

Knowledge Problems and Entrepreneurial Strategy

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ABSTRACT

Entrepreneurs formulate and implement strategies to tackle different knowledge problems over the entrepreneurial journey. This dissertation systematically disentangled and compared the value of two strategic decision logics that have been tested little in the extant entrepreneurship literature: the strategic decision logic that leverages speed advantages versus the logic that leverages comprehensive advantages. Using a pseudo-NK simulation method first in the management and entrepreneurship fields, the comparative effectiveness of new product development strategies that leverage speed (e.g., the lean method [paper one] and a modular strategy [paper two]) versus comprehensiveness (e.g., a more comprehensive method [paper one] and a parallel strategy [paper two]) was tested in the first and second essays of the dissertation. In the third essay, I systematically reviewed, analyzed, and disentangled two existing corporate strategy constructs of decision speed and decision comprehensiveness by investigating different ways these decision strategies could be effective within entrepreneurship. I also used a multilevel meta-analysis to synthesize and test the contingent role of decision speed and decision comprehensiveness in different entrepreneurial decision contexts. That is, I found that the value of these two entrepreneurial strategies would be contingent upon the external and internal conditions of ventures. Overall, this dissertation shows that strategies that leverage comprehensiveness might even be more effective in entrepreneurship than the strategies that leverage speed advantages, depending on the internal and external decision contexts.

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GENERAL AUDIENCE ABSTRACT

Entrepreneurs venture into the unknown to capture abnormal profits. Specifically, entrepreneurs make efforts to develop novel products/services, the market value of which is yet unknown. Thus, a rapid decision-making strategy is typically considered a good decision strategy because it allows entrepreneurs to test the potential new products first and then use the real-time feedback and information that come directly from the market (where there is a high level of 'unknowingness') after testing the products to update those that better satisfy market demands. However, such entrepreneurial strategies that leverage quick decisions do not necessarily capture profits because early adopters from which entrepreneurs collect feedback do not necessarily represent mainstream customers. Rather, it is possible that the market feedback obtained through quick product experimentations fails to indicate actual market demands. Hence, more comprehensive strategies can be a good alternative to rapid decision strategies (e.g., lean startups) for entrepreneurs. Specifically, entrepreneurs can use more comprehensive product designs (paper one), employ systematic approaches (e.g., advanced technologies such as artificial intelligence) to create multiple potential product candidates (paper three), and experiment with multiple products simultaneously (paper two) for new product development. However, this dissertation shows that the effectiveness of comprehensive strategies compared with the entrepreneurial strategies that leverage speed is contingent upon the internal contexts (e.g., available resources and venture lifecycles) and external conditions (e.g., market features).

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CHAPTER 1: INTRODUCTION

Entrepreneurs often make strategic decisions in a unique environment where there is a high level of “unknowingness” (Busenitz & Barney, 1997; Eisenhardt & Zbaracki, 1992; Knight, 1921; McMullen & Shepherd, 2006; Packard et al., 2017; Schwenk, 1995; Townsend et al., 2018; Wiltbank et al., 2006). Such an environment generates an array of knowledge problems (e.g., uncertainty and complexity) that entrepreneurs make efforts to resolve by formulating and implementing entrepreneurial decision strategies.

Knowledge problems refer to:

any decision-making state or context in which the decision-maker has moved past ignorance—that is, he or she is at least minimally aware that a decision, judgment, prediction, observation, or assessment must be made—but does not possess certitude regarding either antecedent conditions, contextual or mitigating factors, or likely consequences. (Townsend et al. 2018, p. 670)

Accordingly, entrepreneurship scholars have investigated how entrepreneurs can use decision strategies to address knowledge problems in entrepreneurial settings through several theoretical lenses (i.e., multiple decision logics), including deductive prediction-based logic, such as business planning (Delmar & Shane, 2003; Gruber, 2007); a more comprehensive decision logic, such as systematic, rule-based logic (Atuahene-Gima & Li, 2004; Forbes, 2005; Gans et al., 2019); adaptation-based logic, such as fast and frugal heuristics (i.e., entrepreneurial strategies that leverage speed) and lean methods (Bingham & Eisenhardt, 2011; Busenitz & Barney, 1997; Khanna et al., 2016; Ott et al., 2017; Rise, 2011); effectual logic, such as effectuation (Wiltbank et al., 2006; Sarasvathy, 2001); and non-reasoned action logic, such as impulse-driven behavior (Lerner et al., 2018). Among these decision logics, I focus on the two middle grounds located

between prediction-based logic and effectual logic. Both comprehensive logic (i.e., decision comprehensive) and adaptation-based logic (e.g., decision speed) have rarely been studied despite their critical validity in explaining actual entrepreneurial decision-making processes and their outcomes. Specifically, comprehensive logic, such as decision comprehensiveness, has largely been ignored in the extant entrepreneurship literature. Moreover, many empirical and analytical studies within the entrepreneurship context also have failed to reflect and operationalize varying entrepreneurial decision contexts (i.e., different knowledge problems). Most previous entrepreneurship studies have dubiously assumed uncertainty as a single entrepreneurial decision context in an omnibus fashion without robust operationalization of the uncertainty construct (Packard & Clark, 2020; Townsend et al., 2018).

In short, the fundamental problem my dissertation delves into is the conflicting strategic decision logic between speed versus comprehensiveness in tackling different knowledge problems likely to prevail within entrepreneurial environments. In other words, the overarching question of my dissertation is: How do different knowledge problems in entrepreneurial environments shape the effectiveness of different entrepreneurial strategies (i.e., the strategies that emphasize speed [e.g., adaptation-based logic] versus the strategies that emphasize comprehensiveness [e.g., comprehensive logic]) in increasing new venture performance?

More specifically, the first paper (Chapter 2) of my dissertation theorizes two types of entrepreneurial choice of new product design strategies—the lean startup, which uses a minimal viable product (MVP) (i.e., a new product development strategy that leverages quick decisions and adaptive decision logic) versus the comprehensive product design strategy that utilizes whole product solutions (WPS) (i.e., a new product development strategy that uses a more comprehensive product design and rule-based decision logic that utilizes systematic processes). I examine whether

the performance of these two entrepreneurial strategies—speed versus comprehensiveness—would be contingent upon the various combinations of two knowledge problems (i.e., dynamic complexity and aleatory uncertainty). In this study, I use an NK-like simulation method (Valente, 2014) to simulate and compare how the performances of these two new product design strategies change over time. The knowledge problems I study in the first essay are dynamic complexity and aleatory uncertainty concerning two types of new product development strategies. I investigate and show how the values of these two entrepreneurial strategies are contingent upon the relationship between different decision logics (i.e., speed versus comprehensiveness) and various knowledge problems (i.e., dynamic complexity versus aleatory uncertainty). That is, under some particular circumstances, such as a low level of aleatory uncertainty yet a high degree of dynamic complexity, a new product development strategy that employs more comprehensive product designs (i.e., WPS) should be preferred over a lean startup because such a comprehensive product development strategy will be more conducive for increasing the fitness level between the market and products ultimately by resolving dynamic complexity effectively.

In the second paper (Chapter 3), I investigate another key dimension of new product development and experimentation strategy regarding the number of new products developed simultaneously—comprehensiveness regarding the number of potential new products experimented with and developed at a time. In this essay, I also use an NK-like simulation to corroborate the implications of the first essay (Chapter 2)—the validity of a comprehensive product development strategy in the entrepreneurship context. By obtaining the simulated longitudinal data by an NK-like method (Valente, 2014), I investigate the influence of dynamic complexity—one of the key sources (e.g., knowledge problems) of “unknowingness”—on the venture performance (i.e., the product-market fit) of two product experimentation and

development strategies—a modular new product development strategy (i.e., developing a single new product at a time, which leverages speed) versus a parallel new product development strategy (i.e., simultaneously developing multiple new products at once, which leverages comprehensiveness). My simulation results indicate that a parallel product development strategy (e.g., more comprehensive product experimentations) is generally more effective than a modular strategy (e.g., speedy yet non-comprehensive product experimentations) and that the relative performance of a parallel strategy over a modular strategy becomes more prominent as the magnitude of dynamic complexity increases. However, these results also show that the comparative advantage of a parallel strategy over a modular strategy is contingent upon both the number of focal new product opportunities developed simultaneously and the internal resource condition of a venture (e.g., the resource coordination costs). This study suggests that the quantity of new product development opportunities pursued simultaneously should be at a moderate level to attain a high product-market fit, particularly if the overall resource coordination cost is high.

Building on the theoretical implications of the first (Chapter 2) and the second (Chapter 3) essay, I turned my attention to the systematic review of the theoretical constructs of decision comprehensiveness and decision speed in my third essay (Chapter 4). Specifically, I highlighted these existing constructs of corporate strategy for entrepreneurship research by systematically reviewing, analyzing, and disentangling these two constructs. Further, given that entrepreneurs act under varying conditions of entrepreneurial decision contexts, I studied how and when decision comprehensiveness and decision speed can be systematically effective within the entrepreneurship context by meta-analyzing the performance of these two strategies for environmental dynamism versus Knightian uncertainty—the two extant environmental contexts that have been studied yet conflated in the extant literature. In addition, I examined whether internal decision contexts of a

venture—performance types (i.e., financial versus non-financial performance) and venture lifecycle (i.e., opportunity exploration versus opportunity exploitation stage)—can moderate the effectiveness of each of these entrepreneurial strategies. By doing so, I illustrated that the value of these decision strategies would be contingent upon external and internal conditions of ventures. Specifically, my meta-analysis indicated that decision comprehensiveness can be systematically effective for opportunity exploration, Knightian uncertainty, and non-financial pursuit. Additionally, decision speed was found to be effective for environmental dynamism but ineffective for Knightian uncertainty, whereas decision speed was similarly effective for the other decision contexts of interest (i.e., opportunity exploration and exploitation and financial and non-financial pursuits). Furthermore, my systematic review found that there have been two major definitions of the decision comprehensiveness construct—the decision comprehensiveness operationalized as external search and market analysis versus the decision comprehensiveness operationalized as extensive generation and systematic analysis of possible alternatives. Both my conceptual review and the post hoc analysis in comparing the effect of these two operationalizations of decision comprehensiveness indicated that the decision comprehensiveness operationalized as extensive generation and systematic analysis of possible alternatives (e.g., new product candidates) were much more conducive to the entrepreneurship context, suggesting reconceptualization of the decision comprehensiveness construct for future entrepreneurship research.

Overall, in my third essay (Chapter 4), I conducted a conceptual review of these two extant constructs—decision comprehensiveness versus decision speed—highlighting the potential value of both approaches for entrepreneurship and employed a multilevel meta-analysis (Cheung, 2014; 2015) to compute the generalized empirical effect size of these two strategies. My meta-analytic results showed that both decision comprehensiveness and decision speed could generally be

effective in entrepreneurship, but the magnitude of these positive effects was contingent upon different types of external and internal decision contexts (e.g., types of performance, different entrepreneurial environments, and entrepreneurial life cycle) that entrepreneurs often encounter throughout the venturing process.

In all three essays, I integrate the organizational learning theory (March, 1978; Simon, 1972, 1990) and contingency theory (Galbraith, 1973; Lawrence & Lorsch, 1967) with the entrepreneurship theory of uncertainty (Knight, 1921; McMullen & Shepherd, 2006; Townsend et al., 2018). More specifically, contingency theory indicates that the knowledge problems (or the key challenges from the environment) that actors face, the resources and tools available to the actors, and the solution sets (e.g., a set of products/services) that they can offer should fit together for an actor to capture entrepreneurial profits effectively (Galbraith, 1973; Lawrence & Lorsch, 1967). However, entrepreneurs should navigate the “unknown” decision contexts (e.g., Knightian uncertainty, environmental dynamism, dynamic complexity) both with limited resources and knowledge accessible to them (McMullen & Shepherd, 2006) and with the bounded rationality of actors (Simon, 1972, 1990). Since entrepreneurs often possess limited resources, they should make prudent judgments regarding how to use, allocate, or combine various resources/knowledge that is accessible to them (Foss & Klein, 2016). Moreover, entrepreneurs are limited in rationality in processing information about the “unknown” environments under which they act, which impedes them from entering the market and/or being accepted into the market (Geroski, 1995). Therefore, whether taking a comprehensive approach by employing systematic tools to analyze and generate a massive possibility set (e.g., various possible new product candidates) that could be created by the accessible resources at hand (Chapters 2 and 4) and simultaneously developing multiple new products at once (Chapter 3) or taking an agile approach by using adaptive decision logics to tackle

“unknowingness (e.g., uncertainty)” (Chapters 2, 3, and 4) becomes a critical question in entrepreneurship. Hence, using an NK-like simulation model (both for the first and the second essay) and a multilevel meta-analytic review (for the third essay), I explored and investigated the extent to which the value of different entrepreneurial strategies is contingent upon the link between multiple decision logics—speed versus comprehensiveness—and various knowledge problems (Davis et al., 2009; Townsend et al., 2018). My two essays (Chapters 1 and 3) showed that effective entrepreneurial strategies do not always rely on adaptive logic (i.e., speed advantages) only, reacting to the whims and vacillations of the entrepreneurial environment.¹ Rather, some entrepreneurial environments, such as a high level of dynamic complexity, often demand entrepreneurs to adopt comprehensive decision logic (i.e., decision comprehensiveness) through which entrepreneurs are likely to capture high entrepreneurial values.

Overall, each of these essays significantly contributes to entrepreneurship literature by examining which types of decision logics—speed versus comprehensiveness—under what type of environmental conditions are more (or less) likely to be effective. More specifically, these essays contribute to entrepreneurship literature that has put little emphasis on decision comprehensiveness (e.g., rule-based decision logic and systematic process) thus far. That is, a comprehensive and systematic approach to new product design and development can be very effective, at least within some decision contexts in the venturing process.

Specifically, essays one (Chapter 2) and two (Chapter 3) contribute to the entrepreneurial strategy literature by first introducing NK-like methods (Valente, 2014) to the field of entrepreneurship and strategy. An NK-like method (Valente, 2014) allows for investigating the dynamic yet nonlinear multilevel interactions among various decision environments, different

¹ Entrepreneurial environments are the business environment where “unknowingness” prevails (Townsend et al., 2018).

product development strategies enacted by individual actors, and a multitude of decision choices manifested in changing dimensions of new products/services that entrepreneurs create and develop over time by reducing inherent methodological constraints of canonical NK models.

Additionally, essay three (Chapter 4) makes a theoretical contribution to entrepreneurship literature by systematically reviewing and disentangling the existing constructs of decision comprehensiveness and decision speed, elaborating fundamental mechanisms through which each of them can be effective within the entrepreneurship contexts, developing the contingency model that synthesizes the existing studies, and meta-analyzing their empirical findings for future entrepreneurship research.

Taken together, my dissertation essays study two important entrepreneurial decision logics that could be formulated—speed versus comprehensive—against the various knowledge problems of dynamic complexity versus aleatory uncertainty (paper one), the magnitude of dynamic complexity (paper two), and Knightian uncertainty versus environmental dynamism (paper three). They examined when and how entrepreneurs should formulate and implement decision strategies to increase performance effectively. Figures 1-2, 1-3, and 1-4 illustrate the key focus of each essay.

