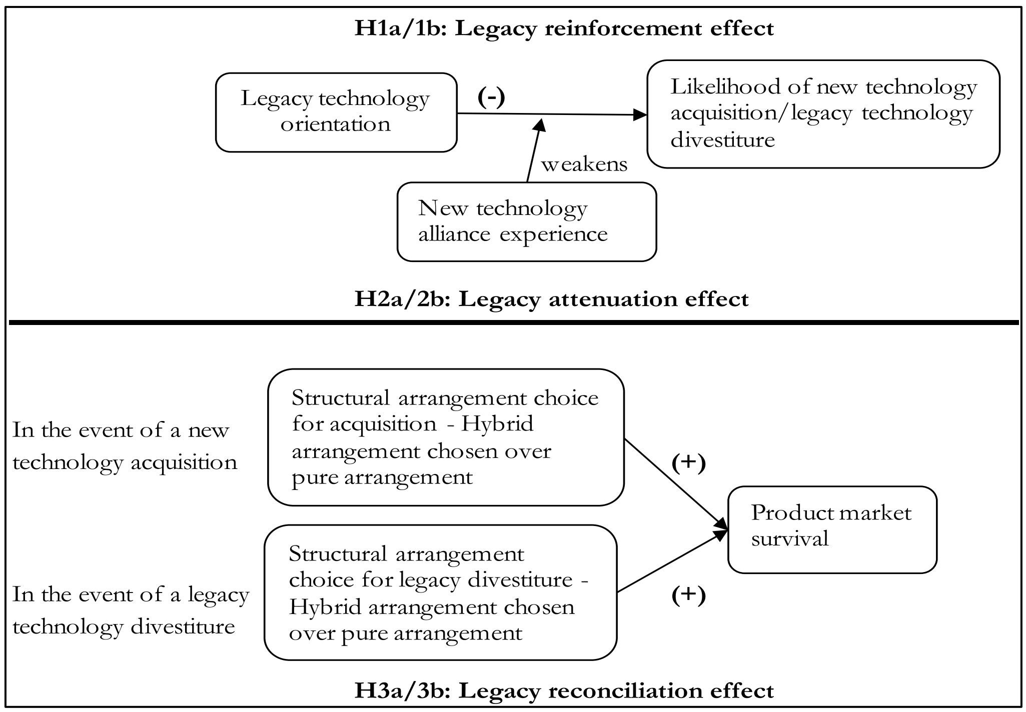
My study contributes to the scholarly conversation on the importance of resource reconfiguration by theorizing how corporate scope decisions and accompanying structural arrangements are mechanisms of resource reconfiguration that help firms overcome the inertia of a legacy technology orientation to improve the likelihood of product market survival in evolving technological ecosystems.

Specifically, I theorize three inertia related effects associated with a legacy technology orientation. A legacy reinforcement effect is an outcome of the inertia of a legacy technology orientation that decreases the likelihood of new technology acquisitions and legacy technology divestitures. New technology alliance experience creates a legacy attenuation effect that decreases the effect of inertia and increases the likelihood of acquisitions and legacy divestitures. In the event of an acquisition or legacy divestiture, hybrid structural arrangements leverage high reconfiguration potential resources from both technologies while isolating low potential resources thus reconciling the tension between the inertia of a legacy technology orientation and adaptation to the new technology thus improving the likelihood of product market survival – a legacy reconciliation effect. Thus, corporate scope decisions and their structural arrangement choices are sources of firm heterogeneity in their capacity to overcome inertia associated with a legacy technology orientation and positively affect product market survival during technological change.

4.2 THEORY AND HYPOTHESES

I first theorize on my approach to resource reconfiguration, corporate scope decisions and their structural arrangement choices. Next, I theorize on how firms' legacy technology orientation exhibits inertia to technological change. I then develop hypotheses for the legacy reinforcement, attenuation and reconciliation effects. Figure 7 depicts the theoretical model of this study.

Figure 7. Theoretical model



4.2.1 Resource reconfiguration - Corporate scope decisions and structural arrangement approaches

Corporate strategy scholars propose that corporate scope decisions and their associated structural arrangement choices are precursors to resource reconfiguration (Capron et.al., 1998, 2001; Karim and Mitchell, 2000; Kaul, 2012). New technology acquisitions provide access to new technology resources by expanding corporate scope (Ahuja and Katila, 2001; Haspeslagh and Jemison, 1991).

Legacy technology divestitures are scope reducing as firms eliminate legacy technology resources from their boundaries (Feldman, 2014; Vidal and Mitchell, 2015). New technology alliances are technological knowledge accessing mechanisms that affect resource reconfiguration processes in firms (Schildt et.al., 2012; Schilling, 2015).

In the event of a new technology acquisition or legacy technology divestiture, structural arrangement choices reflect how firms integrate acquired new technology resources and eliminate legacy technology resources as part of resource reconfiguration (Capron et.al., 1998, 2001; Puranam et.al., 2006, 2009). Pure structural arrangements for acquisitions include i) full integration – absorption of new technology target resources by acquirers (Karim and Mitchell, 2000; Puranam et.al., 2003) or ii) full autonomy – operational autonomy to the target resources (Kale et.al., 2009; Puranam and Srikanth, 2007). For divestitures, pure arrangements include i) business unit/asset restructuring – the structural re-alignment of legacy technology resources (Karim and Kaul, 2015; Karim, Carroll and Long, 2016) or ii) business unit/asset selloffs – the elimination of legacy technology resources (Feldman, 2014). Hybrid structural arrangements for acquisitions include partial integration of acquired new technology resources and autonomy to residual resources (Schweizer, 2005). For legacy divestitures, a hybrid arrangement involves the partial restructuring of legacy technology units/resources and selling residual resources (Capron et.al., 2001; Moschieri and Mair, 2017).

Structural arrangement choices are an important determinant of product market survival in evolving technology ecosystems as they enable firms to reconcile the inertia imposed by a legacy technology orientation with an emerging new technology context (Moschieri and Mair, 2017; Puranam et.al., 2006, 2009; Schweizer, 2005). The reconfiguration potential of resources is defined as their capacity for redeployment (Folta et.al., 2016), resource/unit recombination

(Galunic and Rodan, 1998; Karim and Kaul, 2015) and complementarity (Cassiman and Veugelers, 2006). Hybrid structural arrangements involve the joint deployment of legacy and new technology resources that possess high reconfiguration potential while isolating those with low reconfiguration potential (Capron et.al., 1998, 2001; Schweizer, 2005). Hybrid arrangements generate resource combinations using both sets of resources that in turn enable new resource creation and legacy resource renewal (Graebner, 2004; Schweizer, 2005; Zaheer et.al., 2013). Hybrid arrangements harmonize the pre-existing legacy context with an emerging new technology context as they reconcile the tension between the inertia of a legacy technology orientation and the new technology through the creation of a 'common ground' between both technologies (Moschieri and Mair, 2017; Puranam et.al., 2009).

Pure structural arrangements may lead to inferior resource combinations arising from the joint deployment of low potential reconfiguration resources or opportunity costs of isolating high reconfiguration potential resources (Puranam and Srikanth, 2007; Shaver, 2006). Pure structural arrangements isolate the pre-existing legacy context from the new technology context thereby aggravating the tension between the firm's legacy technology and the new technology due to the conflicting priorities imposed by the co-existence of both technologies (Graebner, Eisenhardt and Roundy, 2010; Schweizer, 2005; Shaver, 2006).

4.2.2 Legacy technology orientation

Research on technological change and corporate diversification conceptualizes a firm's legacy technology as underpinning its dominant logic through coherence and relatedness narratives (Chatterjee and Wernerfelt, 1991; Teece et.al., 1994). The embodiment of the legacy technology in the firm’s knowledge base, products and business units leads to a high degree of structural embeddedness (Karim, 2012; Karim et.al., 2016). Interaction with the legacy technology leads to cognitive and emotional embeddedness of managers and knowledge workers who identify with it and thereby imbue the firm with a distinctive identity (Ahuja and Lampert, 2001; Tripsas and Gavetti, 2000). The legacy technology and associated coherence and relatedness narratives exert inertia that is reinforced by actors in the legacy technology ecosystem and legitimized by institutional entities (Christensen and Bower, 1996; Rajan, Servaes and Zingales, 2000; Wessel, Levie and Siegel, 2016). These dynamics result in a legacy technology orientation - ‘a firm’s relative emphasis on technological knowledge and products aligned to an incumbent technology’.

Notwithstanding the changing ecosystem dynamics arising from the emergence of a new technology, a legacy technology orientation privileges technological knowledge and products driven by the legacy technology thereby hindering adaptation to the threat posed by the emergence of a new technology (Ahuja and Lampert, 2001; Tripsas & Gavetti, 2000). The inertia resulting from a lack of responsiveness to the new technology imperils product market survival when the new technology poses substitution threats to legacy technology resources (Christensen and Bower, 1996; Tripsas and Gavetti, 2000). In this context, new technology adoption through resource reconfiguration enables firms to create or access new technology resources or modify existing legacy technology resources to address the threat of substitution and improve the likelihood of survival (Agarwal and Helfat, 2009). However, the inertia of a legacy technology orientation constrains the firm’s corporate scope decisions to those that adhere to coherence and relatedness narratives (Chatterjee and Wernerfelt, 1991; Silverman, 1999). Thus, the inertia imposed by a legacy technology orientation is likely to conflict with the imperative of new technology adoption (Adner and Snow, 2010; Albert et.al., 2015). Hence, an important condition for adaptation requires reconciling the firm's pre-existing legacy context with an emerging new technology context to adapt to the changing ecosystem context. Corporate scope decisions and their structural arrangement choices represent one approach through which firms can address the resource creation/renewal and reconciliation processes to improve their likelihood of survival.

4.2.3 Legacy reinforcement effect – The inertia of a legacy technology orientation

A firm's legacy technology orientation is likely to pose inertia to resource reconfiguration through new technology acquisitions because of the low degree of coherence and relatedness between the firm's legacy technology resource and the new technology resources to be acquired (Chatterjee and Wernerfelt, 1991; Hitt et.al., 1991; Silverman, 1999). The co-existence of both sets of resources contributes to negative synergies, sub-additivity in resource combinations due to a lack of complementarity and conflicting strategic and operational contexts within the firm (Capron and Pistre, 2002; Harrison et.al., 1991).

The knowledge bases underlying new technology resources pose stickiness, context specificity and imperfect transferability challenges that hinder mindful learning and recombinant exploration ex post new technology acquisitions (Zollo, 2009). This lack of familiarity with new technology resources is likely to lead to excessive premiums in the market for corporate control that posit adverse selection issues and thus dissuade firms with a legacy technology orientation from acquiring (Coff, 2003). Prospective post-acquisition integration issues involve negative spillovers that further decrease the likelihood of acquisition. These spillovers arise from cultural disparities, demotivation in acquirer and target human capital and incentive misalignment (Kapoor and Lim, 2007; Paruchuri, Nerkar and Hambrick, 2006; Stahl and Voigt, 2008).

A third rationale for the opposition to new technology acquisitions may arise from the threat of delegitimization by ecosystem and institutional actors. This results from perceptions of unwarranted category spanning (Rajan et.al., 2000), inconsistent corporate scope decisions due to misaligned managerial incentives (Dalton et.al., 2007) and ecosystem 'lockout' by actors that privilege the legacy technology (Schilling, 1998). Due to a combination of these issues, firms are likely to experience a legacy reinforcement effect driven by the inertia of a legacy technology orientation that decreases the likelihood of a new technology acquisition. Thus,

H1a/Legacy reinforcement effect: In an evolving technology ecosystem, a firm's legacy technology orientation will have a negative effect on the firm's likelihood of making scope expanding new technology acquisitions.