Overall, my dissertation investigates and shows that the value of entrepreneurial strategies is contingent upon external and internal decision contexts of ventures. Specifically, each knowledge problem (e.g., environmental dynamism, Knightian uncertainty, and dynamic complexity) generated from entrepreneurial environments has a unique and significant impact on the performance of entrepreneurial strategies. Different internal conditions, such as entrepreneurial lifecycle and resource coordination cost, also interact with different decision logics that each entrepreneurial strategy uses in shaping the effectiveness of entrepreneurial strategies.

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Figure 1-1 Overview of Dissertation

Fundamental Problem:

Conflicting Logics between Speed versus Comprehensiveness

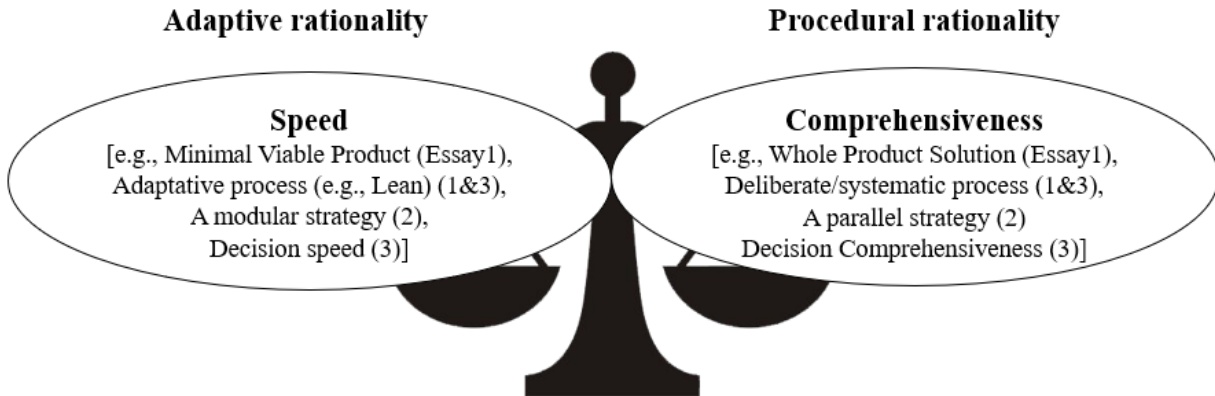


Figure 1-2 Conceptual Model of Essay One

*Firm-level Focus with Multi-level Interactions
 (New Product Design/Development, Market Condition)*

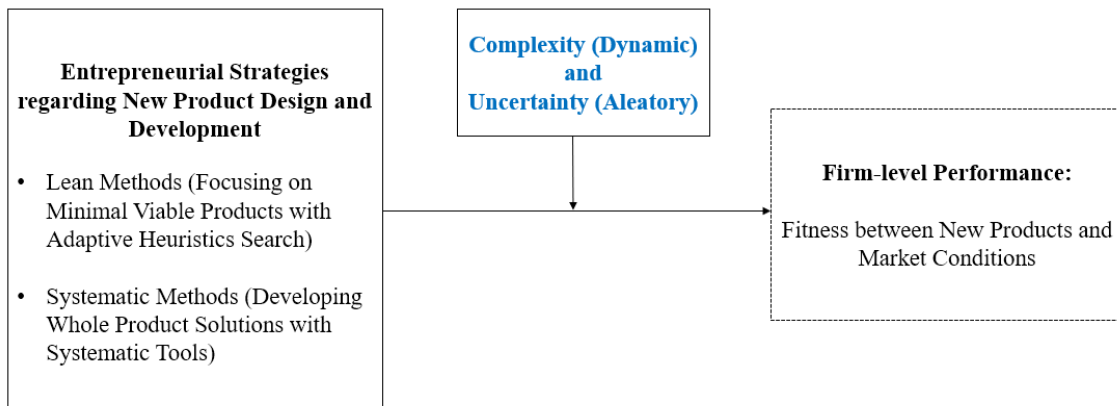


Figure 1-3 Conceptual Model of Essay Two

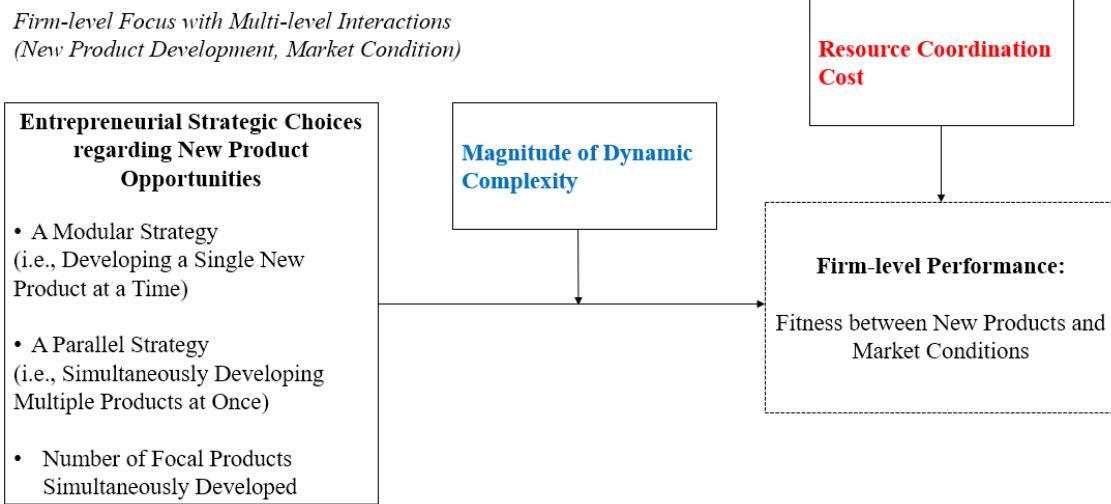
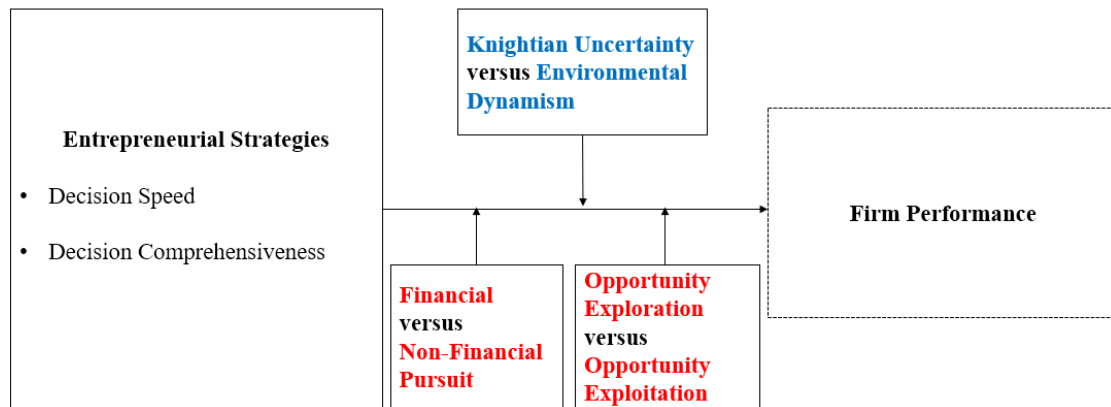


Figure 1-4 Conceptual Model of Essay Three

*Firm-level Focus under Conditions of Uncertainties
and Internal Decision Contexts*



CHAPTER 2: ESSAY ONE

LIMITS OF LEAN: KNOWLEDGE PROBLEMS, ENTREPRENEURIAL STRATEGY, & THE SEARCH FOR PRODUCT-MARKET FIT

2.1. INTRODUCTION

Uncertainty and other knowledge problems (e.g., complexity) play complex roles in entrepreneurship (e.g., Knight, 1921; Townsend, Hunt, McMullen, & Sarasvathy, 2018). Specifically, uncertain and complex environments can serve as precursors to entrepreneurial opportunities. Environmental uncertainty generates entrepreneurial opportunities that can be captured by entrepreneurs who implement effective decision strategies (Knight, 1921; McMullen & Shepherd, 2006; Rindova & Courtney, 2020; Townsend & Hunt, 2019). In addition, dynamic market structures often become so varied and highly interrelated -- dynamic complexity -- that they demand a more sophisticated approach to creating new products. This complexity creates lucrative business opportunities for entrepreneurs who can create a set of products and their features that align well with one another (e.g., a sophisticated business model) (Greenwood, Raynard, Kodeih, Micelotta, and Lounsbury, 2011; Battilana, Leca, and Boxenbaum, 2009). At the same time, these environments also create an array of knowledge problems (e.g., uncertainty and complexity at the actor level) for entrepreneurs to resolve, serving as obstacles to entrepreneurs (Busenitz & Barney, 1997; McMullen & Shepherd, 2006; Townsend et al., 2018). Hence, entrepreneurs should formulate appropriate decision strategies to tackle these paradoxical opportunity-obstacle tensions effectively so that they can increase the fitness level between the market and the new products they create (Gans, Stern, and Wu, 2019; Ott, Eisenhardt, & Bingham, 2017; Ott & Eisenhardt, 2020; Zellweger & Zenger, 2021). Entrepreneurship researchers have thus studied how entrepreneurs should formulate and implement product design and development

strategies in contending with the opportunity-obstacle paradox emerging from these entrepreneurial environments (Blank, 2013; Eisenhardt & Bingham, 2017; Gans et al., 2019; Ott & Eisenhardt, 2020; Zellweger & Zenger, 2021).

In both theory and practice, scholars and practitioners have studied how entrepreneurs can effectively address these opportunity-obstacle tensions when they design and develop new products. Consequently, in the practitioner literature, the lean method has been introduced to address these challenges, advocating the use of “Minimal Viable Products (MVPs hereafter)” in the adaptive search for “product-market fit” (Blank, 2013; Ries, 2011). However, despite the global popularity of the lean method in entrepreneurship communities (Contigiani & Levinthal, 2019; Leatherbee & Katila, 2020), the lean method has not been thoroughly examined until recently. Specifically, entrepreneurial strategy scholars have just begun to raise an array of empirical and theoretical questions about the lean startup method (e.g., Camuffo, Cordova, Gambardella, & Spina, 2020; Felin, Gambardella, Stern, & Zenger, 2019; Hampel, Perkmann, & Phillips, 2020) and to recommend more systematic tools for entrepreneurs to utilize (Agrawal, Gans, & Stern; 2021; Gans, Stern, & Wu, 2019; Gruber, MacMillan, & Thompson, 2008; Ott, Eisenhardt, & Bingham, 2017; Ott & Eisenhardt, 2020; Zellweger & Zenger, 2021). These alternative approaches attempt to offer more rigorous and systematic methods for entrepreneurs to overcome myopic decisions that are likely to perpetuate when using lean methods (Felin et al., 2019).

Although several entrepreneurship scholars have started to question the effectiveness of the lean method in the entrepreneurship context and thus introduced advanced alternative tools – more comprehensive and systematic methods -- recently, both theoretical understanding and scientific evidence of the lean startup and more comprehensive product development strategy are

still lacking. To be specific, there are few entrepreneurship studies that test and directly compare the effectiveness of these competing logics to new product development within entrepreneurial environments. Moreover, little has thoroughly examined the boundary conditions of the lean method. Most existing entrepreneurship studies operationalize uncertainty as a general entrepreneurship context in a universal fashion, conflating other possible environmental contexts such as epistemic uncertainty and environmental complexity (Townsend, Hunt, McMullen, and Sarasvathy, 2018; Mitchell, Mitchell, Hunt, Townsend, & Lee, 2020; Milliken, 1987; Packard and Clark, 2020; Townsend, Hunt, Beal, and, Jin, 2019).

Therefore, in this study, I attempt to fill this gap by testing and directly comparing the effectiveness (i.e., product-market fit) of the lean approach, which uses MVPs (Minimal Viable Products) to promote quick and iterative experimentations and pivoting (e.g., Ries, 2011; Blank & Dorf, 2020), versus that of its alternative entrepreneurial strategies that use more rigorous and comprehensive product design (e.g., WPSs (Whole Product Solutions)) and development strategies (e.g., systematic analysis) (e.g., Felin et al., 2019; Gambardella et al., 2020). More specifically, I argue that the comparative effectiveness of these competing approaches to new product design and development (i.e., MVP versus WPS) is contingent upon the magnitude of particular knowledge problems -- complexity and uncertainty -- entrepreneurs are facing throughout the venturing processes (Mitchell, Mitchell, Hunt, Townsend, & Kim, 2020; Rindova & Courtney, 2020; Townsend et al., 2018). By doing so, this study will explicate under what environmental contingencies the lean approach achieves higher (or lower) product-market fit, making it more (or less) favorable than the comprehensive approach.

Overall, my theoretical framework reveals how the lean method functions (i.e., MVPs with adaptive methods) differently from a comprehensive product design and development method (i.e.,

WPSs with systematic analysis) and how the value of each of these methods is contingent upon different knowledge problems. First, the ways in which (i.e., uncertainty versus complexity) and the extent to which the entrepreneurial environment is changing are central variables for this study because these dynamic entrepreneurial environments have been found to shape yet challenge the emergence of entrepreneurial opportunities at the same time – which is called an opportunity-obstacle paradox. Second, the key advantages that each new product development approach offers are another primary focus because the benefits each approach enjoys are likely to address specific challenges (i.e., different types of knowledge problems) coming from the environmental conditions where new products are created and developed.

By following recent studies in the field of entrepreneurship that suggest that different decision strategies and logics are needed to tackle different types of ‘unknowingness’ (Townsend et al., 2018; Mitchell et al., 2020; Hunt, Townsend, Manocha & Simpson, 2023), I believe that the main benefits that each approach – lean versus comprehensive -- to new product development offers will shape product-market fit. I thus review and extend both the entrepreneurship literature on new product development approaches (e.g., Blank, 2003; Gans et al., 2019) and the knowledge problem framework (i.e., uncertainty versus complexity) recently proposed in the entrepreneurship context (Mitchell et al., 2020; Townsend et al., 2018). I then design the specific model using an NK-like simulation technique (Valente, 2014) -- one of the advancements in NK models (e.g., McKelvey, 1999; Siggelkow & Rivkin, 2006; Welter & Kim, 2018) that allows using ‘real-valued numbers’ to reflect more realistic decision-making processes. Overall, by first extending the ‘pseudo-NK’ simulation model (Valent, 2014) into entrepreneurship research, I directly test and examine the comparative effectiveness of different new product development strategies. Finally, I

posit the propositions based on the results from the simulated data, discussing the main contributions, limitations, and potential future research.

2.2. LITERATURE ON NEW PRODUCT DEVELOPMENT STRATEGY AND KNOWLEDGE PROBLEMS

Knowledge Problems as Contingencies and the Limits of Lean Methods

Ventures face numerous knowledge problems throughout the venturing process (McMullen & Shepherd, 2006; Sarasvathy, 2001; Rindova & Courtney, 2020; Townsend et al., 2018; Hunt et al., 2023). In recent entrepreneurship studies, a knowledge problem is defined as “an epistemological obstacle to strategic action that manifests in terms of the novelty being confronted along one or more dimensions of action, including what is being done, who is doing it, why they are doing it, and when, where, or how they are doing it.” (Townsend et al., 2018, p. 661). Townsend and colleagues (2018) conceptualize critical knowledge problems that can manifest within entrepreneurial decision environments as being comprised of, but not limited to, ambiguity, complexity, uncertainty, and equivocality. They suggest that each knowledge problem creates a unique challenge for entrepreneurs to take strategic action accordingly. Hence, each knowledge problem (e.g., uncertainty versus complexity) serves as a distinct boundary condition under which a new product development method (e.g., the lean startup) works differently.

Therefore, in this study, I shed light on the limits of the lean method and its boundary conditions, as the value of the lean startup method would be contingent upon the different magnitudes of two common knowledge problems in the entrepreneurship context -- complexity and uncertainty (Busenitz & Barney, 1997). Specifically, entrepreneurs rely on the lean method

because the speed advantage that this approach offers allows them to rapidly experiment, obtain feedback, and learn critical information/feedback directly coming from entrepreneurial environments and to *adapt* their new products (e.g., through iterative experimentations and pivoting) to match the environments they encounter quickly. However, at the same time, the lean approach can have a critical downside due to its tendency to perpetuate myopic decision-making. That is, the lean methodology has “its tendency to orient entrepreneurs towards ideas and products that can quickly and transparently be tested with customers” (Felin et al., 2019, p 3). Thus, several entrepreneurial strategy scholars have recently explored more comprehensive and systematic approaches to new product development (Agrawal et al., 2021; Camuffo et al., 2020; Chen, Wang, Cui, & Li, 2021; Gans & Stern, 2003; Gans et al., 2019; Ott and Eisenhardt, 2020; Packard and Clark, 2020; Zellweger & Zenger, 2021). For example, more comprehensive product designs (e.g., WPSs) would generate much more evidence than MVPs, making WPSs helpful in selecting and developing a future product that will likely satisfy potential mainstream customers despite its higher costs and slower process (More detailed explanations will be presented in the next sections).

Furthermore, the effectiveness of these product development methods changes depending on various knowledge problems (e.g., aleatory uncertainty and dynamic complexity) and the magnitudes (e.g., from low to high) entrepreneurs confront. However, a great deal of the existing entrepreneurship research has not measured any uncertainty at all. Studies that do measure uncertainty often incorrectly operationalize environmental uncertainty (i.e., aleatory uncertainty), conflating it with either epistemic uncertainty, environmental dynamism, or even complexity (Milliken, 1987; Packard and Clark, 2020; Townsend et al., 2018; Townsend et al., 2019). Within the entrepreneurship context, where entrepreneurs tend to be overconfident, a measure of aleatory uncertainty should be clearly discriminated from other contingency factors such as epistemic

uncertainty and complexity. Further, a robust indicator of aleatory uncertainty should also vary in degree (Townsend and Hunt, 2019). Hence, I use simulation models to address these issues by operationalizing aleatory uncertainty and complexity in a more robust and clear way.

Background Literature: A Behavioral Theory of the Firm and Entrepreneurial Decision-Making

A consensus within entrepreneurial decision-making literature is that there is no single best optimal path for entrepreneurs to pursue. Instead, entrepreneurs experiment with multiple decision paths through iterative entrepreneurial actions; some of the paths are often equivalent in value (Gans et al., 2019). At the same time, however, entrepreneurs -- bounded rational actors -- who have limited resources often commit to only a few alternative paths at a time (March, 1978; Simon, 1972; 1990). Hence, entrepreneurs attempt to formulate and implement an effective product development strategy in order to finally select only one (or a few) alternative(s) (e.g., potential new product candidates) each time (Gans et al., 2019; Ganco & Hoetker, 2009; Levinthal, 1997; Rivkin & Siggelkow, 2003; Schwenk, 1995) that they believe is likely to align well with the knowledge problems (e.g., uncertainty and complexity) they face throughout the business venturing process (Eisenhardt, & Zbaracki, 1992; Ott, Eisenhardt, & Bingham, 2017). Nonetheless, they are not able to accurately predict and know the future value of the alternatives *a priori*, mainly because the entrepreneurial environments under which they act themselves often are stochastically changing -- aleatory uncertainty -- and intricately interconnected -- dynamic complexity (Gans et al., 2019; Ching, Gans, & Stern, 2019; Rosenberg, 1994).

Knowledge Problems & New Product Development Tools

Knowledge Problems: Aleatory Uncertainty versus Dynamic Complexity

Dynamic environments in which entrepreneurs act are precursors to entrepreneurial opportunities that generate abnormal profits. More specifically, unpredictable random changes in the market -- aleatory uncertainty -- generate new possibilities for novel products and services (Knight, 1921; McMullen & Shepherd, 2006). Additionally, the number of opportunity contingencies and their interconnectedness -- dynamic complexity -- can also create new lucrative opportunities for entrepreneurs who create a group of products/services and their features that are sophisticatedly interconnected to align with these dynamically interconnected environmental factors (Davis, Eisenhardt, and Bingham, 2009). In other words, if an entrepreneurial firm can address these various contingencies of an entrepreneurial opportunity that manifest in environmental complexity, then the complexity of such environments can also actualize possible lucrative business opportunities. For instance, when the structure of an industry dramatically changes due to some expected or unexpected causes (e.g., exogenous shocks like the COVID-19 pandemic and the emergence of new technology (e.g., AI)) and when the market structures (e.g., numerous requirements from different institutions, the convergence between different knowledge domains, and so on) become so varied and highly interrelated that they require much more sophisticated products/services than before, entrepreneurs who can create a new set of products/services and their features that are sophisticatedly aligned with one another are more likely to capture the entrepreneurial opportunities.

To wit, aleatory uncertainty and dynamic complexity can serve as distinct environmental conditions where new entrepreneurial opportunities can be actualized (Townsend et al., 2018; Mitchell et al., 2020). In my model, aleatory uncertainty (e.g., objective environmental

uncertainty) refers to unpredictable random changes in the environment, whereas dynamic complexity refers to the multiplicity of entrepreneurial environment components (e.g., multiple opportunities and various features of an opportunity) and their dynamic interactions (e.g., interconnected contingencies of opportunities and interrelatedness of the features of an opportunity). At the same time, at the micro-level (i.e., actor-level), each of these dynamic environmental conditions also creates unique challenges that entrepreneurs should tackle in order to capture these opportunities.

New Product Development Methods

Hence, in order to tackle these opportunity-obstacle paradoxes, both practitioners and scholars have investigated and developed new product development tools that can employ to tackle different knowledge problems. One of the popular methods that have been developed to help address the opportunity-obstacle tensions is lean methodology. Lean methods utilize Minimal Viable Products (MVPs) by focusing on *deepening* and *adapting* the core feature of a new product (MVPs) to align well with the dynamically changing market (Black, 2013; Ries, 2011). The lean method's speed advantage provides entrepreneurs with ample time to conduct iterative product experimentations to rapidly update, pivot, and/or develop the focal products/services in response to the feedback and information directly obtained from some customers in the market. Specifically, lean startup methods allow entrepreneurs to test new product ideas very quickly by iteratively testing the prototypes, gaining customer feedback, and incrementally updating their product ideas to align with the dynamically changing environments.

However, a growing number of entrepreneurial strategy scholars have started to raise questions about the logic and effectiveness of the lean startup approach to entrepreneurship and to

develop various tools, methods, and frameworks that could be effective alternatives to the lean process (Agrawal, Gans, & Stern, 2021; Camuffo et al., 2020; Chen, Wang, Cui, & Li, 2021; Gans & Stern, 2003; Gans et al., 2019; Ott and Eisenhardt, 2020; Packard and Clark, 2020; Zellweger & Zenger, 2021). The main weakness of the lean method is its inherent tendency to direct entrepreneurs toward potential product concepts that are tested mainly with the immediate customers (e.g., early adopters), generating focused yet limited information on the product-market fit. That is, even though the lean startup enables entrepreneurs to test the new product concept(s) quickly and iteratively so that the potential new product(s) can swiftly adapt to the rapidly changing market, lean methods promote incremental discoveries, thereby aggravating its issue of myopic decision-making (Felin et al., 2019). Hence, the recently emerging novel approaches for new product development strategy suggest more rigorous and comprehensive methods (e.g., Gans et al., 2019; Gruber, MacMillan, & Thompson, 2008; McDonald & Gao, 2019) to cope with the tradeoffs between speed (e.g., rapid adaptation advantages) and comprehensiveness (e.g., informational advantages) in the new product development process. Specifically, startups could utilize more comprehensive product designs such as Whole Product Solutions (WPS) instead of MVPs for new product experimentations. Such product design strategies for product experimentation and development help generate much more robust evidence for the fitness level between potential customers and the new product(s) being developed. More specifically, more comprehensive product development strategies help explore and investigate a broader choice set of new technologies, product specifications, and/or customer segments before committing extensive resources for the new product experimentations, although it is likely that entrepreneurs cannot enjoy speed advantages when adopting these more comprehensive product development tools instead of lean methods.

However, this lean method's critical weakness could result in failures in capturing long-term opportunities. Although the lean methodology can quickly help deepen the focused feature of the new product/service being developed for rapid adaptation to the immediate potential customer feedback, it can also generate biases and errors in the information about the future mainstream customer market. That is, these biases and errors may ultimately lead the product development process in the wrong direction (Felin et al., 2019). In other words, the lean approach is likely to help quickly update their focal core product/service feature(s) to fit better with the immediate potential customer feedback in the short term, but the final destination may end up being too far from any sub-optima primarily due to the narrow scope of the lean startup process (cf. Billinger, Stieglitz, & Schumacher, 2014; Rivkin & Siggelkow, 2006). For example, if the initial available resources and experiences of a startup are situated within the particular product, and market domain(s) (e.g., the specific knowledge domains and/or the new product experimentations with only a few customer segments such as only a few early adopters who were already interested in the products entrepreneurs have been developing) that are innately difficult to fit within the future mainstream customer market (e.g., the future latent demand), the startups who heavily rely on the lean startup process are vulnerable to failure in the long run.

Therefore, a more comprehensive approach to new product development (e.g., WPS with systematic methods) can be a good alternative to the lean method. Although the more comprehensive approach may fail to discover early customers rapidly and to adapt the new product to their direct feedback quickly, this approach helps explore a broader choice set of product features, technologies, and market segments deliberately, offering informational advantages to enhance the ultimate product-market fit effectively despite its inherent slower process.

Taken together, there is a fundamental tradeoff between these two approaches: speed versus comprehensiveness. The lean approach prioritizes the iterative, rapid adaptation of the new product concepts (i.e., MVPs) in response to feedback, stimulating incremental or even myopic decisions that may end up relying on minimal information (e.g., feedback from a few early adopters). In contrast, the comprehensive approach prioritizes the systematic analysis of the whole product concepts (i.e., WPS) through consideration of a broader set of information on both focal markets (e.g., industries) and product features, promoting deliberate exploration of new possibilities that may produce slow decisions.

In short, each product development approach has its own advantages and disadvantages, which exposes the fundamental tradeoff between speed and comprehensiveness in the new product development process. And yet, there are also multiple combinations of environmental contingencies that could also affect the performance of these approaches simultaneously, leading to the key research question of this study:

What are the environmental boundary conditions of the lean method and the comprehensive method? Under what environmental contexts does the lean approach outperform the comprehensive approach and vice versa? What are the key environmental mechanisms behind these methods?

As noted in the previous section on knowledge problems, there are two environmental contingencies that entrepreneurs frequently encounter during the dynamic venturing process: environmental dynamic complexity and aleatory uncertainty (Bremner & Eisenhardt, 2022; Busenitz & Barney, 1997; Eisenhardt, 2013; Townsend et al., 2018). Specifically, the dynamic environments where entrepreneurs act create new possibilities for new products/services, yet the

environment generates an array of knowledge problems that entrepreneurs must address in order to capture value. Hence, both the extent to which the environment is complex (e.g., low, moderate, or high) and the choice of product development approach will simultaneously shape the degree of fitness between products and the market. If the environment becomes more complex, where its market structures (e.g., customer demand structures and institutions that exist for entrepreneurship) become diverse and interconnected, it will be more likely to demand a set of products whose elaborateness among a set of firm products and product features is high.

If the environment the ventures encounter is not aleatorily uncertain but only dynamically complex, a great deal of information about the future market (e.g., latent demand) is not necessarily inestimable. In this baseline model, whether the lean method is generally more (or less) effective than the comprehensive approach can be examined. Thus, I ask the following research question:

Question 1: Is the lean method more (or less) effective than the comprehensive method under environmental dynamic complexity?

Further, both aleatory uncertainty and dynamic complexity may often prevail simultaneously in the environment where entrepreneurs act (Bremner & Eisenhardt, 2022; Busenitz & Barney, 1997; Eisenhardt, 2013; Townsend et al., 2018). Aleatory uncertainty is distinct from environmental complexity in that the information about the future market (e.g., customer demand) becomes largely unpredictable under aleatory uncertainty but not necessarily under dynamic complexity. Thus, to address aleatory uncertainty, it is vital for entrepreneurs to quickly and iteratively obtain information and feedback from the experimentations in the rapidly changing market. However, accumulating such simple feedback does not necessarily help resolve dynamic complexity. The simple feedback data may even exacerbate complexity when these

additional data fail to help analyze the multiple factors of the market, the venture products, and their interconnectedness (Townsend et al., 2018). Instead, dynamic complexity is likely to be resolved if the information that entrepreneurs obtain is of adequately high quality to address multiple interacting issues.

Thus, the relative performance of the lean method compared with a more comprehensive product design would be contingent upon the various possible combinations of both dynamic complexity and aleatory uncertainty. For instance, if dynamic complexity is high yet aleatory uncertainty is low, then the effectiveness of any strategies in these conditions will be highly affected by dynamic complexity while minimally influenced by aleatory uncertainty. Therefore, in order to test this contingency model, it is essential to operationalize these knowledge problems as the constructs that vary in degree and thus that can measure the magnitude of each environmental condition, setting each environmental condition as a critical antecedent to the effectiveness (i.e., product-market fit) of each product development method as the relative effectiveness of these product development tools – lean versus comprehensive approach -- could differ depending on the levels of different combinations of environmental conditions (i.e., dynamic complexity and aleatory uncertainty). Thus, I raise the second research question:

Question 2: Is the lean method more (or less) effective than the comprehensive method when aleatory uncertainty increases? How do the various combinations of both the environmental dynamic complexity and aleatory uncertainty and the magnitude affect the relative performance of the lean method compared with the comprehensive approach to new product development? What are the key mechanisms of this differential performance in relation to these combinations of varying degrees of dynamic complexity and aleatory uncertainty?

2.3. ANALYTICAL MODEL

In the following sections, I describe how an NK-like model (Valente, 2014) is set in order to examine these research questions noted above. The main purpose of this study is to test and compare the effectiveness of the lean approach versus the more comprehensive approach to new product development, which is known to be shaped by the various combinations of environmental contexts (i.e., complexity, aleatory uncertainty, or both) and their magnitude.