The legacy reinforcement effect also decreases the likelihood of legacy technology divestitures. The orchestration of legacy technology resources through routines at the team and individual levels leads to interdependencies across business units resulting in an inertia driven equilibrium (Albert et.al., 2015; Porter and Siggelkow, 2008). These interdependencies create a legacy technology activity system wherein resources, knowledge, routines and individuals become tightly coupled hence strengthening the legacy technology orientation (Karim, 2012; Siggelkow, 2011). In this scenario, legacy divestitures disrupt structural and relational patterns and processes as critical legacy resources, routines and individuals exit (Hannan et.al., 2003; Shah, 2000). Divestiture may also adversely affect legacy technology driven performance and demotivate human capital due to discontinuity introduced by structural change (Gopinath and Becker, 2000; Hannan et.al., 2003). Hence, a firm's legacy technology orientation discourages divestiture as it leads to performance-related opportunity costs thus undermining legacy technology driven competitive advantage.

A second factor that deters legacy divestitures is the development of structural rigidity and cognitive inertia due to the embeddedness of resources, business units and individuals in a legacy technology context (Sandri et.al., 2010; Shimizu and Hitt, 2005). These factors reinforce coherence and relatedness narratives and introduce inertia through competence and learning traps, resource and routine rigidity and over-exploitation (Leonard-Barton, 1992; Levinthal and March, 1993; Sull, Tedlow and Rosenbloom, 1997; Tripsas and Gavetti, 2000). Ecosystem relationships and institutional legitimation concerns further discourage legacy divestitures as relevant actors develop interest in the legacy technology over time and expect firms to retain commitment to it (Christensen and Bower, 1996; Rajan et.al., 2000; Wessel et.al., 2016). These issues capture the inertia of a firm's legacy technology orientation to divestiture - a legacy reinforcement effect.

H1b/Legacy reinforcement effect: In an evolving technology ecosystem, a firm's legacy technology orientation will have a negative effect on the firm's likelihood of making scope reducing legacy technology divestitures.

4.2.4 Legacy attenuation effect – Alliance experience as an inertia weakening mechanism

A key advantage of alliances is that they facilitate inter-organizational learning by enabling access to new technology resources through collaboration in new technology ecosystems (Asgari, Singh and Mitchell, 2017; Davis, 2016). As alliance experience increases, teams and individuals develop absorptive capacity in the resource characteristics and reconfiguration potential of the new technology (Lane et.al., 2001; Schildt et.al., 2012). These insights improve clarity on how and why the new technology poses threats of substitution and hence enhance the motivation and rationale for new technology adoption (Eggers and Kaplan, 2009; Maula et.al., 2013). As these initiatives increase familiarity with the new technology, alliance experience facilitates a shift away from the legacy technology orientation thereby mitigating inertia (Anand, Oriani and Vassolo, 2010; Hsu and Prescott, 2017). Over time, alliancing may also include the deployment of legacy technology resources that are complementary to the new technology and present possibilities of recombinant exploration (Cassiman and Veugelers, 2006; Rothaermel and Boekar, 2008).

To increase commitment to new technology adoption and more effectively mitigate the inertia of a legacy technology orientation, alliancing leads to to new technology acquisitions that enable firms to initiate broader programs of resource reconfiguration through greater levels of access to new technology resources (Ahuja and Katila, 2001; Dyer et.al., 2004; Haspeslagh and Jemison, 1991). Acquisitions benefit from positive spillovers through an 'alliance transfer effect' through which they enhance commitment to prior initiatives developed through alliancing activity decreasing the turnaround time in new resource creation (Hsu and Prescott, 2017; Zollo and Reuer, 2010). Thus, alliances mitigate the inertia of a legacy technology orientation and increase the likelihood of new technology acquisitions – a legacy attenuation effect.

H2a/ Legacy attenuation effect: In an evolving technology ecosystem, the negative effect of a firm's legacy technology orientation on its likelihood of scope expanding new technology acquisitions is weakened by the firm's new technology alliance experience.

Since alliance experience weakens the inertia of a firm's legacy technology orientation, the probability of legacy technology divestitures increases. Alliancing activity directs managerial attention towards the identification of legacy technology resources that are particularly vulnerable to the threats of technology substitution and impede reconfiguration processes if they have low reconfiguration potential (Kraatz, 1998; Koka and Prescott, 2008). Thus, alliancing augments 'preparedness' for resource reconfiguration by easing the structural embeddedness of legacy technology resources and overcoming managers' cognitive embeddedness (Feldman, 2014; Shimizu and Hitt, 2005). Hence, the likelihood of divesting legacy technology resources increases to address the prospective aspiration-performance gap that may arise from the threat of substitution (Kuusela et.al., 2017; Vidal and Mitchell, 2015)

As discussed, alliance experience leads to insights into complementarities and recombinant opportunities between legacy and new technology resources that present opportunities for new resource creation or legacy resource renewal (Cassiman and Veugelers, 2006; Galunic and Rodan, 1998). To avail of these opportunities, alliancing increases the possibilities of resource 'unbundling' required for redeploying legacy technology resources while divesting residual resources with low reconfiguration potential (Anand and Singh, 1997; Capron et.al., 2001). The influence of alliancing on the selloff of legacy technology resources or unbundling decreases the inertia of a legacy technology orientation and increases the likelihood of legacy divestiture to support resource reconfiguration through a 'legacy attenuation effect'. Hence:

H2b/Legacy attenuation effect: In an evolving technology ecosystem, the negative effect of a firm's legacy technology orientation on its likelihood of scope reducing legacy technology divestitures is weakened by new technology alliance experience.

4.2.5 Legacy reconciliation effect – Harmonizing inertia and adaptation through structural arrangements

In the event of an acquisition/legacy divestiture, an important requirement for improving the likelihood of product market survival is the joint deployment of acquired new technology resources and existing legacy technology resources that have high reconfiguration potential along with the isolation of resources with low reconfiguration potential (Capron et.al., 1998, 2001; Schweizer, 2005). The joint deployment of high reconfiguration potential resources facilitates recombinant innovation, super-additivity and complementarity resulting in resource combinations that form the precursor to new resource creation or legacy resource renewal and lead to a 'common ground' between both technologies (Galunic and Rodan, 1998; Kale et.al., 2009; Puranam et.al, 2009). The developed 'common ground' along with the isolation of low potential resources help mitigate conflicts that may arise from the co-existence of a legacy technology orientation and new technology adoption (Albert et.al, 2015; Puranam et.al, 2009; Schweizer, 2005). In the event of an acquisition/legacy divestiture, I theorize that a hybrid structural arrangement is central to achieving the twin aspects of resource creation/renewal and reconciling the tension between the inertia of a firm's legacy technology orientation and new technology adoption thus benefiting survival.

First, hybrid arrangements facilitate the partial integration of acquired new technology resources and partial restructuring of legacy technology resources through processes of 'un-bundling' (Anand and Singh, 1997; Capron et.al., 1998, 2001). Subsequently, hybrid arrangements facilitate the joint deployment of legacy and new technology resources through 'grafting' that leverages resource recombination processes facilitating new capability development or legacy capability renewal (Haspeslagh and Jemison, 1991; Puranam et.al., 2003). Alternatively, firms may implement business unit reconfiguration initiatives that promote joint deployment through structural recombination resulting in path breaking change through new resource creation (Karim and Mitchell, 2000; Karim and Kaul, 2015). Finally, joint deployment at the unit level - 'patching' legacy and new technology business units leverage the complementarity between them and facilitate legacy technology resource renewal (Eisenhardt and Brown, 1999). These initiatives lead to resource combinations that represent a 'common ground' between both sets of technological resources and are important for the reconciling the tension between both contexts (Kale et.al., 2009; Puranam et.al., 2009). The joint deployment of high reconfiguration potential resources also mitigates relatedness and coherence narratives imposed by the legacy technology since the resource combinations oI their origin to both technologies and therefore correspond to an alternative conceptualization of relatedness (Moschieri and Mair, 2017; Puranam et.al., 2009; Schweizer, 2005).

Second, hybrid arrangements isolate acquired new technology resources with low reconfiguration potential by granting them partial autonomy (Kale et.al., 2009). This enables targets to adopt entrepreneurial approaches for new technology resource development via charters that emphasize forward looking search and exploration (Ahuja and Lampert, 2001; Chesborough and Rosenbloom, 2002; Galunic and Eisenhardt, 1996). Hence, through structural differentiation, firms achieve the benefit of 'localized' reconfiguration as isolation facilitates new resource creation through the autonomous operation of the target (Puranam and Srikanth, 2007; Puranam et.al., 2009). To ensure alignment with the broader reconfiguration context, firms align entrepreneurial charters using administrative control mechanisms that proactively avoid conflicts between the firm's legacy technology orientation and the new technology (Kale et.al., 2009; Galbraith, 2014).

For legacy divestitures, the process of business unit or resource 'unbundling' facilitates the segregation of legacy technology resources with low reconfiguration potential that can be eliminated through a market interface (Anand and Singh, 1997; Capron et.al., 2001; Feldman, 2014). Selloffs help firms reconcile the pre-existing legacy context with the emerging new technology context as they facilitate the exit of resources, knowledge and human capital that is prone to structural and cognitive inertia and hence represent potential sources of conflict between both technological contexts (Sandri et.al., 2010; Shimizu and Hitt, 2005). While they decrease the opportunity cost of inertia posed by the eliminated resources, selloffs also enhance the availability of slack resources for the smooth progress of resource reconfiguration initiatives (Kuusela et.al., 2017; Vidal and Mitchell, 2015). In doing so, selloffs thus exert a ‘selection effect’ that ensures only high reconfiguration potential resources are retained for joint deployment with new technology resources thus enhancing the likelihood of new resource creation and legacy resource renewal and development of a ‘common ground’ between both technologies (Barkema and Schijven, 2008; Capron et.al., 2001). Alternative forms of divestiture (e.g. spinoffs) provide the benefit of structural differentiation or isolation through which residual legacy technology resources may be ‘milked’ to their maximum potential while avoiding a direct conflict with an emerging new technology context (Chesborough and Rosenbloom, 2002; Jansen et.al., 2009).

For acquisitions and legacy divestitures, hybrid arrangements facilitate the joint deployment of high reconfiguration potential resources while isolating low reconfiguration potential resources. Hence, they permit flexibility in collaboration routines, approaches to resource development/modification, organizational and workflow designs, incentives and acculturation approaches (Haspeslagh and Jemison, 1991; Karim and Williams, 2012). Consequently, they expedite the creation and renewal of new and legacy technology resources by forming an effective support system for resource reconfiguration (Graebner et.al., 2010; Zaheer et.al., 2013). Also, as hybrid arrangements isolate resources with low reconfiguration potential, the tension between the inertia of a legacy technology orientation and adaptation to the new technology is alleviated (Puranam and Srikanth, 2007; Puranam et.al., 2009). Hence, firms can harmonize the pre-existing legacy context with a new technology context benefiting from a ‘legacy reconciliation effect’

(Puranam et.al., 2009; Schweizer, 2005). This benefits firm adaptability and increases the likelihood of product market survival (Schweizer, 2005).

In contrast, pure structural arrangement choices result in inferior outcomes of resource reconfiguration and delay or hamper new resource creation and legacy resource modification. This is because they involve uniform approaches of joint deployment or isolation without factoring in the reconfiguration potential of both sets of resources (Graebner et.al., 2010; Puranam et.al., 2003, 2006; Schweizer, 2005). Pure arrangement choices also aggravate the tension between the firm's legacy technology orientation and the new technology either due to negative spillovers from structural co-location or conflicts in the technological resource characteristics of both technologies thereby precluding a 'legacy reconciliation effect' (Puranam and Srikanth, 2007; Shaver, 2006).

For example, pure structural arrangements such as full integration (acquisitions) are vulnerable to inferior resource combinations when firms enforce the joint deployment of low reconfiguration potential resources that should have been isolated through partial autonomy (Puranam et.al., 2009; Shaver, 2006). Full autonomy choices isolate the target's high reconfiguration potential resources and are hence susceptible to opportunity costs of foregone resource combinations with high reconfiguration potential legacy technology resources (Schweizer, 2005; Shaver, 2006). For legacy divestitures, business unit restructuring is based on structural re-alignment or redeployment of legacy technology resources being limited to incremental outcomes that at best facilitate legacy resource renewal as opposed to new resource development (Girod and Whittington, 2015; Karim et.al., 2016). Finally, unit selloffs result in the elimination of high reconfiguration potential legacy technology resources and thus raises opportunity costs to resource reconfiguration as critical resource combinations with acquired new technology resources may be lost (Moschieri and Mair, 2017). Hybrid structural arrangements are more effective in facilitating the process of resource creation/renewal and contributing to a ‘legacy reconciliation effect’ thus enhancing the likelihood of product market survival. Hence:

H3a - Legacy reconciliation effect: In the event of a new technology acquisition, firms that use a hybrid structural arrangement for resource reconfiguration will have a greater likelihood of survival compared to firms that use a pure structural arrangement.

H3b - Legacy reconciliation effect: In the event of a legacy technology divestiture, firms that use a hybrid structural arrangement for resource reconfiguration will have a greater likelihood of survival compared to firms that use a pure structural arrangement.

4.3 EMPIRICAL CONTEXT, DATA AND METHODOLOGY

4.3.1 Empirical context

The digital camera product market ecosystem that emerged due to the technological and market convergence of three industries; computing (SIC 3571, 3572, 3577 and 5045), consumer electronics (SIC 5064 and 5065) and photography (SIC 3861 and 5043) was my empirical context (Benner and Tripsas, 2012; Tripsas and Gavetti, 2000). The technological discontinuity of digital photography (the new technology) posed a threat of technological substitution and obsolescence to analog photography (the legacy or incumbent technology) (Tripsas and Gavetti, 2000). The sample period was 1991 to 2006 because the first digital camera in the United States was commercialized in 1991 while in 2007 the iPhone introduced the ‘feature phone camera’ with a technological substitution implication for digital cameras (Logitech press release, 1991).

4.3.2 Data

The COMPUSTAT database provided financial data for firms in the three industries. The total number of sample firms was 62 (16 computing, 24 consumer electronics and 22 photography) with 843 firm year observations. I included a firm if it had introduced analog and/or digital camera models (mass market camera segment). I extracted data on new technology alliances/acquisitions and legacy technology divestitures from the Thompson Financial SDC database. I used databases such as Lexis-Nexus and company websites to support the SDC data and identify additional alliances, acquisitions and legacy divestitures. I identified a total of 63 alliances, 41 acquisitions and 28 instances of legacy divestitures.

I classified a new technology alliance as one that provided access to partner digital photography resources/capabilities or was based on an R&D agreement in the new technology i.e. digital photography (Schilling, 2015). For example, Sony Inc's strategic alliance to share digital photography competence and co-develop digital cameras with Konica-Minolta was an example of a new technology alliance (Sony website, 2005). A new technology acquisition was identified when a firm purchased a target possessing digital photography resources/capabilities (Ahuja and Katila, 2001). As per Feldman (2014), I identified a legacy technology divestiture when the eliminated resources were based on the legacy technology i.e. analog (film) cameras. Hence, in the above example, Konica-Minolta's sale of their analog camera assets to Sony Inc. is a legacy divestiture (Konica-Minolta website, 2006). I collected data for the structural arrangement choices for acquisitions and legacy divestitures using public corporate, news and trade documents.

4.3.3 Dependent Variables

I used two dependent variables for H1a/b and H2a/b - *Likelihood of new technology acquisition* was coded one if a firm made a new technology acquisition (as described above) in a year and zero otherwise (Hsu and Prescott, 2017). *Likelihood of legacy technology divestiture* was coded one if a firm divested legacy technology resources/units in a year and zero otherwise (Feldman, 2014). For H3a/3b, I used *product market survival* as a dichotomous dependent variable coded one in the year when a firm exit the digital camera product market and zero otherwise. Using Lexis-Nexis and public sources, exit was recorded when a firm ceased operations and/or discontinued production of digital cameras in their product markets (Josefy et.al., 2017). I did not code a firm as having exit if it was taken over and given operational autonomy or was bailed out and resumed operations related to digital cameras *ex post*. In the sample, 30 of the 62 firms (48 percent) exit and the remaining 32 cases were treated as right censored for empirical analysis (Allison, 1984).

4.3.4 Independent variables

i) Legacy technology orientation - linked to analog photography and operationalized as a composite variable of three measures - a firm's patent portfolio (technological knowledge), digital camera model portfolio (products) and analog business units for each year (products and technological knowledge) (Kline, 2011). I collected analog and digital photography patent data using the USPTO database as a proxy for the firm's technological knowledge (Katila and Ahuja, 2002). Second, to proxy a firm's product base, I collected data on camera models (analog and digital) using a variety of sources (e.g., company websites, trade publications, Future Image

Report, PC Photo and digital camera web sites (e.g., dpreview.com, imaging-resource.com, digicamhistory.com and dcviews.com) (Benner and Tripsas, 2012).

Third, I collected data for the number of business units based on analog photography for each firm using a two-step process. I first identified a firm's product markets using S&P Industry Reports and the sources used to collect product model data. Next, I identified the 6-digit SIC/NAICS codes for each firm's business units. If a firm had a business unit with products based on analog photography, I classified it as a legacy business unit (Feldman, 2014). I collected these data for each firm year. The composite measure of legacy technology orientation captures the inertia of the firm's knowledge and products and is methodologically congruent with my theory (Karim, 2012).

I operationalized the patent and product portfolio measures for each firm year as follows, $p_{analog}/\{ p_{analog} + p_{digital}\}$ represents the proportion of patents based on analog (digital) photography in the firm's patent portfolio or the proportion of analog (digital) photography camera models in the firm's product portfolio. The business unit measure was operationalized as a Blau index of diversity: $1 - pi^2$ in each firm year, where pi represents the proportion of business units based on analog photography. A high value for each measure implies a high legacy technology orientation.

I performed confirmatory factor analysis using structural equation modeling (sembuilder option in STATA 14.1) to estimate the measurement model comprising the composite legacy technology orientation measures. The standardized factor loading of each of the three measures onto the composite independent variable was significant at $p<0.05$. The goodness of fit statistics were within the range as prescribed by Kline (2011) (RMSEA = 0.03, Tucker Lewis Index = 0.95, Comparative fit index = 0.98). Detailed results are available. The Cronbach alpha for the composite variable was 0.83 and the individual measure alphas were > 0.75. I calculated the legacy technology orientation variable for each firm year as a weighted sum of the product of the three measures and their respective standardized factor loadings as $\sum_{i=1}^{3} wixi$, where wi refers to the standardized factor loading of the i^{th} variable and xi refers to the value of the i^{th} variable. I standardized the independent variable to facilitate interpretation and lagged it by one year.

ii) Structural arrangement choices - For H3a/3b, I classified resource reconfiguration through acquisitions as a pure structural arrangement under two conditions. First, full integration - when the target was fully absorbed by the acquirer within its corporate hierarchy. For example, Kodak's acquisition of Chinon Industries was full integration where Chinon's R&D, manufacturing and marketing resources was merged within Kodak (Businesswire, 2004). Second, full autonomy – when the acquirer assumed a majority stake in a target but ceded operational control by retaining the identity of the target as a separate unit within its boundaries (Kale et.al., 2009; Puranam and Srikanth, 2007). An instance of this was Kodak's acquisition of PictureVision Inc. that provided full autonomy to the latter by retaining its identity as wholly owned subsidiary in an overseas location (The Washington Post, 1998). Resource reconfiguration through a hybrid structural arrangement occurred when the target was absorbed partially and granted partial operational autonomy (Zaheer et.al., 2013). Panavision Inc.'s acquisition of Plus 8 Digital used a hybrid arrangement. Panavision retained the Plus 8 brand name in specific product markets using an autonomous operation but integrated other brands with its product lines in other markets (The Hollywood Reporter, 2006).

For legacy divestitures, pure structural arrangements included i) unit/asset restructuring – when a legacy technology business unit (or assets) was spun off, reconfigured through resource/personnel transfer or split up (Karim and Kaul, 2015; Karim et.al., 2016). For example, Kodak restructured its analog camera business by laying off 15,000 personnel while redeploying resources towards digital photography (The Guardian, 2004) ii) unit/asset selloffs – when a firm sold a legacy technology business unit or assets through a market interface (Feldman, 2014). An instance of selloff was when Konica Minolta sold its film camera assets to Sony Inc. thereby exiting the mass market camera segment (Sullivan, 2006). The hybrid structural arrangement occurred when there was a partial unit sale with residual legacy technology resources retained within the firm (Moschieri and Mair, 2017). For example, Kyocera ceased production of its film-based cameras (Contax and Yashica) and redeployed its manufacturing resources across its other businesses while selling relevant downstream assets to Tocad (Raymond, 2005).

For each firm year where an acquisition or legacy divestiture was made, I coded the structural arrangements choice as one when a pure structural arrangement was selected for resource reconfiguration (full integration or full autonomy for acquisitions and unit/asset restructuring or selloff for legacy divestitures) and two for a hybrid structural arrangement. The years when a firm did not make an acquisition or a legacy divestiture were treated as a baseline case and coded as zero. I included firm years where no acquisitions/legacy divestitures were made to control for alternative drivers of product market survival and a clustering effect arising from dependence across multiple firm year observations corresponding to a firm (Cleves et.al., 2016; Shaver, 1998). This decision enabled me to partially control for endogeneity in decisions regarding making an acquisition/legacy divestiture. No firm made multiple acquisitions or legacy divestitures using more than one arrangement in a year.

4.3.5 Moderator variable

For H2a/H2b, I operationalized new technology alliance experience as the cumulative number of alliances formed to access or jointly develop digital photography related capabilities and knowledge. The moderator variable was lagged by one year. (Lane et.al., 2001).

4.3.6 Control variables

The operationalization and rationale for inclusion of the control variables are in table 8. Apart from the product market size, population density, product market and time fixed effect variables, all controls were operationalized at the firm level. All controls were lagged by one year.