Simulation methods (e.g., an NK model) are powerful for investigating my research questions because other possible models, such as empirical models (e.g., observational studies), do not allow measuring environmental conditions (e.g., aleatory uncertainty and dynamic complexity) and product-market fits in robust and clear ways (McKelvey, 1999; Siggelkow & Rivkin, 2005; Welter & Kim, 2018). These knowledge problems and the product-market fit can be modeled more effectively using NK landscape models. Moreover, simulation models allow operationalizing both firms' decision processes over a long period of time and the long-term evolution of the fitness levels of a set of firm products to the changing market conditions by generating simulated longitudinal data that is almost impossible for researchers to collect. Further, a set of products (i.e., micro-level agents) created and developed by a firm in the entrepreneurial environment where aleatory uncertainty and dynamic complexity can exist and even prevail are the actual agents that link to markets (i.e., the macro-level phenomena) in such agent-based models. Thus, simulation models such as an agent-based model (e.g., an NK model) offer good tools for computing how complex processes of the agents at a micro-level (i.e., a product feature decision made by entrepreneurs) that are aggregated at upper levels (i.e., the firm and the entire market) shape the performance of new product development strategies.

Even though a canonical NK model is a powerful tool for examining the effectiveness of decision strategies, however, this model is less suitable for addressing my research questions because each element of the vector of a firm can only take a binary value (either 0 or 1) in the canonical NK models. An NK-like simulation model (Valente, 2014), however, overcomes this limitation by allowing for real-valued numbers to be taken for each element of the vector, reflecting the reality of entrepreneurial decisions regarding products and their features.

Further, a canonical NK model suffers from a substantial computational burden when decision space is large (e.g., $N=16$) and any other complicated computations occur. An NK-like model, however, uses deterministic functions to reduce computational difficulty due to large decision space (e.g., a large N) so that multiple product development steps that require large computations can be modeled and tested. In an NK-like model, the users also can easily manipulate the landscape's overall shape so that the *a priori* unpredictable random change in the environment -- aleatory uncertainty -- can robustly be operationalized and measured. For these reasons, I use an NK-like model to address the research questions of this study.

Key Characteristics of NK Models

The applications of the NK simulation models to organizational studies are to examine the fitness level between the decisions of a group of agents and the decision landscape where agents make decisions and behave (Kauffman, 1993). The parameter N refers to the number of decisions/choices (e.g., decisions on the product features for a potential new product). Additionally, parameter K in the canonical NK models refers to the magnitude of environmental complexity in the decision landscape².

² In this study, the environmental complexity is modeled using parameter 'A', following the pseudo-NK model presented by Valente (2014)

Mapping the NK-like Model onto the Research Context: Model Characteristics

In my model, each venture has a total of four products, all of which reflect its business model (i.e., assuming that a set of firm products are interconnected). Each product has four product features that can mostly vary from 98 to 102 with an interval of 0.05 (following Valente's (2014) original modeling). That is, a firm is represented as a string of product decision dimensions (each firm has 16 product dimensions in total), and the value of each dimension normally ranges from 98 to 102. Thus, every four product features represent one product.

Such representation of a possible decision space on a product feature is impossible in a typical NK simulation model, which uses only binary values. An NK-like model, however, uses real-valued numbers to indicate the specific value of each product feature instead of just using either 0 or 1. In my pseudo-NK model, every venture has sixteen (16) product features ($N=16$), and thus four (4) products in total; every four consecutive product features constitute one product. For example, each firm has a capacity of 16 product features (98.05, 98.9, 100, 101.1, 109.85, 101.95), and the first four consecutive product features (i.e., 98.05, 98.90, 100, 101.1) represent the specifications of the first product in a certain period, such as $T=2$.

Every time each firm conducts product experiments with either the lean method (i.e., MVP) or comprehensive method (i.e., WPS), a firm updates the current value (at $T=t$) of the focal product feature(s) to the value of the focal new product feature(s) that is expected to produce a higher performance in the next period (at $T=t+1$). For instance, the first consecutive four product features in the third period (i.e., **98.05**, 98.90, 100, 101.1 at $T=2$) will be updated to (i.e., **98.10**, 98.90, 100, 101.1 at $T=3$) in the following period if this iterative development on the core dimension of the product is expected to produce a higher fitness level. If the expected update on the focal feature(s) is not expected to produce a higher product-market fit, then all vector elements of the firm product

feature(s), including the value of the focal feature(s), will remain the same in the next period (i.e., **98.05, 98.90, 100, 101.1** at $T=3$).

Additionally, I limit the degree of radical changes in the product development. That is, each product feature can move by either +0.05 or -0.05 per period in the entire model for this study (regardless of which type of product development tool is used) unless the entrepreneurs decide to use prior experiential knowledge (e.g., the accumulated stock of knowledge in the industry). In this study, it is assumed that each product feature can be updated by one step ($\Delta=0.05$) only in either direction (i.e., + or -) because of the bounded rationality of entrepreneurs. However, NK-like methods enable us to model more realistic agent behaviors by allowing the agents to move beyond the delta ($=0.05$)³ if they believe they encounter opportunities (i.e., the core product values that are the same as its experiential knowledge the firm already experienced in previous decision rounds (i.e., one of the prior sets of the focal product feature values, representing accumulated stock of knowledge in the market)) when they take the lean approach.

Second, as a traditional NK model does, an NK-like model also maps a set of product dimensions that are assumed to make up of a firm (i.e., a business model) onto product-market fit by drawing a random value from the uniform distribution, $u[0,1]$. That is, such product-market fit is randomly assigned to each firm that is assumed to be comprised of four products before the firm initiates the product development process. As a firm continues to refine its new product for its higher product-market fit, its fitness level tends to increase over time. However, unlike a canonical NK model, complexity in NK-like models is measured by “A,” which varies from 0.1 to 0.9. In my model, “A” represents the intensity of interconnectedness among 16 vector elements of products in the market. Hence, my model assumes that all the ventures are working in a dynamic

³ Please note that every interval of the possible values in this space is still set to 0.05.

environment, and they will equally be challenged by the intensity of interconnectedness that is held constant in each market. Thus, the intensity of interconnectedness is varied across different markets.

Modeling Performance: Product-Market Fit

NK-like methods model a venture performance by a product-market fitness level that reflects the degree to which a set of products the venture develops meets the multiple yet interconnected needs (e.g., multiple complicated standards demanded by the market) that are held constant at the market level. Therefore, the dynamism and complexity of the market vary at the market level in my model. An effective new product development strategy under these conditions requires more interconnected products (and thus a more elaborate business model -- a set of products that are closely and highly interrelated -- high alignment among their products and their features being developed) in order for ventures to increase product-market fit effectively.

Modeling Product Development Costs

In addition, I further limit the total amount of product development periods (i.e., decision rounds) to each type of new product strategy by accounting for the variable product development costs each strategy requires. One of the primary advantages of lean methods is that product experimentation is conducted rapidly and inexpensively by using minimal viable products. On the other hand, the resource expenditure of more systematic approaches outlined in the entrepreneurial strategy literature is assumed to be higher. To model these differences, the total product development periods are set to either 100 (for the lean approach) or 50 (for the comprehensive approach) in order to reflect these varying degrees of resource constraints. Specifically, the firms

that take a comprehensive approach are assumed to have much fewer product development opportunities (i.e., its total periods = 50) than those that use the lean method (i.e., its total product development period is set to 100). In other words, under the assumption that every firm has the same amount of capital, the firms that use the lean method will have much more opportunities to experiment with their products until they exhaust all the resources (e.g., capital) than those that take the comprehensive approach.

More specifically, I draw on both ‘learning curve theory’ and ‘the number of focal products developed at a time’ to determine the product development expenditures and the product development opportunities (i.e., decision rounds) allocated for each new product development method – the lean versus the comprehensive approach. Previous research on the learning curve indicates that intensive learning or the repetition of certain work (i.e., routinized work) will reduce the amount of time needed for that work. In my models, a 70% learning curve is assumed as a common baseline condition for all agents (i.e., a 70% learning curve means that a 30% decrease in time needed for the search of a single product development each time the number of intensive learning/repetitions (e.g., the number of focal product features searched for in my models) is doubled). This indicates that the time needed for either the comprehensive method that develops only one product (i.e., a total of four product features that make up one product) or the lean method that develops a total of four core product features (i.e., one core product feature per product simultaneously) will decrease about 49% ($=100*(7/10)*(7/10)$) on average, under the assumption of 70% learning curve. Hence, it follows that the firms that employ the new product development methods to develop a total of four product features simultaneously at a time⁴ are able to search for

⁴ Either the comprehensive method that develops only one product (i.e., a total of four product features that make up one product) or the lean method that develops a total of four core product features (i.e., one core product feature per product simultaneously) in my models.

about 50 periods (instead of 25 periods) if the firms that use the lean method to develop one core product feature at a time will be able to search for about 100 periods (i.e., decision rounds), *ceteris paribus* (e.g., a total amount of capital available for each agent is the same across all the agents)⁵. Hence, the following comparative product development cost function is developed: comparative product development cost = \sqrt{P} (where P is the number of focal product features developed in each decision round).

Accounting for Agent Search Behavior

Since N=16 with four products is used in this study, four product features constitute one product. Recent studies in the entrepreneurial strategy literature contend that lean methods tend to utilize incremental myopic search, whereas the comprehensive methods suggested by entrepreneurial strategy scholars enable entrepreneurs to search for broader product features in each decision round. Hence, I set fewer focal product features developed in each decision round (P) for lean methods (i.e., P=1, 4) than comprehensive methods (i.e., P=4, 8). Thus, the total product development cost ratio of (the lean method that develops one product feature only): (the lean method that develops one core product feature per product -- a total of four core product features): (the comprehensive method that develops one product only -- a total of four product features that make up one product) : (the comprehensive method that develops two focal products (i.e., a total of eight product features that make up two products)) becomes $\sqrt{1} : \sqrt{4} : \sqrt{4} : \sqrt{8} = 1 : 2 : 2 : 2\sqrt{2}$. Accordingly, this indicates that approximately 100: 50: 50: 35 total decision rounds should be allocated for each new product development approach, based on the 70% learning curve.

⁵ In addition, it also follows that, in the same logic, the firms that implement the comprehensive methods to develop two (i.e., multiple) products (i.e., a total of 8 focal product features at a time) will be able to search for about a total of 35 periods ($\approx 100 * (7/10)^3 = 34.3$).

But the propositions in this study compare two methods (the lean versus the comprehensive methods) with the others being covariates (e.g., the number of focal product features developed at a time), the ratio of total decision rounds between the lean methods versus the comprehensive methods finally becomes $(100+50):(50+35) = 150:85 \approx 100:50$. Hence, if 100 decision rounds are allocated for the lean method, then approximately 50 decision rounds should be allocated for the comprehensive methods in my models. Overall, the specific parameters of this model explained thus far are summarized in Table 2-1.

Modeling the Environments: Complexity versus Aleatory Uncertainty

As previous studies conflate dynamic complexity with aleatory uncertainty and fail to objectively and clearly measure both dynamic complexity and aleatory uncertainty, the key premise of this study is to examine the distinct role of these two knowledge problems in shaping the effectiveness of different product development tools in entrepreneurship. In my models, dynamic complexity (Parameter A) is measured as the intensity of interrelatedness (Simon, 1969; Gavetti & Levinthal, 2000) regarding the product design standards that impose on firms, as described above. Parameter A can vary from 0.1 to 0.9, where 0.1 indicates low complexity, 0.5 moderate complexity, and 0.9 high complexity.

In addition, following recent studies (Packard & Clark, 2020), aleatory uncertainty is operationalized as the environmental shocks that randomly change the entire landscape by using the stochastic function to change all the ‘peaks and valleys’ of the landscapes. Hence, the magnitude of aleatory uncertainty is measured by how often the environmental shocks exist over time. Specifically, if there are environmental shocks every period, the landscape is completely random. In this situation, aleatory uncertainty is measured as extremely high. If the environmental

shocks occur every 25th period, it is termed ‘low’ aleatory uncertainty. In other words, how often the entire landscape randomly changes represents the degree to which the environment is aleatorily uncertain. Since the user can determine the overall shape in a pseudo-NK simulation model, including its global maximum, by changing the optimal positions of the landscape, I made the overall shape of the landscape randomly change by specifying the times when the optimal positions stochastically change. The parameter P is used to indicate the level of aleatory uncertainty by specifying every Pth period when the entire landscape stochastically changes. Please note that the lower P, the higher aleatory uncertainty, while the higher P, the lower aleatory uncertainty, and the initial optimal position of the first landscape is set to a vector with 16 strings of 100.00 (i.e., 100.00, 100.00,....., 100.00) following the original model developed by Valente (2014).

Modeling Product Development Strategies: Lean Methods

In each environmental condition, the entrepreneurs of a firm must make a strategic decision regarding the development of the new product(s) every period iteratively. N reflects the entire decision space of the full product features. However, every four product features are nested within a product in the model because one product consists of several feature dimensions (i.e., four product features per product in this study). Each product development approach (i.e., the lean vs. the comprehensive method) differs in limiting the decision space for the development of a new product. Specifically, the lean method only considers a single core product feature per product of interest. Although my model assumes that firms may choose to focus on either multiple focal products simultaneously (i.e., the total of four focal products each time) or a single focal product (i.e., only one product) per each period, the firms that employ the lean method will choose only one core product feature per product (i.e., an MVP) to experiment and update.

Firms employing this approach will continue to update the core product feature(s), considering one step (the delta (=0.05)) in either direction (+ 0.05 or -0.05) at a time unless they encounter a situation that resembles their current experiential knowledge (i.e., the accumulated stock of knowledge that exists in the industry where entrepreneurs act). That is, if the chosen decision path regarding the new product designs (i.e., the possible value of the core product feature(s) of interest) is not equivalent to one set of their experiential knowledge, the entrepreneurs will create a new version (i.e., either choosing +0.05 or -0.05) of a product that updates one focal core product feature only per focal product, leaving all of the other product features in the same position in the background and obtaining the expected fitness level(s) after testing them and collecting the feedback. Suppose the updated version gives a better fitness level; in this case, the firm will choose to revise the core product feature(s) of interest (also known as the adaptive decision-making process).

This procedure is similar to a local search in a canonical NK model, except that the vector element can have a real-valued number with an interval of 0.05 (i.e., Delta) and except that the entire vector elements will be changed if a firm encounters the situation that matches with the experiential knowledge (i.e., the accumulated stock of knowledge in the market) at that point. Additionally, firms can update multiple decision vector elements at once when they choose to develop multiple MVPs simultaneously (i.e., the total of four core product features) every period. For instance, the current set of product features of a focal product such as (98.00, **98.75**, 101.40, 99.50) will be updated to (98.00, **98.80**, 101.40, 99.50) if a firm with the updated core feature is expected to produce better market-product fit than the previous one.