4.3.7 Empirical Methodology

I used event history modeling given its ability to handle data with right censoring (Allison, 1984; Cleves et.al., 2016). For each set of hypotheses, I used a proportional hazards mixed effects Cox regression model. An important benefit of the Cox model is that it does not pose restrictive assumptions about the form of the baseline hazard and permits estimation using time-varying covariates (Allison, 1984; Cleves et.al., 2016). Each firm has a unique hazard function $ht(t) = h0(t) \exp(\beta X[t])$; where 't' is the time at which a firm exit, $h0(t)$ is the baseline hazard function, $X[t]$ is a matrix of covariates at time 't' and β is a vector of modeled coefficients. I used a mixed effects specification (frailty) for the model using the shared option in STATA 14.1 to control for time dependence in individual firm observations and unobserved heterogeneity across firms (Cleves et.al., 2016). I estimated the hazard rate of new technology acquisition and legacy technology divestiture as ‘events’ given the main effects of legacy technology orientation (H1a/1b) and the moderating effect of alliance experience (H2a/2b). For H3a/3b, I estimated the main effect of the structural arrangement choices for acquisitions and legacy divestitures on the hazard rate of product market exit (the ‘event’).

4.3.8 Endogeneity concerns

My study may be prone to external drivers or omitted variables that lead to endogeneity in firms maintaining a legacy technology orientation rather than adopting the new technology (Ahuja and Lampert, 2001; Tripsas and Gavetti, 2000). Persistence with the legacy technology may be also be a case of self-selection when firms view it as a strategic response to the new technology (Sull et.al., 1997). This limitation also affects corporate scope decisions as established by Shaver (1998). Firms may employ alliances, acquisitions and legacy divestitures when their respective product markets have a record of corporate scope activity (Anand and Singh, 1997). They also use these corporate scope decisions to address aspiration performance gaps by eliminating underperforming assets and allying with or acquiring high performing firms (Asgari et.al., 2017; Kaul, 2012).

I controlled for endogeneity in legacy technology orientation and corporate scope decision variables using a two-stage procedure (Hamilton and Nickerson, 2003). For each year, I evaluated the likelihood that a firm added a new patent or camera model based on analog photography (coded zero and one respectively) or a combination of the two (coded two). For the corporate scope variables, I evaluated the likelihood that a firm made an alliance, acquisition or legacy divestiture (coded zero, one and two respectively) or a combination of the three (coded as 3).

I developed two instrumental variables – i) *legacy technology persistence* as the natural log of the total number of firms that introduced a new patent and/or camera model based on analog technology and ii) *product market corporate scope activity* as the natural log of the total number of firms that used any combination of the three corporate scope decisions. Empirically, I observed that the null hypothesis of regressor exogeneity was rejected at $p < 0.1$ indicating that endogeneity was an issue. I found that the null hypothesis of the Hansen J statistic $\chi 2$ test was rejected ($p > 0.1$) justifying the validity of the instruments to test for endogeneity. I ran two first stage probit models to predict the likelihood of patent and/or camera model introduction and corporate scope decisions using the variables and the respective instruments. I used the predict procedure to save the predicted values of the residuals (inverse Mills ratios) for both equations and included them in the second stage model to control for endogeneity.

4.4 RESULTS

4.4.1 Legacy reinforcement and legacy attenuation effect hypotheses

Figure 8 shows aspects of my empirical context. In the top panel, the dotted line indicates that between 1991-1996, firms' legacy technology orientation did not change significantly and less than 1 percent of legacy divestitures and less than 10 percent of new technology acquisitions being made in this period. These observations support the legacy reinforcement effect. As 18 of the 63 new technology alliances (30 percent) were formed by 1996 (dashed line), a takeoff in new technology acquisitions (solid line) and legacy technology divestitures (dashed-dotted line) was

Table 8. Control variables, operationalization and rationale for inclusion

Control variable	Operationalization	Data Source	Reference	Rational for inclusion
Firm size	Natural log of revenue for a firm	COMPUSTAT	NA	Firm size is an important driver of corporate scope through acquisition and divestiture as well as a determinant of survival during different types of environmental change
Product market size	Natural log of revenue of each product market	Standard and Poor Industry Survey Handbooks, Mergent Online, IBIS World	NA	Varying levels of product market size are likely to affect acquisitions and divestitures in different ways as well as firm survival
Product market population density	Natural logarithm of number of firms in product market	Standard and Poor Industry Survey Handbooks, Mergent Online, IBIS World	Suarez and Utterback (1995)	Population may affect firm survival depending on the competitive dynamics in the product market. Acquisitions and divestitures may be a result of high or low population density.
Product market fixed effects	Dummy variable code 1 if SIC code is 3861, 0 otherwise	NA	NA	The photography firms had a higher probability of adopting digital photography compared to computing and consumer electronics firms that were diversified into alternative technologies

Time fixed effects	Dummy variable- coded 1 if year was 2001; 0 otherwise	NA	Hsu and Prescott (2017)	The technology crash (dotcom bubble) of 2001 was a significant macroeconomic event affecting the entire technology sector with implications for corporate scope and firm survival
Organizational slack	Natural log of (total assets - total liabilities)	COMPUSTAT	Vidal and Mitchell (2015)	Unabsorbed slack contributes to acquisitions in terms of providing resources and also precludes the need for liquidity related or performance enhancing divestitures. Slack benefits survival attempts during environmental change
Corporate diversification	Number of four digit SIC codes that a given firm was present	Standard and Poor Industry Survey Handbooks, Mergent Online, IBIS World	Chatterjee and Wernerfelt (1991)	Diversified firms may be more likely to acquire and divest while leveraging fungible resources to improve firm survival.
Prior performance (ROA)	Natural log of (Operating profits/Total assets)	COMPUSTAT	Hitt *et.al.*(1991)	Influences subsequent acquisition and divestiture activity from an aspiration performance gap perspective
Debt to equity ratio	Ratio of market value of equity and total debt (long term liabilities + short term	COMPUSTAT	Hitt *et.al.*(1991)	Greater debt to equity ratios may increase the likelihood of firm divestiture for reasons of solvency

	liabilities+ current liabilities)			
Prior R&D expenditure	Natural log of (R&D expenditure/Total Revenue)	COMPUSTAT	Hitt *et.al.*(1991)	Diversified firms may have greater R&D expenditure committed to digital photography that precludes the need for acquisitions and legacy divestitures.
Prior alliance experience	Cumulative number of all the alliances made by a firm	SDC Platinum, Lexis Nexis	Lane *et.al.* (2001)	Prior alliancing may positively influence future alliancing that expedites the legacy attentuation effect and leads to firms decreasing the time taken for acquisitions and legacy divestitures
Prior acquisition experience	Cumulative number of all the acquisitions made by a firm	SDC Platinum, Lexis Nexis	Puranam *et.al.* (2006)	Past acquisition experience may lead to firms doing more acquisitions in future.
Prior divestiture experience	Cumulative number of all the divestitures made by a firm	SDC Platinum, Lexis Nexis	Vidal and Mitchell (2015)	Past divestiture experience may lead to firms doing more divestiture in future

observed. These findings support the legacy attenuation effect. In the bottom panel, survivors accounted for 81 percent of the hybrid arrangement choices but < 50 percent of the pure arrangement choices. Also, the mean legacy technology orientation for the sample firms decreased by 42 percent between 1991-2006. These findings support the legacy reconciliation effect.

Table 9 shows the descriptive statistics and correlations. The legacy technology orientation variable had a mean value of 0.41 (41 percent) while the mean for surviving and non-surviving firms was 0.62 (62 percent) and 0.32 (32 percent). This implies that the relative emphasis of non-survivors on analog photography was about twice that of survivors. Table 10 contains the mixed effects proportional hazards Cox model results for both dependent variables (acquisitions – models 1-3; legacy divestitures – models 4-6). Assumptions for event history modeling were met and multicollinearity was not an issue for the full model (VIF = 1.62) or for individual variables (max. VIF = 3.62). A positive (negative) coefficient for a variable indicates a higher (lower) hazard of the event in question (i.e. acquisition/legacy divestiture) (Allison, 1984).

The controls for the acquisitions and legacy divestitures hypotheses reveal important insights. For acquisitions (table 10: model 1), high levels of new technology knowledge breadth and prior R&D expenditure decreased the likelihood of acquisition indicating alternative modes of sourcing/developing new technologies (Capron and Mitchell, 2012). Prior performance and high levels of debt to equity ratio increased the likelihood of acquisition. For legacy divestitures (table 10: model 4), higher prior R&D expenses decreased the likelihood of divestiture indicating contextual effects and legacy technology inertia. High debt to equity ratio and fixed time effects increased the likelihood of divestiture.

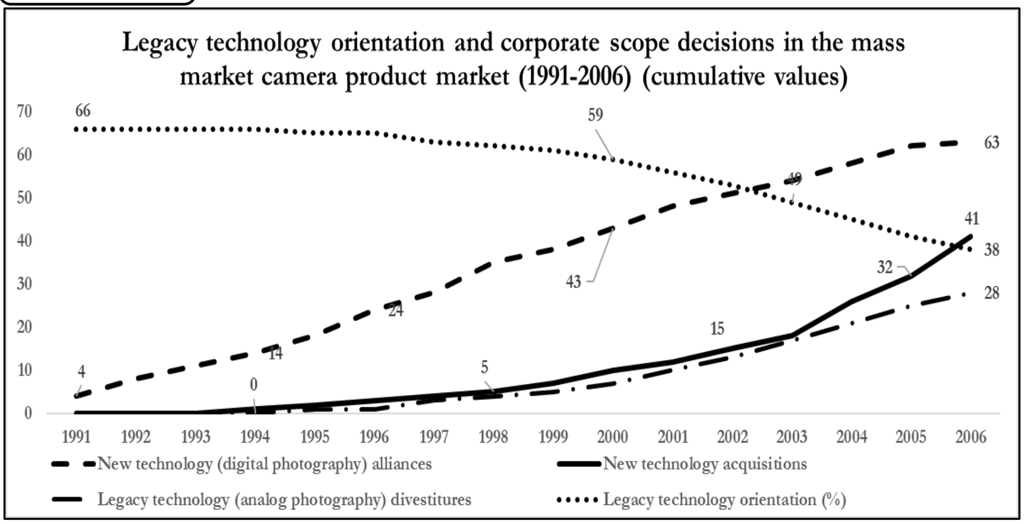
Hypothesis 1a proposed that in an evolving technology ecosystem, a firm's legacy technology orientation had a negative effect on its likelihood of scope expanding new technology acquisitions. The hypothesis was supported (table 10, model 2: $\beta = -2.45$, $p < 0.01$). For a 10 percent increase in legacy technology orientation, the hazard rate of an acquisition decreased by 22 percent (1-(exp (0.1 * - 2.45) =0.22). This result was material as firms that had a higher legacy technology orientation (≥ 25 percent) made only 11 of the 41 acquisitions (27 percent).

Hypothesis 1b proposed that in an evolving technology ecosystem, a firm's legacy technology orientation has a negative effect on its likelihood of scope contracting legacy technology divestitures. It was supported (table 10, model 5: $\beta = -2.82$, $p < 0.05$). For a 10 percent increase in legacy technology orientation, the hazard rate of a legacy divestiture decreased by 24 percent. I found material effects for this result as firms with a higher legacy technology orientation (≥ 25 percent) made only nine of the 28 legacy divestitures (32 percent).

Hypothesis 2a proposed that in an evolving technology ecosystem, the negative effect of legacy technology orientation on its likelihood of scope expanding new technology acquisitions is weakened by new technology alliance experience. It was supported (table 10, model 3: $\beta = 1.44$, $p < 0.05$). For a 10 percent increase in alliance experience, the hazard rate of an acquisition increased by 15 percent. The moderation effect of alliance experience in panel 9a of figure 9 shows that the relative hazard rate of making an acquisition was higher for firms with higher levels of alliance experience (solid line) compared to firms with lower levels (dashed line). The hazard rate of acquisition for a firm with higher alliance experience was 16 percent higher relative to a firm with lower experience at a legacy technology orientation of 10 percent but this difference increased four times to 65 percent at a 100 percent orientation. This result was material as firms forming 43 of the 63 alliances (69 percent) made 27 of the 41 acquisitions (65 percent).

Figure 8. Empirical context and material effects

Top panel



Bottom panel

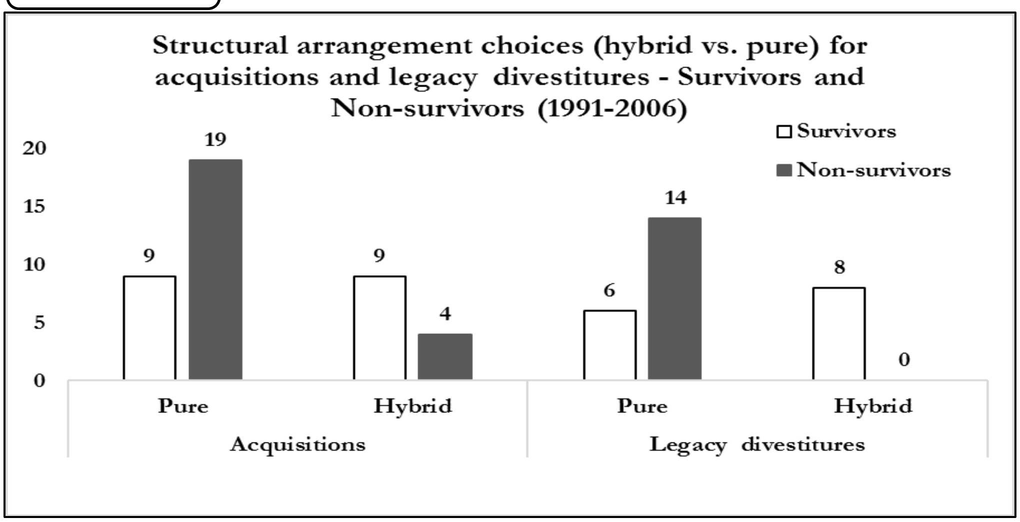


Table 9. Correlations and descriptive statistics

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1) Firm size	1													
2) Prod mkt size	0.00	1												
3) Prod mkt. population	-0.25	-0.35	1											
4) Prod. mkt fixed effects	0.23	0.09	-0.31	1										
5) Time fixed effects	0.09	-0.11	0.03	0.02	1									
6) Organizational slack	0.57	-0.04	-0.14	0.17	-0.03	1								
7) Diversification level	0.02	0.02	-0.05	0.01	-0.07	-0.03	1							
8) Prior performance	0.27	-0.05	-0.05	0.01	0.12	-0.03	-0.03	1						
9) Debt/equity ratio	0.42	0.03	-0.15	-0.01	0.03	0.35	-0.06	0.06	1					
10) Knowledge breadth	-0.02	0.00	0.20	-0.11	-0.03	-0.02	0.02	0.02	-0.03	1				
11) Prior R&D expenditure	0.21	0.01	0.01	0.02	-0.00	-0.04	0.02	-0.16	-0.09	0.06	1			
12) Alliance experience	0.26	0.02	-0.34	0.30	0.01	-0.04	0.03	0.06	-0.00	-0.10	-0.03	1		
13) Acquisition experience	0.16	0.09	-0.12	0.07	0.10	0.09	0.04	0.05	0.09	0.04	-0.02	0.01	1	
14) Divestiture experience	0.39	0.00	-0.14	0.34	0.01	0.03	-0.03	0.07	0.23	0.06	0.00	0.20	0.30	1
15) Legacy tech. orientation	0.42	0.04	-0.18	0.23	0.11	0.10	-0.02	0.05	0.26	0.09	0.01	0.15	-0.48	-0.78
16) New tech. alliancing	0.26	0.01	-0.21	0.27	-0.04	0.19	0.01	0.05	0.05	0.25	-0.03	-0.02	0.38	-0.02
17) Likelihood of acquisition	0.14	0.04	-0.11	0.02	0.08	0.04	0.02	0.03	0.05	0.01	0.05	0.00	0.03	0.21
18) Likelihood of divestiture	0.00	0.08	-0.08	0.01	0.08	0.00	0.02	0.08	0.03	-0.04	-0.06	-0.03	0.21	-0.02
19) Product market exit	0.02	0.09	0.04	-0.06	0.01	0.03	0.00	0.00	-0.02	0.10	0.06	-0.04	-0.01	-0.01
Mean	0.25	2.07	0.51	0.15	0.25	0.82	0.47	0.04	0.20	0.86	0.58	2.05	0.39	1.16
S.D.	0.10	1.18	0.14	0.36	0.43	1.18	0.29	0.65	0.55	0.18	1.17	3.97	0.72	1.86
Maximum	0.50	3.31	0.97	1	1	7.04	5	1.82	7.60	1	1.82	19	4	2
Minimum value	0.06	0.24	0.10	0	0	-3.00	0	-1.35	0	0	0	0	0	0

N= 843 firm year observations. All values ≥ 0.05 and ≤ -0.05 are significant at $p<0.1$.

Table 9. (continued)

Variable	**15**	**16**	**17**	**18**	**19**
15) Legacy tech. orientation	1				
16) New tech. alliancing	0.11	1			
17) Likelihood of acquisition	0.27	-0.01	1		
18) Likelihood of divestiture	0.02	0.04	0.16	1	
19) Product market exit	-0.26	-0.03	-0.03	-0.04	1
Mean	0.41	0.73	0.09	0.04	0.03
S.D.	0.24	2.36	0.29	0.20	0.18
Maximum	0.84	19	1	1	1
Minimum value	0.10	0	0	0	0

N= 843 firm year observations. All values ≥ 0.05 and ≤ - 0.05 are significant at $p<0.1$.

Hypothesis 2b proposed that in an evolving technology ecosystem, the negative effect of a firm's legacy technology orientation on its likelihood of scope contracting legacy technology divestitures is weakened by new technology alliance experience. From model 6 of table 10, hypothesis 2b was supported ($\beta= 0.60$, $p< 0.05$). For a 10 percent increase in the alliance experience, the hazard rate of a legacy divestiture increased by 6 percent. The moderation effect of alliance experience in panel 9b of figure 9 shows that the relative hazard rate of legacy divestiture for a firm with higher levels of alliance experience was > two times that of a firm with lower levels of experience at a legacy technology orientation of 10 percent. This difference increased to > three times at a legacy technology orientation of 100 percent. I found material effects for this result as firms making 33 of the 63 alliances (52 percent) accounted for 22 of the 28 legacy divestitures (79 percent).

Table 10. Event history modeling results - legacy reinforcement/legacy attenuation effects (endogeneity adjusted estimates)

	Likelihood of new technology acquisition			Likelihood of legacy technology divestiture		
Control variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Firm size	0.71**(0.28)	0.45^{+}(0.27)	0.53^{+}(0.30)	-1.51(1.13)	-0.62(1.61)	-0.88(0.19)
Product market size	0.28**(0.01)	0.26(0.08)	0.23(0.09)	-0.39(0.44)	-0.10(0.45)	-0.33(0.23)
Product market population density	-0.58^{+}(0.31)	-0.80**(0.32)	-0.61^{+}(0.33)	-0.25(0.19)	-0.25(0.21)	-0.77(0.56)
Product market fixed effects	-0.68(0.44)	-1.12**(0.44)	-0.25(0.53)	0.15(0.22)	0.24(0.22)	0.21(0.14)
Time fixed effects	0.17(0.32)	0.42(0.34)	0.42(0.36)	0.22^{+}(0.13)	0.34*(0.16)	0.53*(0.23)
Organizational slack	-0.12(0.77)	-0.25(0.83)	-0.16(0.10)	-0.88(0.80)	-1.22^{+}(0.72)	-0.26(0.25)
Corporate diversification level	0.30(0.53)	0.62(0.55)	0.60(0.62)	0.91**(0.37)	0.92*(0.39)	0.53*(0.24)
Prior performance	0.56(0.57)	0.83(0.58)	0.35(0.56)	0.19(0.32)	0.32(0.41)	0.38(0.50)
Debt to equity ratio	-0.31(0.39)	-0.56(0.41)	-0.09(0.50)	0.54(0.23)	0.73**(0.28)	-0.24^{+}(0.14)
New technology knowledge breadth	-0.54 (0.49)	0.36(0.51)	0.10(0.54)	-0.27(0.23)	-0.66*(0.29)	0.19(0.14)
Prior R&D expenditure	-0.18(0.77)	-0.14(0.89)	0.32(0.83)	-0.38*(0.18)	-0.24(0.21)	0.57(0.51)
Prior alliance experience	0.04(0.05)	0.11*(0.05)	0.45(0.64)	0.56*(0.23)	0.52*(0.24)	0.33(0.60)
Prior acquisition experience	0.33**(0.17)	0.79**(0.14)	0.80(0.15)	0.12^{+}(0.07)	0.61(0.78)	0.88(1.03)
Prior divestiture experience	0.18(0.19)	0.20(0.20)	0.03(0.21)	0.22(0.10)	0.24**(0.09)	0.29(0.21)
H1a/b: Legacy technology orientation (legacy reinforcement effect)		**-2.45**(0.53)**	-2.66**(0.57)		**-2.82*(1.31)**	-2.39(1.80)

Table 10. (continued)						
New technology alliancing experience			-0.91^{+}(0.55)			0.29*(0.13)
H2a/b: Legacy technology orientation * New technology alliancing experience (legacy attenuation effect)			**1.44*(0.64)**			**0.60*(0.31)**
Inverse Mills ratio 1 – Legacy technology orientation	-0.12(0.11)	0.10(1.15)	-0.47(1.22)	0.44(0.34)	-0.66(0.56)	0.45(0.76)
Inverse Mills ratio 2 – Corporate scope decisions	0.05(0.21)	-0.24(0.21)	-0.17(0.24)	-0.62(0.37)	0.32^{+}(0.18)	0.14(0.16)
Over-dispersion (frailty) (θ)	0.21	0.21	0.21	0.20	0.20	0.21
LR test (χ^2) of θ (p-value)	0.50(0.49)	0.86(0.49)	0.25(0.50)	0.38(0.50)	0.75(0.49)	0.40(0.49)
Log likelihood	-225.28	-214.25	-199.31	-22.19	-19.56	-15.27
Wald χ^2 (df)	31.32(16)	49.76(17)	50.83(19)	13.27(16)	14.05(17)	19.59(19)

Notes for table 10: a) n= 62 firms with 843 firm year observations.
b) The first value for each variable in each model is the regression coefficient. The value in brackets is the standard error calculated through the concept of shared frailty that accounts for dependence between observations and unobserved heterogeneity.
c) ** p<0.01, * p< 0.05 and + p< 0.1.
d) Bold values refer to the hypotheses results.
e) When the LR test of theta is not significant, unobserved heterogeneity (frailty) is accounted for in the model.