However, if the next possible product paths (i.e., the value(s) of the core product configurations (i.e., a set of product features) of a firm for the upcoming experimentation in my

simulation model) that is chosen for the experimentation (e.g., the specifications of a product for the upcoming experimentation) are matched with any set of the prior experiential knowledge, then the radical pivoting of entire product design will happen. For instance, let's assume that the current position of a focal product is (98.00, **98.80**, 101.40, 99.50) and that the firm selects the next possible product design to be experimented with as (98.00, **98.75**, 101.40, 99.50). In this situation, if entrepreneurs realize that the value of the next possible focal product feature chosen for the product experimentation (i.e., (98.00, **98.75**, 101.40, 99.50) in this example) happens to be the same as any sets of experiential knowledge (i.e., more empirical evidence) the firm can access at that point, they might change the entire business model (i.e., the entire vector of the product designs) that is recommended by experiential knowledge the firm was able to access. For instance, let's assume prior experiential knowledge of the following two product designs exist: (99.00, **98.75**, 100.20, 100.00) and (98.45, **98.75**, 99.40, 101.60). Since the next possible update of the focal core product feature for the upcoming experimentation (e.g., **98.75**, the second feature of the focal product) is the same as any sets of prior experiential knowledge (i.e., any vectors with the second dimension of the focal product equals to 98.75), the firm will pivot to change the entire business model (i.e., an entire set of four products) to the same position that produces the highest fitness level guided by the experiential knowledge in the market (i.e., the highest product-market fit according to the accumulated stock of knowledge). For the example above, the firm with a focal product of (98.00, **98.75**, 101.40, 99.50) will be updated to the position either (99.00, **98.75**, 100.20, 100.00) or (98.45, **98.75**, 99.40, 101.60) with a higher expected product-market fitness level if both of them produce higher product-market fit than the fitness level of the current position [i.e., (98.00, **98.75**, 101.40, 99.50)]. Please note that the other background features will also change

according to the positions that the experiential knowledge (i.e., the accumulated stock of knowledge in the market) indicates.

Modeling Product Development Strategies: Comprehensive Methods

Compared with the lean method, my study models a more comprehensive method to product development in the following way. First, the possible new product design for the experimentation is essentially either full (i.e., the complete product features that constitute a whole product solution (WPS) or partial (i.e., the core product feature of a product). A clear alternative to an MVP, which the lean methods employ, a WPS design is chosen as a critical dimension of the comprehensive product development strategy. More specifically, this comprehensive product development strategy systematically considers and analyzes the entire focal product features (i.e., all four product features) that constitute each product, a WPS, rather than just one core product feature, an MVP, for each experimentation before pursuing a renewed product solution.

Of course, startups that take this comprehensive approach can develop either only one single product (i.e., all the four product features of one focal product) or multiple products [it is assumed that it is possible to develop up to two products (i.e., either one or two products) simultaneously⁶] at a time. Hence, a total of either four product features (of one focal single product) or eight product features (of two focal products) can be developed per period. Firms employing the comprehensive method will search over the entire product features that constitute the chosen product(s), either one or two products.

⁶ I assume that up to two products (i.e., a total of eight product features that constitute two WPSs) can be updated each period to be tested for the comprehensive method due to the bounded rationality of actors and due to the limited resource assumptions. For the lean method, up to a total of four core product features (i.e., a total of four products but with MVP designs) can be updated each period to be tested. But the respective resource constraints are reflected and controlled in the model.

Additionally, emerging entrepreneurial strategy studies view the new product identification process as selecting one (or a few) option(s) out of ‘a set of possible choices’ as a good alternative to the simple experimentation methods (e.g., the lean method, trial-and-error, etc.); this process is also called ‘fixing’ from the pragmatist perspectives (Gans et al., 2019; Smith 1978; Zellweger & Zenger, 2021). Specifically, they argue that entrepreneurs can be deliberate decision-makers (e.g., acting like scientists) who develop theories and relevant hypotheses, validate them, and conduct experiments to improve the product-market fit. Deliberately formulating and framing the problem faced by entrepreneurs to identify suitable tools (e.g., theories) would require a comprehensive exploration of a set of possible choices (e.g., theories and ideas regarding new products) worth pursuing. Gans and colleagues (2019) also explain the foundation of an entrepreneurial strategy formulation process, stating that entrepreneurs with a more systematic approach will first analyze a broad set of possible future paths (e.g., a group of possible ideas) regarding the new product development and then remove the paths that are estimated to generate low values (Ellsberg, 1961; Gans et al., 2019; Savage, 1954). Further, they point out that the value of new product ideas will only be roughly estimated due to the high noise in the entrepreneurial environments, often generating equivalent rough estimates (Gans et al., 2019).

Building on this approach, I assume that every rough estimate of product-market fitness level (before each experimentation) calculated by this comprehensive method will be rounded to the nearest 1,000th, producing multiple equivalent product-market fit estimates. Additionally, my model assumes that, due to the bounded rationality of actors and the resource availability (e.g., financial constraints, technologies available in the market), the firms with this comprehensive product development strategy can systematically explore only half of the possible combinations of the focal product features by updating each product feature by only one step [i.e., ‘delta’ parameter

(either + 0.05 or -0.05)] each period. Since each focal product feature has only two possible update options (i.e., either + 0.05 or -0.05) per each product development period before choosing one set of firm products for the upcoming experimentation⁷, either $\frac{2^4}{2}$ (=8, when a firm decides to develop one single product⁸ at a time) or $\frac{2^8}{2}$ combinations (=32 combinations, when a firm chooses to develop two products at a time) of the product feature update options (i.e., half of the possible configurations of the focal product features) are explored. Thus, their product-market fitness level is roughly estimated, generating a smaller pool of product configurations that share the same yet relatively high fitness estimates after eliminating some product configuration options with relatively low fit estimates.

I also assume that all agents are bounded to resource and cognitive constraints, making it impossible to navigate the entire decision space (e.g., the entire possibilities of the new product ideas) with accurate predictions. Thus, after obtaining the rough estimates of the product-market fitness of some (e.g., half) of the potential product candidates and thus narrowing the potential possible decision space down to a smaller pool of the future product alternatives that share the equivalent product-market fitness level, ventures will then choose the first product candidate they encounter (from this smaller set of potential product choices) to create the updated product design for the experimentation and to actually test it in the market each period in my model (Gans et al.,

⁷ In my model, it is assumed that only one step (i.e., Delta =0.05) update per each focal product is possible per each period for both the lean and the comprehensive approach. Firms that use WPS designs can possibly update either one (i.e., consisting of four product features) or two products (i.e., consisting of eight product features) for experimentation per each period. Additionally, firms that use MVPs can possibly update either one or four core product features (i.e., one core feature per product) for experimentation per period. Firms that use the comprehensive method systematically explore some of the possible product configurations before each experiment.

⁸ Since four product features constitute one product and each product feature has two options to choose one from each period in my model, there are a total of 2^4 (=16) possible combinations for the configurations (i.e., specific product designs) of one product for the experimentation per each period. But it is also assumed that entrepreneurs can explore only half of the entire decision space (i.e., the possible product configurations) regarding the product development due to the bounded rationality of entrepreneurs; thus 2^4 (=16) will be divided by 2, resulting 8 product configuration (i.e., design) options to choose one from for the actual experimentation per each period.

2019). After the experiment with the final chosen product design (i.e., the specific configurations) in the market, the firm will gain the actual fitness level of a firm, not just rough fit estimates, between the set of venture products (i.e., the business model of a venture) and the market each period, directing them to move forward with iterative experimentations.

2.4. RESULTS & IMPLICATIONS

With the simulation model described so far, I conduct the NK-like simulation following Valente's original model (2014), and its specific procedure is as follows: First, given N , Δ , A (i.e., dynamic complexity), and P (i.e., aleatory uncertainty), the starting position of each firm is seeded with random values of a set of product features. Second, every 100 firms as a cohort start to develop their products by employing the assigned product development tools (i.e., the lean vs. the comprehensive method) until its total development opportunities (i.e., total periods) are permitted (i.e., either 50 for the comprehensive approach or 100 for the lean approach), and the change in fitness levels is continuously recorded over time. Lastly, these processes are repeated for the 40 different values of the critical combinations of A (i.e., dynamic complexity) and P (i.e., aleatory uncertainty). For the final results, I run the simulation 1,000 times for each set of parameters, which totals up to 100,000 data points of the firm performance each period per unique environment condition, guaranteeing more than 99% statistical significance for the mean estimates. I then observe and analyze how the averaged fitness levels (across 100,000 data points) of each product development method change over time (either 50 or 100 periods) across 40 different environmental conditions (i.e., five environment conditions where there is only

complexity (i.e., 0.1, 0.3, 0.5, 0.7, and 0.9) and the rest of the environmental conditions where both complexity and uncertainty exist at the same time).

As noted earlier, I use this pseudo-NK modeling of dynamic complexity and aleatory uncertainty, under which two product development tools can be employed to test and compare the product-market fit of these product development tools. My analysis in this study focuses on comparing the performances (i.e., product-market fit) of the lean and the comprehensive product development method. The first set of analyses is conducted under varying degrees (5 different levels in total) of dynamic complexity only where no aleatory uncertainty exists. The second set of analyses brings aleatory uncertainty into the model in addition to dynamic complexity for the environmental conditions. Hence, there are multiple combinations (i.e., 35) of varying levels of dynamic complexity and aleatory uncertainty in the second set of analyses.

This second set of analyses explores how the multiple combinations of different levels of complexity and aleatory uncertainty change the relative performances of the lean and the comprehensive product development approach. For every simulation, there are a total of 100 firms that implement the same product development tool, and each firm makes decisions on 16 product features that constitute four products (i.e., each four product features are comprised of one product) and is simulated for either 100 or 50 periods depending on the total costs of the product development tool chosen by firms on 1,000 landscapes (i.e., the number of iterations). Additionally, such analysis is done for every combination of environmental conditions and types of new product development methods, which will be summed up to generate the final results.

Simulation Results: Final Product-Market Fit

One of the key questions in both lean startup and entrepreneurial strategy literature is the total performance (i.e., product-market fit) of each product development method. In the first set of the analysis, I analyze the total performance of each method by computing the average final total product-market fitness level of each approach.

Figure 2-1 reports the averaged (across all the 100,000 firms per product development tool) fitness levels attained at the last product development period (i.e., decision round) by the firms with the lean approach (the final period=100) and the comprehensive approach (the final period=50) in the baseline model where no aleatory uncertainty exists. The solid red lines denote the average product-market fitness levels attained by the use of the lean product development method. The dashed green lines denote the average product-market fitness level produced from the comprehensive product development method. Black vertical lines denote 95% confidence intervals for each mean estimate.

Figure 2-1 indicates that the final product-market fitness of the comprehensive product development method (the final period=50) is found to be consistently higher than that of the lean method (the final period=100) in complex environments. Additionally, as the dynamic complexity increases, the final product-market fit of the comprehensive approach (the final period=50) tends to increase, whereas the final product-market fit of the lean approach (the final period=100) tends to decrease. All of these results indicate that the recent strategic recommendations in entrepreneurial strategy literature that suggest adopting more comprehensive product development methods are generally more effective than the lean method when the market is complex. Further, the results also suggest that the comprehensive approach becomes stronger while the lean approach becomes weaker as dynamic environmental complexity increases. In other words, the

comprehensive approach handles the knowledge problem of complexity much more effectively than the lean method. The lean methods tend to be more vulnerable to a high degree of complexity than the comprehensive methods.

This simulation result is consistent with the recent theoretical development of both the lean method and entrepreneurial strategy (e.g., Felin et al., 2019; Gans et al., 2019). As the lean method focus more on quick experiments to obtain feedback and then updates the products being developed to match the received feedback, the use of this method can clearly perpetuate myopic decisions. Therefore, the lean approach is likely to be weak in dealing with dynamic complexity. The comprehensive approach, on the other hand, is more likely to be strong in dealing with complexity, as the comprehensive method makes efforts to consider broader sets of possible product configurations as a whole. Furthermore, the market where no aleatory uncertainty is present indicates that the information about the future market is not necessarily unpredictable. Since there will be much less randomness in this environment where there is no aleatory uncertainty than in the uncertain environment, the estimates that the more systematic approach to new product development generates tend to be accurate with low biases. Hence, the following proposition has been drawn:

Proposition 1: In the environments that are characterized by high levels of complexity, firms that use the comprehensive product development method will outperform those that use the lean method, and such differential performance becomes larger as complexity increases.

Simulation Results: Speed to Product-Market Fit

A relevant key question in both the lean startup and entrepreneurial strategy literature centers on how quickly each method attains its optimal product-market fit. Hence, I analyze the

temporal advantages of each method by computing the average product-market fit level of each approach at each decision stage.

Figures 2-2, 2-3, and 2-4 report the overall trends of the fitness levels of the lean method and the comprehensive method over its designated product development periods. These figures demonstrate that each product-market fitness has a clear pattern of change depending on the varying degree of complexity. As noted in the previous sections, the product development cost differences in implementing each product development method are reflected. The comprehensive product development strategy requires more time and resources to test the product than the lean method. Hence, I account for the cost differences by reducing the number of product development periods for the comprehensive product development approach (i.e., Total development periods = 50) versus the lean method (i.e., Total development periods = 100).

As figures 2-2, 2-3, and 2-4 show, the effectiveness of both the comprehensive and lean methods tends to increase as complexity increases. However, the increasing rate of the comprehensive approach before it reaches its peak is lower than that of the lean approach. The lean method is quicker at achieving its optimal product-market fit than the comprehensive method. However, the final product-market fitness level of the firms that employ the comprehensive approach is clearly higher than that of the lean approach. These results illustrate that the comprehensive method is ultimately more effective than the lean method but slower than the lean method. Nevertheless, the speed advantages of the lean method are clearly offset. That is, in the long run, the comprehensive approach is systematically much more effective than the lean method. This set of results is meaningful because the firms with the lean method might often fail to find and satisfy future mainstream customers because early adopters from which the firms often get feedback cannot be representative of prospective mainstream customers.

Additionally, even after strictly taking into account the cost differences between the lean method and the comprehensive strategy I described in the previous section ('analytical model') and the operationalization of cost difference as the number of product development periods allowed for each method to interpret the results, the results still suggest that the comprehensive approach is ultimately more productive than the lean method. Specifically, according to figures 2-2, 2-3, and 2-4, the product-market fitness levels of the lean method become lower than those of the comprehensive approach before they reach the 20th period. This suggests that the lean method achieves lower product-market fit than the comprehensive method does under conditions of complexity unless the product development cost of the lean method per period is lower than $\frac{1}{5}$ of that of the comprehensive method. To wit, firms with the comprehensive method will clearly achieve a higher average product-market fitness level than the lean method ultimately, while the lean method is quicker at attaining a good-enough product-market fit.

This simulation result is also consistent with the academic understanding of both the lean method and the recent entrepreneurial strategy studies that are emerging (e.g., Felin et al., 2019; Gans et al., 2019; Zellweger & Zenger, 2021). Although entrepreneurial strategy scholars acknowledge the speed advantages of a simple experimentation approach that leverages learning-by-doing (e.g., the lean method, trial-and-error, bricolage, etc.), they have recently advanced alternative strategies that employ more systematic methods because the lean method can lead to poor performance due to myopic decisions. A more deliberate approach to new product experimentation has thus been suggested to increase product-market fit (e.g., Zellweger & Zenger, 2021). Hence,

Proposition 2: In the environments that are characterized by high levels of complexity, firms that use the lean method are quicker in generating product-market fit than the comprehensive

method, but these speed advantages are offset by systematically lower levels of product-market fit than firms that use the comprehensive product development method. Overall, under complexity where no aleatory uncertainty exists, the comprehensive method is systematically more effective than the lean method in the long run.