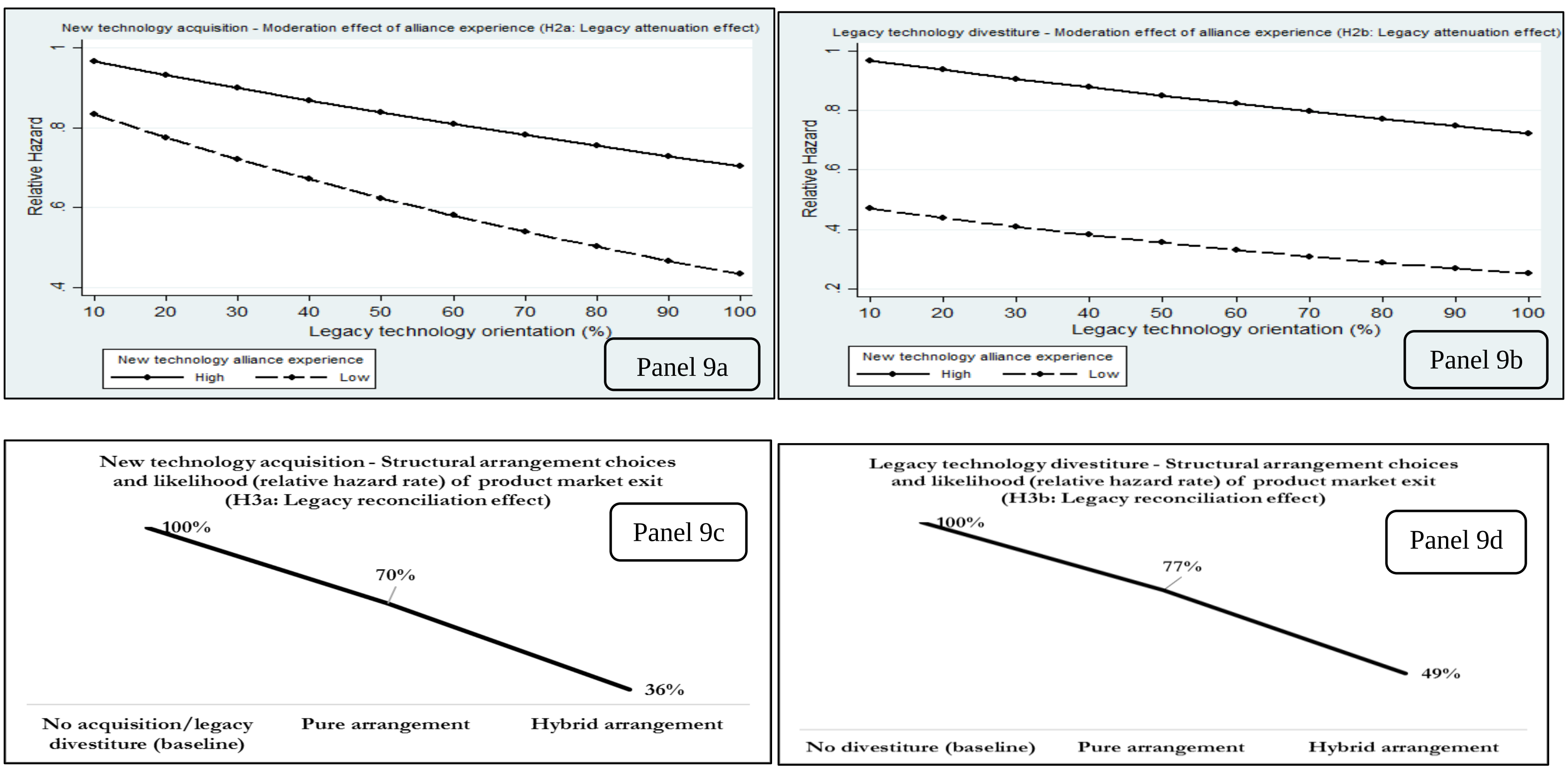
4.4.2 Legacy reconciliation effect (product market survival)

Table 11 contains the mixed effects proportional hazards Cox model results (acquisitions – models 1-3; legacy divestitures – models 4-6). Assumptions for event history modeling were met and multicollinearity did not pose an issue for the full model (VIF = 1.62) or for individual variables (highest VIF = 3.62). A positive coefficient for a variable indicates a decreasing (increasing) likelihood of product market survival (exit) and vice versa (Allison, 1984).

The controls in model 1 of table 11 reveal important insights. Product market size and time fixed effects increased the likelihood of product market survival indicating the benefits of contextual munificence. Organizational slack, level of diversification, past performance and new technology knowledge breadth also positively affected product market survival indicating the importance of having slack and fungible resources and broad technological knowledge. However, product market population had a negative effect on firm survival indicating the adverse impact of competitive dynamics in product markets affected by technological change. Legacy technology orientation had a negative and significant effect on product market survival ($\beta= 1.05$, $p< 0.05$) indicating that a 10 percent increase in legacy technological orientation decreased the likelihood of product market survival by ~ 11 percent. This result is in accordance with existing literature on technological change (Christensen and Bower, 1996; Sull et.al., 1997; Tripsas and Gavetti, 2000).

Hypothesis 3a proposed that in the event of a new technology acquisition, firms that use a hybrid structural arrangement for resource reconfiguration will have a greater likelihood of product market survival compared to firms that use a pure structural arrangement. It was supported. For firms that chose a hybrid structural arrangement, the hazard rate of product market exit was 36

Figure 9. Graphical representation of legacy attenuation effect hypotheses and legacy reconciliation effect hypotheses



percent (64 percent lower) relative to the baseline of no acquisition (table 11, model 2: $\beta = -1.01$, $p < 0.05$). For firms that chose a pure structural arrangement, the corresponding hazard rate was 70 percent (30 percent lower) relative to the baseline (table 11, model 2: $\beta = -0.36$, $p < 0.01$). Panel 9c of figure 9 demonstrates that the relative hazard rate of exit was lowest for firms that chose a hybrid arrangement in the event of an acquisition. This was ~49 percent lower compared to the hazard rate of firms with a pure arrangement supporting the legacy reinforcement effect. I found material effects for this result as surviving firms accounted for nine of the 13 acquisitions (69 percent) with a hybrid arrangement but only nine of the 28 acquisitions (32 percent) with a pure arrangement (figure 8, bottom panel).

Hypothesis 3b proposing that in the event of a legacy technology divestiture, firms that use a hybrid structural arrangement for resource reconfiguration will have a greater likelihood of survival relative to firms that use a pure structural arrangement. It was supported. For firms that chose a hybrid arrangement, the hazard rate of product market exit was 49 percent (51 percent lower) relative to the baseline of no divestiture (table 11, model 3: $\beta = -0.72$, $p < 0.05$). For firms that chose a pure structural arrangement, the corresponding hazard rate was 77 percent (23 percent lower) relative to the baseline (table 11, model 3: $\beta = -0.26$, $p < 0.05$). Panel 9d of figure 9 demonstrates that the relative hazard rate of product market exit was lower for firms that chose a hybrid arrangement compared to firms that chose a pure arrangement by ~36 percent thus supporting the legacy reconciliation effect. I found material effects for this result as firms that survived accounted for all eight legacy divestitures that chose a hybrid structural arrangement (figure 8, bottom panel).

4.4.3 Robustness Checks

I used several robustness checks to ensure the validity and consistency of the results. First, since the alliance experience variable may include the effect of time on the likelihood of acquisition and legacy divestiture, I included a time trend variable (1 for 1991, 2 for 1990....15 for 2006) to control for alternative processes that may predict the relationship between these corporate scope variables (Hsu and Prescott, 2017). My results were robust to this variable.

Extant research on digital cameras has found that in 1991, the first commercially available digital camera was introduced in the United States while in 1999, the established 'dominant design' of the digital camera was introduced (Benner and Tripsas, 2012). In 2003, the sales of digital camera models surpassed those of analog camera models for the first time. I controlled for time fixed effects through dummy variables for each of these three years and did not find significant changes in my results. My data indicates a temporal trend in corporate scope decisions wherein there was a sharp increase in acquisitions and legacy divestitures after 1996 (left panel, figure 2). To ensure that this trend did not bias the results, I tested the model between 1991-1996 and found results that were consistent with the main results. I tested the robustness of the structural arrangement choice variable by creating an alternative coding scheme for acquisitions and legacy divestitures where I coded hybrid arrangements for each as 0, full integration and full selloff as 1 and full autonomy and asset restructuring as 2. I tested the model using this coding scheme and found support for the results.

Table 11. Event history modeling results - legacy reconciliation effect (endogeneity adjusted estimates)

Control variables	Model 1	Model 2: Structural arrangement choices - acquisitions	Model 3: Structural arrangement choices – legacy divestitures
Firm size	-0.89(0.54)	0.45(0.51)	-0.14(0.51
Product market size	-0.43**(0.09)	-0.44**(0.09)	-0.37**(0.10)
Product market population density	0.36**(0.10)	0.25**(0.08)	0.38**(0.11)
Product market fixed effects	0.16(0.18)	0.57*(0.25)	0.64*(0.27)
Time fixed effects	-1.59^{+}(0.87)	-2.32**(0.87)	-2.73*(1.20)
Organizational slack	-0.37^{+} (0.20)	-0.94(0.59)	-0.01(0.20)
Corporate diversification	-0.21(0.13)	-0.85(1.35)	-0.25(0.16)
Prior performance	0.83*(0.38)	0.15(0.33)	0.20(0.57)
Debt to equity ratio	0.32(0.39)	0.10 (0.08)	0.18*(0.08)
New technology knowledge breadth	-0.89*(0.40)	-0.44**(0.16)	-0.39(0.44)
Prior R&D expenditure	0.26(0.56)	0.65(0.74)	0.37(0.89)
Prior alliance experience	0.60*(0.25)	0.35**(0.13)	0.64**(0.22)
Prior acquisition experience	0.26(0.23)	0.20**(0.07)	0.21**(0.08)
Prior divestiture experience	0.02(0.42)	0.97**(0.39)	0.12*(0.05)

Table 11. (continued)			
Legacy technology orientation	1.05*(0.48)	0.83**(0.25)	0.99**(0.36)
H3a/3b: Structural arrangement choice (Legacy reconciliation effect)			
i) Hybrid structural arrangement choice		**-1.01*(0.41)**	**-0.72*(0.35)**
ii) Pure structural arrangement choice		**-0.36*(0.15)**	**-0.26*(0.11)**
Inverse Mills ratio 1 – Legacy technology orientation	0.44^{+}(0.34)	0.19(0.22)	0.22(0.25)
Inverse Mills ratio 2 – Corporate scope decisions	1.40**(0.49)	0.45(0.43)	-0.11**(0.04)
Frailty model over dispersion parameter(θ)	0.14	0.16	0.17
LR test (χ^2) of θ (p-value)	0.01(0.99)	0.01(0.99)	0.01(0.99)
Log likelihood	-49.75	-45.59	-48.24
Wald χ^2 (df)	70.25 (17)	86.04 (21)	80.81(21)

Notes for table 11: a) n= 62 firms with 843 firm year observations.
b) The first value for each variable in each model is the regression coefficient. The value in brackets is the standard error calculated through the concept of shared frailty that accounts for dependence between observations and unobserved heterogeneity.
c) ** p<0.01, * p< 0.05 and + p< 0.1.
d) Bold values refer to the hypotheses results.
e) When the LR test of theta is not significant, unobserved heterogeneity (frailty) is accounted for in the model.
f) The hazard rate of hybrid and pure structural arrangements are interpreted against the baseline case where firms did not make an acquisition/legacy divestiture.

Further, I bifurcated my sample to create two subsamples – one with the 32 survivor firms and the second with the 30 non-surviving firms. I ran a competing risks event history model to check if there was heterogeneity in structural arrangement choices for survivors and non-survivors (Cleves et.al., 2016). I found that surviving firms were more likely to have chosen a hybrid structural arrangement compared to pure arrangements but non-survivors were more likely to have chosen a pure arrangement. These results conform to the main findings.

Empirically, I tested my model using alternative distributional assumptions - proportional hazards Weibull and Gompertz specification (both allowing for monotonically increasing/decreasing hazard functions) and the results were supported (Cleves et.al., 2016). I also tested for the piecewise exponential distribution (a special case of the Weibull distribution when the scale parameter = 1) and found results in favor of the Weibull model. As suggested by Amezcua et.al. (2013), I plotted the Cox and Snell residuals for both distributions and the results showed the Weibull specification to have a superior fit. I also ran a fixed effects model with robust standard errors clustered on individual firms to which my results were robust.

Finally, my sample is subject to a 'rare event' bias due to the infrequent nature of acquisitions and legacy divestitures relative to firm years (King and Zeng, 2001). A drawback of this issue is that the maximum likelihood estimation of the Cox model may be prone to small sample bias that underestimates the probability of acquisitions and divestitures. To address this, I ran my models using a rare event specification (relogit in STATA) to which my results were robust.

4.5 DISCUSSION

Drawing on the resource reconfiguration perspective, I asked the following research question - For firms with a legacy technology orientation, how does resource reconfiguration through corporate scope decisions and their structural arrangement choices affect the likelihood of product market survival in evolving technology ecosystems? I motivated my research question by emphasizing that the role of resource reconfiguration as an adaptive mechanism is critical for as firms in several legacy technology ecosystems are threatened by the emergence of new technologies. I found three inertia-related effects linked to product market survival in the evolving technology ecosystem related to mass market photography. A firm's legacy technology orientation reinforces inertia, new technology alliances attenuate inertia and acquisitions and divestitures coupled with hybrid structural arrangements help reconcile the inertia of a legacy technology orientation with new technology adoption to improve the likelihood of product market survival.

4.5.1 Contribution

The growing body of research on resource reconfiguration has provided important insights into how the addition, subtraction, redeployment and recombination of firm resources facilitate the process of resource creation and renewal (e.g., Folta et.al., 2016; Galunic and Rodan, 1998; Karim and Capron, 2016). I contribute to this body of work by demonstrating the role of resource reconfiguration as an adaptive mechanism that reconciles the inertia of a firm's legacy technology orientation with adaptation to a new technology to improve its likelihood of survival during technological change. I do this by theoretically formulating and empirically testing the legacy reinforcement, attenuation and reconciliation effects.

By introducing the legacy reinforcement effect, I show that the inertia of a firm's legacy technology orientation is an instance of scope preservation. Scholarly research has conceptualized organizational inertia as a pathology that imperils firm survival. Several maladaptive mechanisms have been forwarded to explain the pathology including structural and cognitive inertia (Hannan and Freeman, 1984; Leonard-Barton, 1992; Tripsas and Gavetti, 2000), competence and learning traps (Levinthal and March, 1993), over-commitment to inferior strategies (Ahuja and Lampert, 2001; Christensen and Bower, 1996; Sull et.al., 1997) and competitive blind-spots (Zajac and Bazerman, 1991). I contribute to this body of work by providing a corporate strategy perspective wherein the inertia of a firm's legacy technology orientation hinders the reconfiguration and adaptation of corporate scope through acquisitions and legacy divestitures during periods of change in technology ecosystems. By theorizing a firm's legacy technology orientation in terms of its relative emphasis on technological knowledge, products and business units aligned to a legacy technology, I show that these organizational resources are a source of inertia associated with a legacy technology orientation (Karim, 2012). Thus, my work demonstrates how organizational inertia manifests as a pathology to precludes changes in a firm's boundary decisions thereby attenuating its capacity to adapt to evolving technology ecosystems.

Through the legacy attenuation effect, I contribute to research by emphasizing the importance of how corporate scope decisions mitigate the inertia of a legacy technology orientation. By demonstrating the role of new technology alliance experience in decreasing inertia associated with the legacy reinforcement effect, my work complements research emphasizing the role of alliancing as an adaptive mechanism when technology ecosystems face periods of change

(Anand et.al., 2010; Asgari et.al., 2017; Schilling, 2015). Since new technology alliance experience increases the likelihood of resource reconfiguration via acquisitions and legacy divestitures (scope modification), my work complements research emphasizing the importance of acquisitions and divestitures as agents of discontinuous or path breaking change that facilitate strategic renewal (Barkema and Schjiven, 2008; Karim and Mitchell, 2000).

The legacy reconciliation effect shows that the choice of structural arrangements associated with corporate scope decisions (e.g., choosing hybrid over pure) was central to reconciling the tension between the inertia of a firm's legacy technology orientation and adaptation to the new technology. Hybrid structural arrangements facilitated the joint deployment of high reconfiguration potential resources from both technologies while isolating low potential resources. Thus, they not only enabled new resource creation or legacy resource renewal but also helped develop a 'common ground' wherein resource combinations of both sets of technological resources harmonized the pre-existing legacy context with an emergent new technology context (Puranam et.al., 2009). These findings demonstrate that firm's structural arrangement choices associated with acquisition and divestitures was an important determinant of the winners and losers within the evolving technology ecosystem. I contribute to the organization design literature by showing that structural arrangement choices are a source of firm heterogeneity in terms of addressing organizational inertia and impacting product market survival (Galbraith, 2014; Rumelt et.al., 1994). For instance, the acquisition of Konica by Minolta was implemented through a pure integration arrangement (Konica Minolta website, 2003). While Minolta had advanced capabilities in digital photography, Konica's core competence was in based on digital imaging products (e.g. scanners etc.) suggesting that a hybrid arrangement may have been more suitable to accommodate the differences in the firms' products (Griffith, 2014). Konica Minolta exited the digital camera market in 2006 through a selloff to Sony Inc. (Konica Minolta website, 2006). It is notable that Sony integrated the acquired digital photography assets by giving autonomy to Konica Minolta's design engineers (McNamara, 2006) – a hybrid structural arrangement.

4.5.2 Managerial implications

For corporate strategy practitioners, my findings emphasize the importance of corporate transactions - acquisitions and divestitures in overcoming inertia and the threat to survival associated with a legacy technology orientation. Scholarly work on corporate renewal has conceptualized the role of acquisitions and divestitures as drivers of corporate renewal through growth and retrenchment (Chakrabarti et.al., 2011), revitalization and rationalization (Ghoshal, 1997) and investing in new growth opportunities and away from less promising avenues (Kaul, 2012; Kuusela et.al., 2017; Vidal and Mitchell, 2015). I complement this body of work with a cautionary message for managers – a 'legacy reinforcement effect' associated with an entrenched commitment to a legacy technology that negatively affects corporate renewal programs by decreasing the likelihood of new technology acquisitions and legacy technology divestitures.

Equally important is the management of a firm's corporate development portfolio. My work expands on how the alliancing function contributes to corporate renewal by engaging with the new technology and developing insight into its technological knowledge and the rationale behind the threat posed by it to a legacy technology. A firm's alliancing function is hence a critical resource during technological change as it increases managerial attention to legacy technology divestitures and new technology acquisitions (legacy attenuation effect) as part of a corporate renewal program. An associated takeaway is the importance of managing the corporate portfolio through a holistic approach wherein decisions to 'go it alone', ally, acquire and divest should be designed as a coherent pattern aimed at resource and capability renewal rather than as siloed and stochastic (Capron and Mitchell, 2013; Dyer et.al., 2004). For instance, the legacy attenuation effect indicated that alliance experience leads to acquisitions and legacy divestitures. Hence, managers who consider the nuances of multiple corporate development activities will be strategically positioned to address inertia and enhance their firms' chances of survival.

Finally, managers may note the importance of being circumspect in their choices regarding how they integrate acquisitions and implement divestitures particularly as these choices have repercussions for product market survival through their capacity to reconcile conflicts arising from the co-existence of different technologies (legacy reconciliation effect). Scholarly work on implementation of corporate transactions has focused on issues such as determining the degree of acquisition integration and divestment (Moschieri and Mair, 2017; Puranam et.al., 2009; Zaheer et.al., 2013), implementation speed and agility (Graebner et.al., 2010), enablers and disrupters of implementation (Kapoor and Lim, 2008; Paruchuri et.al., 2006; Stahl and Voigt, 2008) and how implementation affects corporate renewal outcomes (Capron et.al., 1998, 2001; Graebner, 2004; Puranam and Srikanth, 2007). I complement this work by demonstrating that hybrid structural arrangements are a key determinant of whether firms can successfully adopt a new technology while retaining a selective focus on their legacy technology. These choices also affect the firm's capacity to develop new technology assets or modify legacy technology assets through the recombination of fungible resources from both technologies while isolating less fungible resources to minimize the conflict between technologies.

4.5.3 Limitations and future research directions

My work examined three corporate scope decisions (new technology alliances, acquisitions and legacy technology divestitures) as agents of resource reconfiguration. However, a firm's decision to 'go it alone' (through internal development) is an alternative approach to resource reconfiguration through structural differentiation (Chesborough and Rosenbloom, 2002; Jansen et.al., 2009) or recombinant innovation (structural or resource related) (Galunic and Rodan, 1998; Karim and Kaul, 2015). I suggest that a prospective research program for scholars is to evaluate how internal development driven reconfiguration complements reconfiguration through alliances, acquisitions and divestitures.

Although the number of acquisitions and legacy divestitures in my data sample may appear limited, the robustness checks indicated that this was not a significant issue. I did not expect to find high numbers of acquisitions because attractive targets with digital photography capabilities may have preferred to retain autonomy thereby restricting the number of targets in the market for corporate control (Hitt et.al., 1996). My expectations were similar regarding legacy divestitures given the entrenched commitment to analog photography wherein firms identified with the technology and privileged a legacy technology orientation as a bet to compete with the substitutive threat of digital photography (Tripsas and Gavetti, 2000). Moreover, as digital photography began to outperform analog photography, the market for corporate control would have been less attractive for firms trying to divest legacy technology resources. I suggest that to enhance the external validity of my study, scholars may contemplate studying alternative industries where inertia imposed by firms' legacy technologies was addressed through corporate scope decisions.

The operationalization of structural arrangement choices focused on the degree to which firms integrated acquired resources or divested legacy technology resources. However, alternative aspects of organizational design such as degree of formalization and centralization, culture and control mechanisms also exercise influence on the implementation of corporate scope decisions (Galbraith, 2014). For example, in the legacy reconciliation effect, the mechanisms behind joint deployment of high reconfiguration potential resources are likely to be associated with informal as well as formal structures. Thus, how these aspects affect implementation of corporate scope decisions represents an avenue of future research.

While the use of isolated regression models for acquisitions and legacy divestitures enabled me to observe the three hypothesized effects for the two dependent variables, this approach framed each as different system states wherein how one decision affected the other could not be evaluated (Dubin, 1978). I suggest that a prospective research stream of interest to scholars of corporate scope is the study of how different corporate scope decisions interact with each other and affect the overall composition, evolution and reconfiguration of the corporate development portfolio. For example, some scholarly research on resource reconfiguration has conceptualized acquisitions and divestitures as a duality ('cooking sweet and sour') by treating them as symbiotic and mutually reinforcing activities as part of a single system state promoting concurrent growth and retrenchment (Chakrabarti et.al., 2011; Ghoshal, 1997; Kuusela et.al., 2017). Acknowledging this duality reflects a dynamic approach to corporate scope with significant implications for growth and profitability. I incorporated the role of alliances as an important component of the corporate development portfolio for resource reconfiguration in addition to acquisitions and divestitures. Further, I theorized an interaction effect between firms' alliancing experience and divestitures - a relationship that has received scant scholarly attention in corporate scope research.