Simulation Results: Total Product-Market Fit under Conditions of Aleatory Uncertainty

In the following paragraphs, I analyze the extent to which increasing degrees of aleatory uncertainty – defined as stochastic randomness in the environment – shape the total performance (i.e., product-market fit) of these new product development methods.

Figure 2-5 provides information on the performance change of each product development method (i.e., the lean versus the comprehensive method) that is affected by the magnitude of dynamic complexity, while every level of aleatory uncertainty exists as a covariate, which varies from 30 (very low) to 1 (very high). Figure 2-6 reports the performance trend of each product development tool, which is influenced by the degree of aleatory uncertainty, while every level of dynamic complexity exists as a covariate, which varies from 0.1 (low) to 0.9 (high). As both figures 2-5 and 2-6 report, neither the lean method nor the comprehensive method clearly generates a relatively higher product-market fit as the level of aleatory uncertainty increases. Although figure 2-6 suggests that the level of aleatory uncertainty may affect the differential performance between the lean and the comprehensive method, the overlapping confidence intervals of the mean fit estimates between the two methods indicate that there are no performance advantages to either of the two methods, even though the lean startup advocates who assert that lean methods generate better performance than deliberate methods under conditions of uncertainty. Compared with the complexity-only environment, however, the performance gap between the lean and the

comprehensive approach tends to become much smaller or even converged to zero as aleatory uncertainty increases. Clearly, the positive relationship between complexity and the performance of the comprehensive method no longer exists once aleatory uncertainty becomes present. Instead, as figure 2-6 shows, there is a negative relationship between complexity and the performance of the comprehensive method when aleatory uncertainty increases. Hence, the following proposition is posited:

Proposition 3: In the environments that are characterized by increasing levels of aleatory uncertainty, neither the lean method nor the comprehensive method clearly produces a relatively higher product-market fit.

Researchers who advocate for the lean method argue that the lean method is more effective than slow yet deliberate methods in dealing with uncertainty because the adaptive actions the lean method is based on will quickly gain the recent market information and feedback to update their products to increase their fitness to the market (e.g., Bocken and Snihur, 2020; Ries, 2011). On the other hand, scholars who recommend deliberate, systematic approaches to new product development assert that more scientific approaches achieve higher product-market fit than the lean method because more scientific approaches will help entrepreneurs overcome cognitive biases and errors due to the informational advantages, which will be very useful in dealing with uncertainty (e.g., Felin et al., 2019; Zellweger & Zenger, 2021). And yet, my simulation results demonstrate that neither the lean method nor the comprehensive method generates higher mean estimates. Furthermore, the results also suggest that there is a fundamental tradeoff between the speed advantage that the lean approach (i.e., MVP with adaptive search) can offer versus the information advantage that the comprehensive product development approach provides (i.e., WPS with

systematic methods), leading to an equivalent performance between these two approaches dealing with both uncertainty and complexity simultaneously.

Nevertheless, existing literature on both entrepreneurial strategy and lean startups is less clear about the key environmental mechanisms for which each new product development method work. Additionally, identifying key environmental mechanisms for both methods will be helpful in dealing with such tradeoffs noted above. Hence, using my simulation results, I try to identify and theorize the key environmental mechanisms and the boundary conditions of these two methods.

Given that the positive relationship between the comprehensive method and the performance under conditions of complexity changes (according to figure 2-1) into a negative relationship (according to figures 2-5, 2-6, 2-7, and 2-8), whereas the negative relationship between the lean method and the performance under conditions of complexity remains once aleatory uncertainty kicks in (according to figures 2-1, 2-5, 2-6, 2-7 and 2-8), it can be inferred that aleatory uncertainty would have a greater negative impact on the effectiveness of the comprehensive method than that of the lean method. Furthermore, the results presented in figures 2-9, 2-10, 2-11, 2-12, 2-13, 2-14, and 2-15 demonstrate that the performance of the comprehensive method tends to become higher than those of the lean method as complexity becomes higher yet aleatory uncertainty becomes lower. In contrast, the performance of the lean method tends to become higher than that of the comprehensive method when complexity becomes lower yet aleatory uncertainty becomes higher.

Figures 2-9, 2-10, 2-11, 2-12, 2-13, 2-14, and 2-15 explore the mean fitness levels of the lean approach and the comprehensive approach over the designated product development periods, whose general trends shift depending on the various combination of the critical levels of both

dynamic complexity (i.e., low and high) and aleatory uncertainty (i.e., low, moderate, high, and very high). As the overarching trends that these figures verify, aleatory uncertainty serves as a moderator for the performance gap between the comprehensive and lean methods. Moreover, according to figures 2-1, 2-5, 2-6, 2-7, and 2-8, a positive relationship between the comprehensive method and the performance under dynamic complexity changes into a negative relationship after aleatory uncertainty kicks in. In other words, in environments where both aleatory uncertainty and complexity simultaneously exist, *ceteris paribus*, the higher the aleatory uncertainty, the lower the product-market fitness levels of both methods. Therefore, it follows that the environmental contingent factors such as aleatory uncertainty and its degree might have significantly influenced the relative performance between the lean and the comprehensive approach to new product development.

Specifically, the simulation results show that there are several threshold points of aleatory uncertainty that reverse the sign of this performance gap. According to the results, when the aleatory uncertainty is lower than or equal to the moderate level ($P \geq 15$, note that the higher P, the lower aleatory uncertainty in the model of this study), the comprehensive method is generally more effective than the lean method, but the lean method becomes more effective than the comprehensive method when the aleatory uncertainty is around the high level ($1 < P < 5$, please note that the lower P, the higher aleatory uncertainty in the model of this study) if complexity is below the moderate level ($A \leq 0.5$).

By implication, these results also clearly illustrate that the lean method emphasizes adaptive behaviors that are often incremental, which helps entrepreneurs to quickly adjust to the changing market that is aleatory uncertain (i.e., *deepen* and *adjust* the new product being developed), while the comprehensive method puts emphasis on deliberate and comprehensive

processes (i.e., *broaden* the possibility sets and then *remove* some unpromising new product candidates) which would help to integratively take into account multiple possibilities/contingencies that emerge in the environment -- dynamic complexity (Felin et al., 2019; Gans et al., 2019). Taking both simulation results and theoretical reasoning altogether, I posit the following proposition that identifies the key environmental mechanism behind the performance of each method:

Proposition 4: The comprehensive method is weaker in tackling aleatory uncertainty than the lean method, whereas the lean method is weaker in resolving complexity than the comprehensive method.

2.5. DISCUSSION & CONCLUSION

In this paper, I theorize, examine, and compare the effectiveness of two different product design and development methods -- the lean method versus the comprehensive method, which could simultaneously be influenced by both complexity and aleatory uncertainty and their varying degrees. Although recent entrepreneurial strategy scholars have studied how different entrepreneurial strategies might be carefully and scientifically formulated and implemented instead of simple experimentation tools such as the lean startup, little attention has been given to testing and theorizing the comparative performance (i.e., product-market fitness levels) of these two product development tools. Thus, this study is the first to test and compare the product-market fitness level that can be achieved with these new product development methods by theorizing the nuanced contingent effect of multiple knowledge problems -- dynamic complexity and aleatory uncertainty -- that are robustly measured in an NK-like simulation model.

In recent years, the lean method has gained popularity due to its flexibility and speed advantage for new product experimentation that enables entrepreneurs to quickly obtain customer feedback (Blank, 2013; Contigiani & Levinthal, 2019; Leatherbee & Katila, 2020; Ries, 2011). However, the lean method puts too much emphasis on adaptive behaviors that are often incremental, leading to myopic decisions that fail to address multiple knowledge problems (Felin et al., 2019). Hence, entrepreneurial strategy scholars have recently advanced alternatives that offer more comprehensive and systematic methods for new product development (Agrawal et al., 2021; Gans et al., 2019; Gruber et al., 2008; McDonald & Gao, 2019; Ott et al., 2017; Ott & Eisenhardt, 2020; Zellweger & Zenger, 2021) that help overcome this key limitation of the lean method.

Overall, my systematic analysis of the effectiveness of the different product design and development strategies (i.e., MVPs versus comprehensive products) verifies the key premises of our theoretical understanding that the performance of these different product development methods is contingent upon the key nature of the particular knowledge problems that entrepreneurs encounter during the business venturing processes. I distill three sets of implications from the results of this simulated model.

First, my simulation results show that lean methodology generates product-market fit more quickly than a more comprehensive product development strategy. However, the total product-market fitness levels of the comprehensive method are systematically higher than the lean method under conditions of complexity. Moreover, my model shows that this total performance difference increases as dynamic complexity increases. Thus, these results suggest that a comprehensive product development strategy should be recommended to entrepreneurs, especially when the market (e.g., the industry) under which they act is highly complex.

Second, my model also reveals environmental mechanisms when the lean approach should be preferred over the comprehensive approach. The simulation results show that the lean method is weaker in resolving dynamic complexity than the comprehensive method, while the comprehensive method is weaker in tackling aleatory uncertainty than the lean method. More specifically, the lean method tends to have a slight edge over the comprehensive method when the level of aleatory uncertainty is high, yet the level of complexity is below a moderate level. However, when the level of aleatory uncertainty is below or equal to a moderate level, the comprehensive method has the edge over the lean method. Otherwise, according to the simulation results, neither the lean approach nor the comprehensive approach achieves higher product-market fit if aleatory uncertainty increases. In other words, even though the lean method generally tends to be a little more effective than the comprehensive method when aleatory uncertainty is at a high level, the comparative effectiveness of the lean method over the comprehensive method might only be limited to particular circumstances (e.g., dynamic complexity is low yet aleatory uncertainty is high). Overall, my research model suggests that it might be better to take a comprehensive approach to new product development instead of the lean method unless aleatory uncertainty is high and complexity is low at the same time in the market. Specifically, according to my model's results, if ventures can survive long enough to obtain sufficient product development opportunities and if the level of aleatory uncertainty they face is not around high-level, it may be acceptable or even preferable to formulate and implement more comprehensive product development strategies rather than the lean method. The customers with whom the lean startups test their updated product designs may often be early adopters, who are already interested in the new types of products they are creating but might not necessarily be representative of future mainstream customers who will

actually purchase and enjoy them. In sum, the lean methods might not necessarily resolve various knowledge problems that startups often encounter effectively during the startup process.

Third, my model does not necessarily discredit the benefits of the lean method entirely. My simulation results also suggest that the lean approach can be preferred over the comprehensive approach when speed and cost advantages are the most critical. Since the lean method has both speed and cost advantages over the comprehensive method, entrepreneurs with the lean method are likely to obtain great new product insights very quickly, particularly in the early stage of new product development. Thus, it may be the most effective for the firms to start with the lean method at the very early stages of product development and then switch to the comprehensive method in order to navigate and explore information on latent market demands, technology, and/or new product features comprehensively and thoroughly.

Future Research and Limitations

As I noted in the previous sections, my model focuses on investigating when it is better to choose the lean over the comprehensive method and vice versa. However, in certain circumstances, it is possible that higher performance is generated when entrepreneurs can successfully balance between speed and comprehensiveness simultaneously. Hence, future research can also delve into theorizing the possible relationship between speed and comprehensiveness and how the essential tradeoffs between speed and comprehensiveness can be effectively varied and managed in the face of various knowledge problems that entrepreneurs contend with.

In addition, my study assumes that all the product features within a firm are equally interconnected regardless of a separate product domain effect. Specifically, the equal interconnectedness across all products a firm generates can generally be assumed. However, it is

also possible that the interrelatedness within a product domain might be stronger than that across multiple product domains. Hence, future studies can investigate how the interconnectedness among multiple product features and products should be conceptualized depending on various product designs and their structures.

Furthermore, my simulation model relies on the fundamental assumption that entrepreneurial strategies are formulated only by intendedly rational actors that do not have any prior experiential knowledge about the focal market before they start developing new products. Although my model simulates that entrepreneurs who employ the lean method continuously collect and utilize experiential knowledge once they begin to conduct product development, it is possible that there could also be experienced entrepreneurs (e.g., serial entrepreneurs) who already possess experiential knowledge before they start to develop new products. Moreover, even though intendedly deliberate decision logics are core to strategy formulation, it is possible that several other critical dimensions of entrepreneurial actions, such as non-rational actors (Lerner et al, 2018) and several other environmental contexts (e.g., ambiguity and equivocality), can also shape some types of entrepreneurial decision-making processes. To advance entrepreneurship theories, future empirical studies can consider other important dimensions of entrepreneurial behavior (e.g., non-rational behaviors) and other types of knowledge problems (e.g., ambiguity and equivocality). More specifically, as empirical studies that account for non-deliberate decision logics and/or prior entrepreneurial experience are lacking in the extant literature, future research might want to incorporate these dimensions into the model and test how these dimensions shape the effectiveness of various decision logics in entrepreneurship.

Overall, my results confirm the unique yet nuanced role that different knowledge problems play in shaping the effectiveness of new product development methods—lean versus

comprehensive methods. Given that my model offers an important implication in that the performance of different new product development methods is largely dependent upon varying conditions of the entrepreneurial environments, my study lays the groundwork for future research that may delve into multiple contingencies between multiple decision logics and various knowledge problems (Davis et al., 2009; Galbraith, 1973; Hunt et al., 2021; Lawrence & Lorsch, 1967; Townsend et al., 2018).

Notwithstanding these limitations and future possibilities, my study makes excellent contributions to the entrepreneurship literature. First and foremost, this study is one of the first to test and compare the product-market fits of different entrepreneurial decision logic by robustly measuring the degree of critical entrepreneurial environment characteristics. Although several studies have examined the performance of firm strategies under the condition of uncertainty that is often measured unclearly, I contribute to these research streams by specifying both various degrees and possible combinations of multiple environmental contingencies—dynamic complexity versus aleatory uncertainty—in different decision logics within the entrepreneurship context. My model directly tests and exposes the fundamental mechanisms (i.e., the tradeoffs between speed and comprehensive advantages) through which product-market fitness levels of different product development methods are shaped. My simulation results also suggest that strategic choices regarding product design and development method should be judiciously made to fit well with the key features of the entrepreneurial decision environments—knowledge problems—during the venturing process (Hunt et al., 2021; Packard & Clark, 2020; Townsend et al., 2018).

The study also contributes to the entrepreneurship and strategy literature by introducing the NK-like method to these fields to help avoid the inherent methodological constraints of

canonical NK models. By utilizing this method, I introduce new ways for problematizing existing theories by simulating the real decision contexts where every element of a decision vector should vary beyond a binary value (i.e., real-valued numbers). By using this pseudo-NK tool, I was able to simulate a large decision space (i.e., N) and to manipulate the decision landscapes without too much computational burden.