While scholarly research on corporate scope has focused on interactions between alliances and acquisitions (Hsu and Prescott, 2017; Zollo and Reuer, 2010) and acquisitions and divestitures (Kaul, 2012; Kuusela et.al., 2017), the broader implications of how these interactions affect portfolio evolution and firm outcomes are yet to be uncovered. Thus, I suggest that evaluating how corporate scope decisions interact to shape corporate development portfolio and influence firm outcomes can lead to richer theory development and managerial insights into the contribution of corporate scope towards the firm's corporate strategy. As managers develop insight into how these interactions affect portfolio composition and evolution, the process of portfolio reconfiguration can emerge as a dynamic capability that underpins firms' corporate strategy to adapt as well as shape periods of technological change (Agarwal and Helfat, 2009).

4.6 CONCLUSION

Given the increasing threat of substitution and obsolescence from emerging technologies, firms in legacy technology ecosystems cannot remain inertial and must adapt their corporate strategy to adapt to evolving technology ecosystems or face extinction. My study demonstrates that during technological change, resource reconfiguration through corporate scope decisions and their structural arrangement choices enable firms to overcome the inertia of a legacy technology orientation and improve the likelihood of product market survival. For corporate strategy and resource reconfiguration scholars, my work emphasizes the role of corporate scope and structural arrangement choices as options for resource reconfiguration through which firms can improve their adaptability and likelihood of survival in dynamic, fast-paced environments. For managers, my paper demonstrates the need for awareness to acknowledge threats to legacy technologies and address these threats through appropriate corporate development decisions and their associated resource reconfiguration choices in evolving technology ecosystems.

APPENDIX A

AN EXAMPLE OF THE FEATURE IMPLEMENTATION GAP CALCULATION FOR A FIRM IN THE SAMPLE – CANON INC.

In the table below, I show the yearly absent feature score δpt (where p = feature and t = year) between Canon Inc.'s digital camera design and the evolving digital camera dominant design for three sample years. I = Canon introduced feature (scored 0), A = feature absent from Canon's design (scored 1) and NA = feature had not been introduced till that year in the digital camera product market (not considered in calculation).

Year	Optical zoom	Removable Storage	Higher (>) than VGA resolution	LCD	Video recording	Digital zoom	Feature implementation gap score
1993	I	A	NA	NA	NA	NA	0.5
1995	I	A	A	A	A	NA	0.8
2001	I	I	I	I	A	I	0.33

Step 1: For the year 1993, two features of the evolving dominant design had been introduced (optical zoom and removable storage). Canon had introduced the optical zoom in its digital camera design coded as I (scored 0) but removable storage was absent hence was coded as A (scored 1) in the above table.

Step 2: Canon's feature implementation gap for 1993 was δFD ($gap_{t\text{-}overall}$) = (0+1)/2 = 0.5. The numerator is the sum of the scores for Canon's features. I divide by two because the evolving dominant design had two features that had been introduced as of 1993 (but not institutionalized). In material terms, this meant that the threat to Canon's survival in the digital camera product market increased by (1-exp (0.73*0.5)) or by 44 percent from the start of the era of ferment in 1991 and 1993. (See main effect size of the feature implementation gap in table 4).

Now, consider year 1995. Here, five features of the evolving dominant design had been introduced (all but digital zoom). Four of the five evolving dominant design features were absent from Canon's design. Using the coding, the feature implementation gap was, δFD ($gap_{t\text{-}overall}$) = (0+1+1+1+1)/5 = 0.8. Hence, Canon's feature implementation gap increased to 0.8 because it had four evolving dominant design features absent from its design. In material terms, this meant that the threat to Canon's survival increased to 79 percent (an increase of 35 percent from 1993).

Now, consider the year 2001 (two years after the full dominant design was introduced in 1999). Canon had introduced five of the six evolving dominant design features (i.e., absent feature score 0 for optical zoom, removable storage, higher than VGA resolution, LCD and digital zoom). Five of these features had been institutionalized as shown in table 1 above (removable storage and LCD – 1997; > VGA resolution – 1998; digital zoom and video recording – 1999). Canon's feature implementation gap for 2001 was; δFD ($gap_{t\text{-}overall}$) = (0 + 0 + 0 + 0 + 1*2 + 0)/6 = 0.33. As two years had passed since the institutionalization of the video recording feature and Canon still had it absent in its design, I multiplied 1 by a risk factor of 2 (years since institutionalization) in accordance with my framing of added risk (given by φ –see operationalization in the empirical section on pages 38-40) (0.17 without the risk factor). In material terms, this meant that the threat to Canon's survival decreased to 27 percent in 2001 (a decrease of 51 percent from 1995).

APPENDIX B

EXAMPLES OF HIGH AND LOW GROWTH ORIENTATION COMPANIES, GROWTH MODES CHOICES AND SURVIVAL OUTCOMES

Examples can aid in delineating the trends observed in this paper to indicate their empirical importance. I evaluated the raw data sample and archival sources and discovered several instances where the hypothesized effects were supported for firms in both sets of product markets. I outline three cases here.

Consider the popular and highly studied example of **Cisco Inc.** - a networking product market firm that survived my sample period and had an average growth orientation percentile rank of 83 for the overall sample period (Capron, 2013; Puranam et.al., 2003, 2006). However, in the decade between 1991-2001, it was consistently ranked in the top one percentile of the sample. Cisco used internal development growth mode to set up greenfield subsidiaries in the local area network (LAN), wide area network (WAN), multiplexers, modems and fiber optic network product markets. It formed alliances with Cabletron Systems Inc (1990, 1994), SynOptics Communications (1991), Chipcom (1994) to develop cutting edge networking products aligned to the asynchronous transfer mode (ATM) technology, hubs and router modules. In the latter part of the sample period, as the product market focus shifted towards integrated voice, data and video capabilities, Cisco forged alliances with Olicom Inc. (1997) and Acer Inc. and CTC Communications (1999) to explore the possibility of developing integrated capabilities.

Cisco used acquisitions primarily to exploit emerging growth niches. For instance, the acquisition of Kalpana Inc. (1994) was significant as it enabled Cisco to become the product market leader in ethernet switching that was a prominent growth market early in the sample period. It consolidated this position through multiple exploitative acquisitions, LightStream (1994), Internet Junction and Grand Junction Networks (1995). In 1996, Cisco's acquisition of Stratacom enabled it to gain product market leadership in the fast-growing integrated voice, data and video segment due to the complementary capabilities across both firms. The firm exploited this position through subsequent acquisitions of Nashoba Networks (1996), SummaFour (1997) and Active Voice Corp. (2000). A broader acquisition program across the sample period facilitated Cisco to gain access to complementary technologies and capabilities and thus drive its growth orientation.

During this period, Cisco's revenue grew at a yearly average of 67% with an ROA of 22 percent that was significantly greater than the product market average of 11 percent. It was ranked in the top one percentile of the sample firms in terms of growth orientation between 1991-2001. The firm's stock traded at a yearly average of 31 (trailing twelve months earnings) reaching a high of 61.25 in 1999.

A second example is that of **3Com Corp** – another networking firm that survived my sample period and had an average growth orientation percentile rank of 81 for the overall sample period. However, in the decade between 1991-2001, it was also consistently ranked in the top one percentile of the sample.

3Com achieved organic growth through internal development by setting up autonomous operations in the fast-growing network transmission/devices, LAN and WAN product markets to explore these niches. It also formed alliances with IBM and Synernetics (1990) for product related R&D on token ring networks, hub and router technologies. It also collaborated with AT&T Microelectronics and Cascade Communications (1993) and formed a multi-partner alliance with Softbank Corp. and Toshiba (1994) to develop Ethernet switches and routers through joint exploration. In the latter part of the sample period, 3Com participated in alliances with Picturetel Corp. (1998), Intel Corp. and Bell Atlantic (1998) and Broadcom Corp (2000) to develop integrated video, voice and data offerings as the market for these products saw significant growth. 3Com maintained an acquisition program early in the sample period to consolidate its position in the product market for hubs, routers and switches. The firm's acquisitions of BICC (1992), StarTek (1993), alliance partner Synernetics (1994) and Chipcom (1996) provided it with exploitative focus around a broad range of networking related product markets. However, unlike Cisco, 3Com used acquisitions to exploit domains related pure data and packet switching technology solutions and did not initiate acquisitions into the integrated product market of voice, video and data alternatives. It also used the divestiture activity growth mode proactively by selling off its hardware and manufacturing operations located in Salt Lake City and Chicago to increase strategic focus around networking solutions.

During this period, 3Com's revenue grew at a yearly average of 42% with an ROA of 17 percent that was significantly greater than the product market average of 11 percent. It was ranked in the top one percentile of the sample firms in terms of growth orientation between 1993-2002. The firm's stock traded at a yearly average of 24 (trailing twelve months earnings) reaching a high of 42.55 in 1997.

A third instance of note refers to **ADC Telecommunications Inc.** – an equipment product market firm that began the sampler period with a low growth orientation that increased over time and contributed to the firm surviving the substitutive threat posed by computer networking and packet switching technologies. It primarily focused on exploration through internal development wherein it set up autonomous ventures in the LAN, WAN, multiplexers, modems and network components product market segments. However, the firm collaborated with Fulcrum Communications (1991) to develop fiber optic network capabilities, Hitachi Inc. (1995) to explore the possibility of bundling voice and data product lines and Netcomm Inc. (1995) for product R&D related to modems.

Over the sample period, ADC maintained a high degree of exploitation in the acquisition and divestiture activity growth modes. In this, it strengthened its core competency in voice technologies for recombinant outcomes with computer networking capabilities leading to the development of integrated voice and data products. For instance, the acquisitions of Fibermux (1991) (fiber optic capabilities in data transmission), Photonics Applications Inc. and Codenoll Technologies (1996) (both targets providing equipment development capabilities) and Pairgain Technologies Inc. and Centigram Communications (2000) (both targets pertaining to data and voice integration) enabled ADC to integrate and develop a dual set of capabilities pertaining to telecommunication equipment (legacy) and networking (developed through exploration). Finally, ADC divested its telephonic cable manufacturing assets to C-Cor Inc. and its integrated business planning assets to Svi. IBP Ltd. in 2001 indicating a greater focus on computer networking and its integration with voice technologies.

Between 1989-1995, ADC had an average growth orientation percentile rank of 23. However, between 1997-2003, this nearly tripled to 67 as the firm proactively adopted a growth orientation based around product markets related to networking and subsequently, those involving integrated data, voice and video. Over the sample period, ADC's revenue at a yearly average of 27 percent with an ROA of 13 percent that was higher than the average of equipment product markets (8 percent). The firm's stock traded at a yearly average of 16 (trailing twelve months earnings) reaching a high of 25.65 in 1997.

Two critical insights emerge from this analysis. First, the way different growth modes affected the growth orientation and contributed to growth related outcomes is causally complex given the influence of multiple growth modes. Second, the choice of growth modes is a key underpinning of firm heterogeneity with the characteristic of equifinality. In the three examples above, the choice of growth modes varied significantly but each firm survived the sample period.

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