Conclusion

Overall, my study confirms and shows that the value of entrepreneurial strategies is contingent upon the unique and nuanced challenges each knowledge problem generates. The effectiveness of competing decision logics—the lean methods versus the more comprehensive methods rooted in the strategic recommendations, largely depends on the unique roles of different knowledge problems (aleatory uncertainty versus dynamic complexity) play in the decision environments. An NK-like model I used in this study is a useful tool for simulating these different decision environments to examine how these knowledge problems shape the performance of various entrepreneurial strategies. Introducing this new method to the fields of entrepreneurship and strategy will advance the literature moving forward by allowing for problematizing and testing theories through building more realistic decision contexts.

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Table 2-1 An NK-like model Parameter and Assumption Summary

Parameter	Description	Values used for the simulation	Underlying assumptions	Possible Empirical proxies
N	Total number of product features of a firm (Total number of decision components regarding the firm products)	16	The total number of product features a firm offers to the market is fixed at 16 for every model simulated for parsimony.	Total number of decisions that can be made regarding product specifications
B	Total number of products a firm develops	4	Fixed number of products of a firm. Thus, four product features constitute one product in my model.	Total number of products that a firm develops
A	The intensity of linkages among a set of product features (i.e., dynamic complexity) that each market(landscape) requires.	From 0.1 (low) to 0.9 (high)	All of the products within a firm are interconnected. But the intensity of these linkages reflects the degree of environmental dynamic complexity, so A is fixed to a particular value for all firms in each simulation to be measured at the environmental level.	Environmental dynamic complexity
P	How often the landscape itself randomly changes	From 1 (very high) to 30 (very low)	Aleatory uncertainty refers to how often the stochastic change of the entire landscape happens. The entire landscape itself will shift due to the environmental shocks periodically. Hence, the frequency of environmental shock reflects the levels of aleatory uncertainty. But the landscape is fixed and does not change between the environmental shocks.	Aleatory uncertainty
Delta	To what extent entrepreneurs can update a product feature each period when no experiential knowledge	0.05	If the experiential knowledge is not triggered, an entrepreneur can update +0.05 or -0.05 (i.e., Delta) for each product feature per period.	Bounded rationality
Total number of periods	To observe and compare to what extent the fitness levels of firms with their entrepreneurial strategy changes.	50, 100	Depending on the experimentation costs associated with the different types of product development methods, the total number of experimentation periods for each approach is fixed.	Total experimentation costs
Total number of simulated firms per period	To get much higher than 99% statistical significance for the mean, my model simulates 100 firms with 1,000 iterations per period	100,000		

Figure 2-1 Final Performance by Dynamic Complexity When Dynamic Complexity Exists (But No Aleatory Uncertainty)

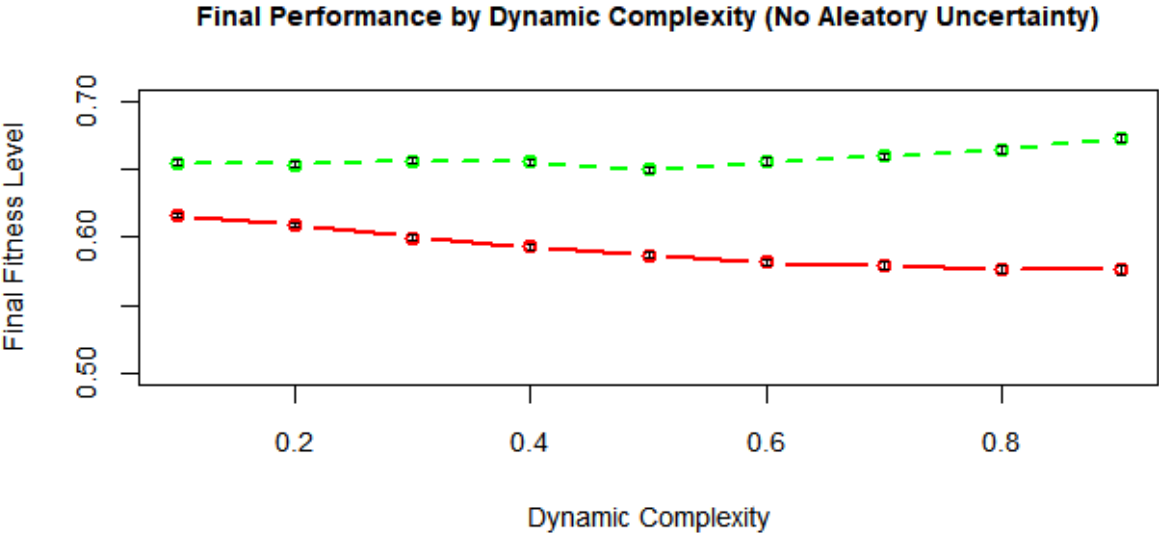


Figure 2-2 Mean Performance by Decision Rounds When Dynamic Complexity is Low (=0.1) (But No Aleatory Uncertainty)

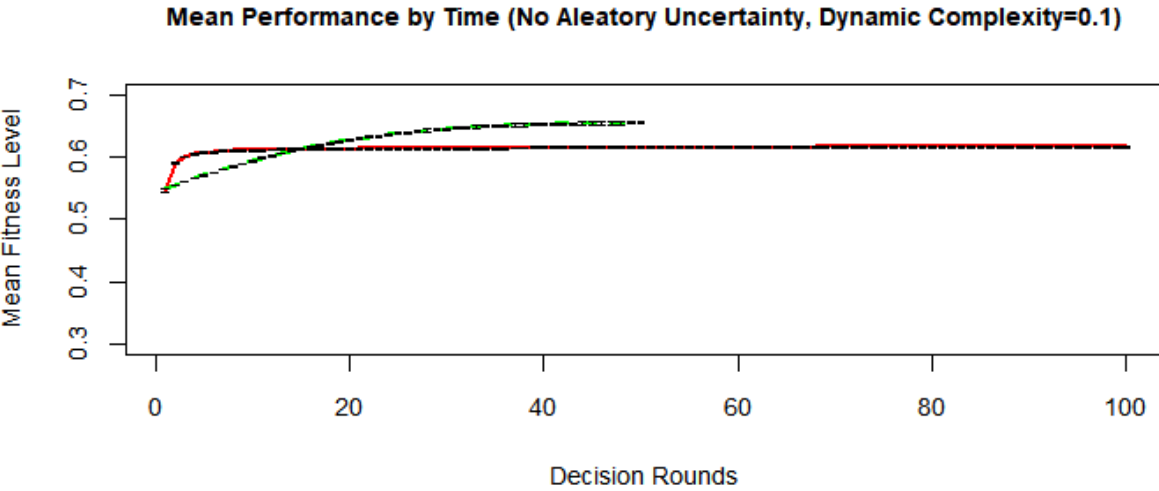


Figure 2-3 Mean Performance by Decision Rounds When Dynamic Complexity is Moderate (=0.5) (But No Aleatory Uncertainty)

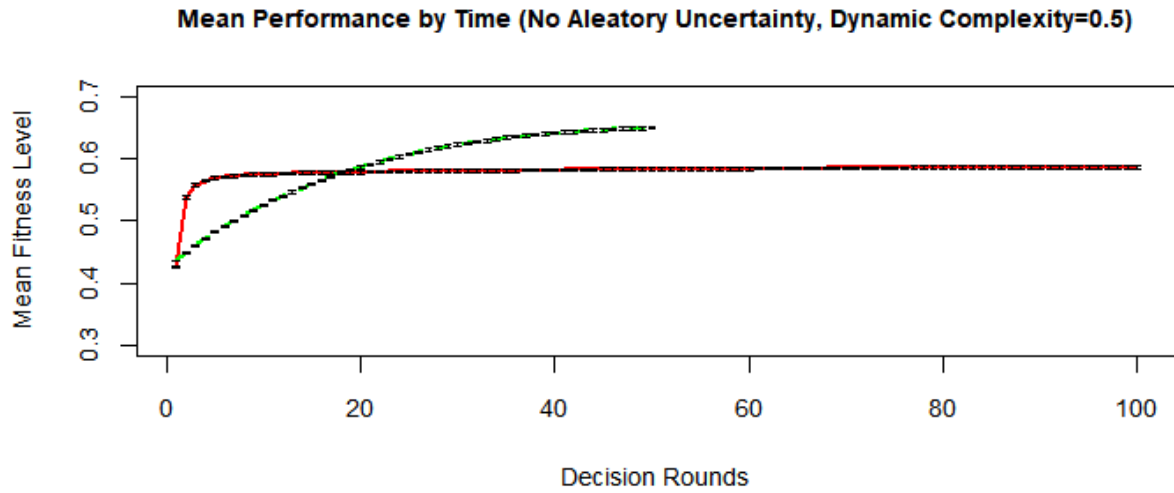


Figure 2-4 Mean Performance by Decision Rounds When Dynamic Complexity is High (=0.9) (But No Aleatory Uncertainty)

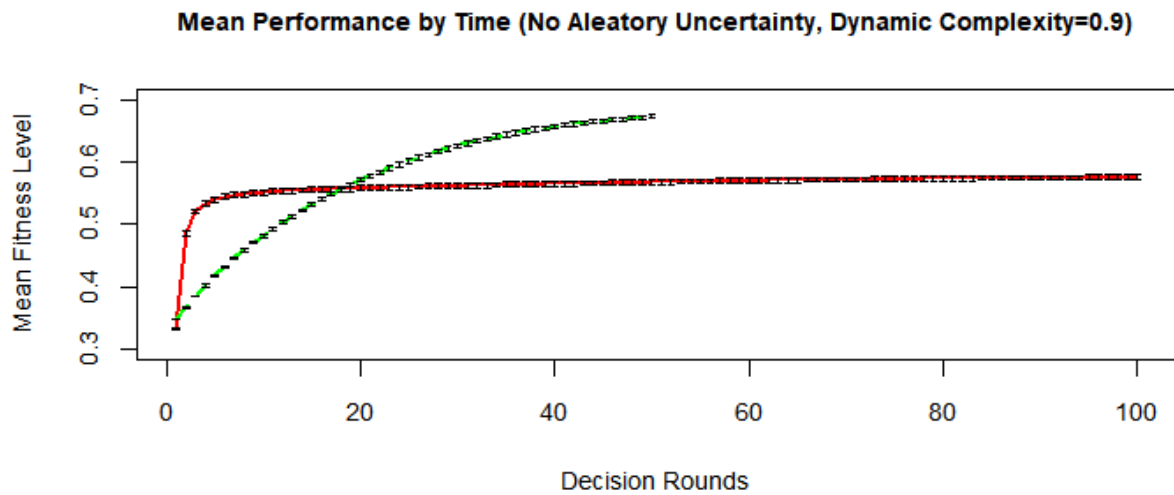


Figure 2-5 Mean Performance by Dynamic Complexity When Every Level of Aleatory Uncertainty Exists as a Covariate

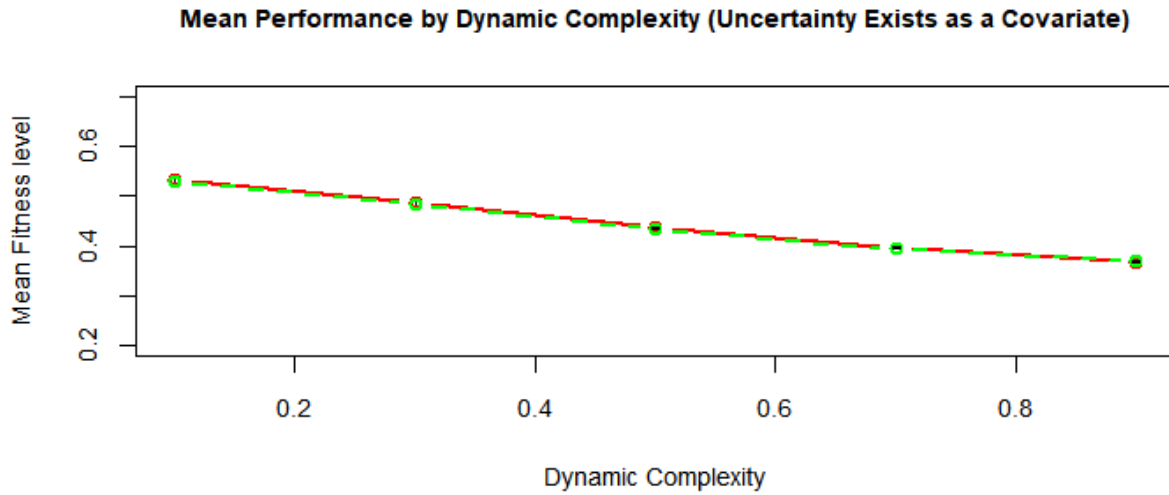


Figure 2-6 Final Performance by Dynamic Complexity When Every Level of Aleatory Uncertainty Exists as a Covariate

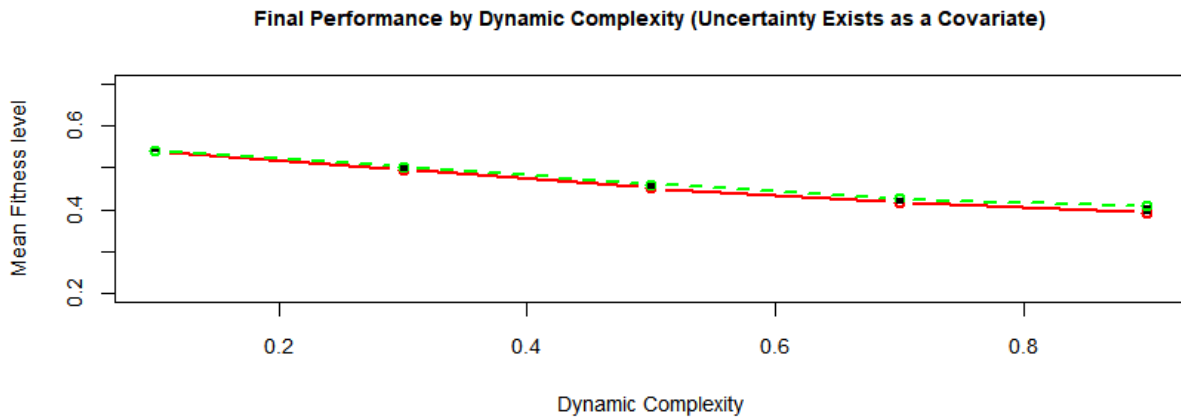


Figure 2-7 Mean Performance by Aleatory Uncertainty When Every Level of Dynamic Complexity Exists as a Covariate

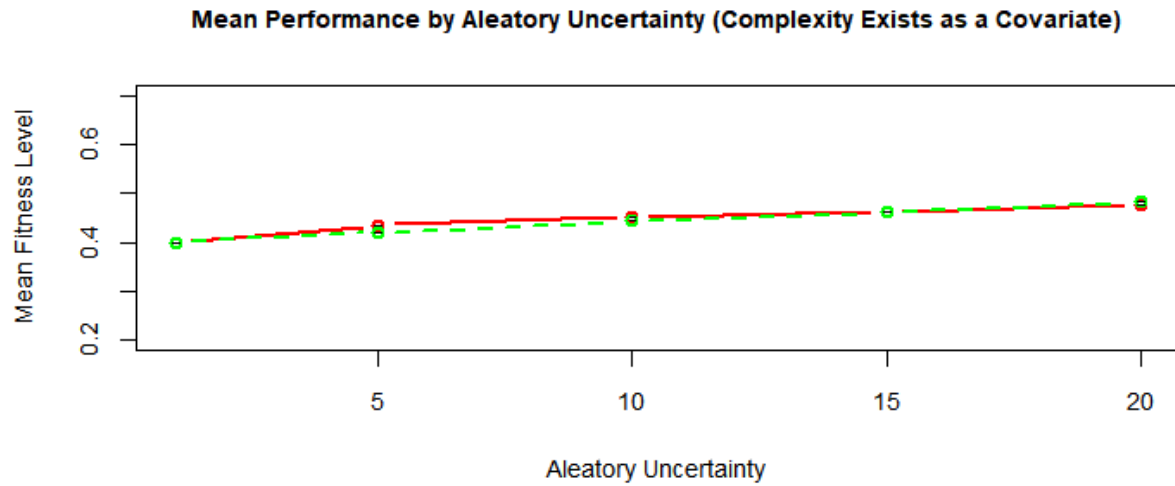


Figure 2-8 Final Performance by Aleatory Uncertainty When Every Level of Dynamic Complexity Exists as a Covariate

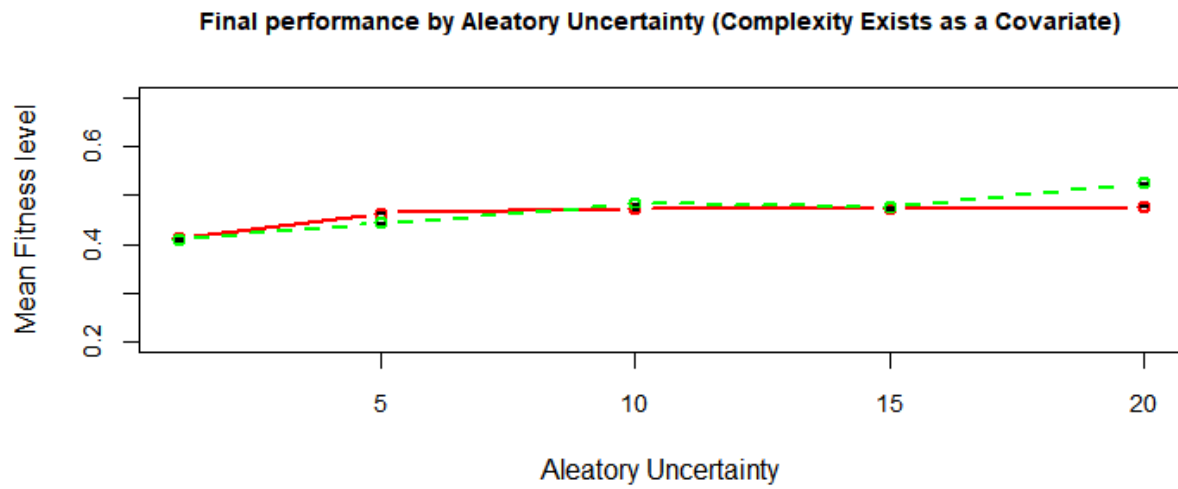


Figure 2-9 Mean Performance by Time: Aleatory Uncertainty Low (25) and Dynamic Complexity Low (0.1)

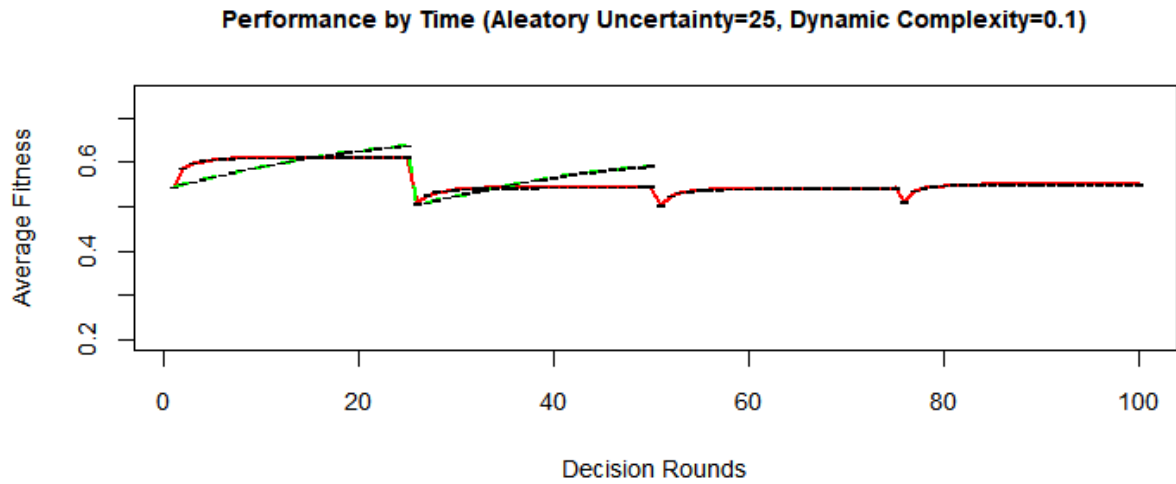


Figure 2-10 Mean Performance by Time: Aleatory Uncertainty Low (25) and Dynamic Complexity High (0.9)

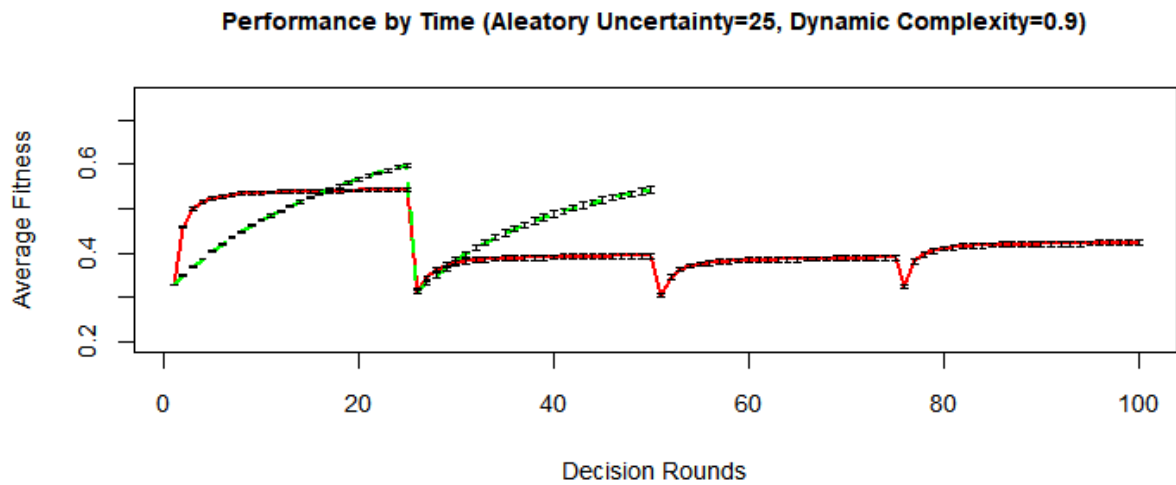


Figure 2-11 Mean Performance by Time: Aleatory Uncertainty Moderate (15) and Dynamic Complexity Low (0.1)

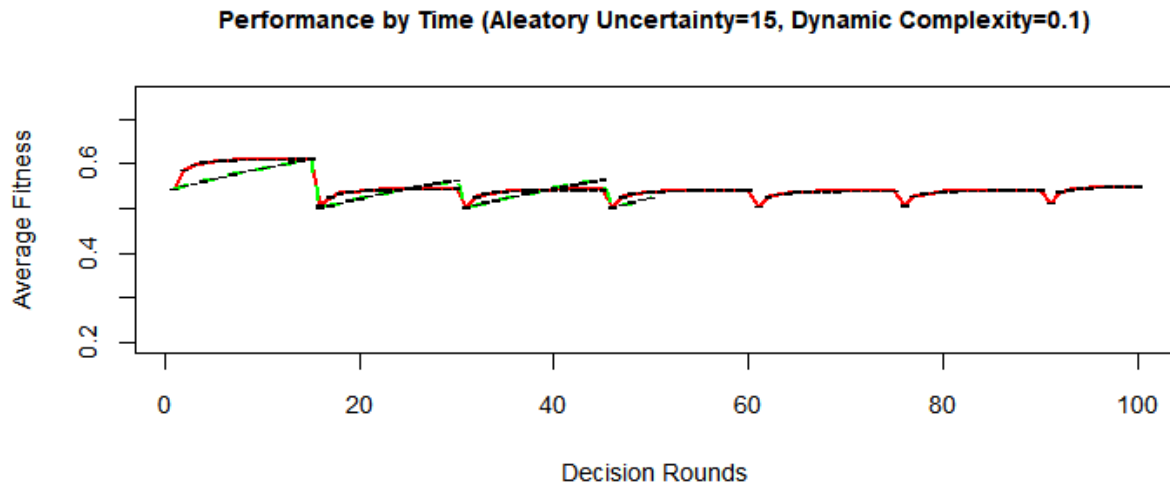


Figure 2-12 Mean Performance by Time: Aleatory Uncertainty Moderate (15) and Dynamic Complexity High (0.9)

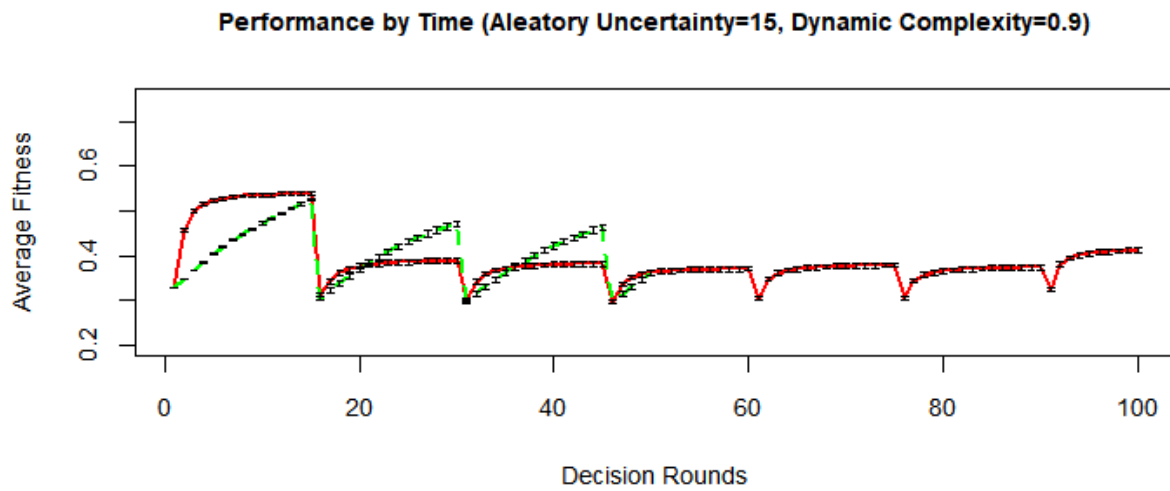


Figure 2-13 Mean Performance by Time: Aleatory Uncertainty High (5) and Dynamic Complexity Low (0.1)

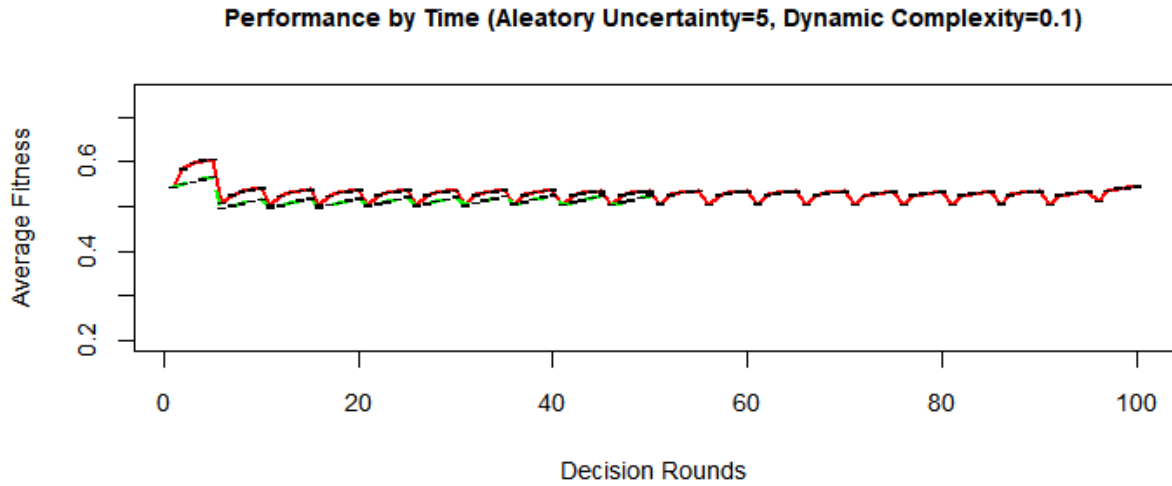


Figure 2-14 Mean Performance by Time: Aleatory Uncertainty High (5) and Dynamic Complexity High (0.9)

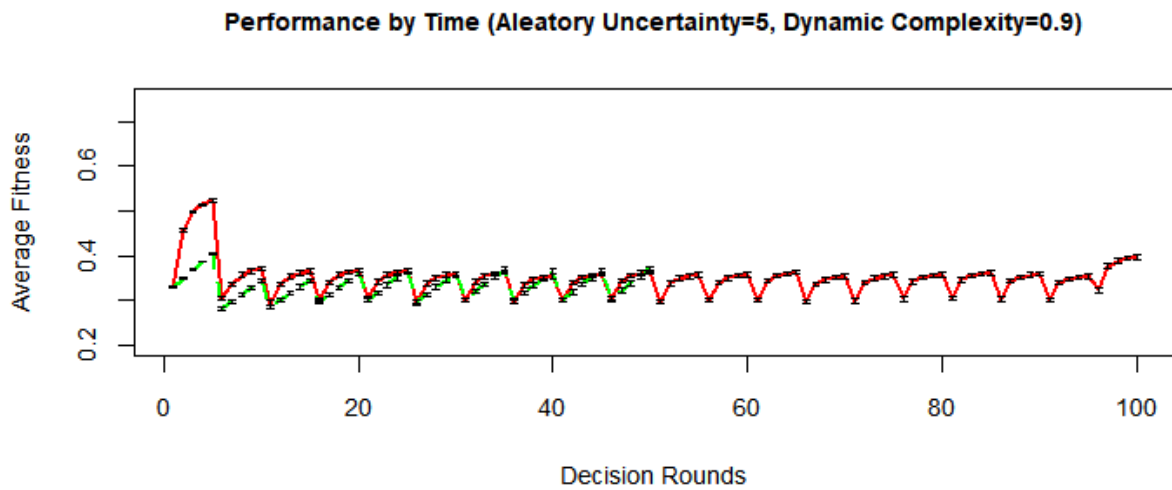
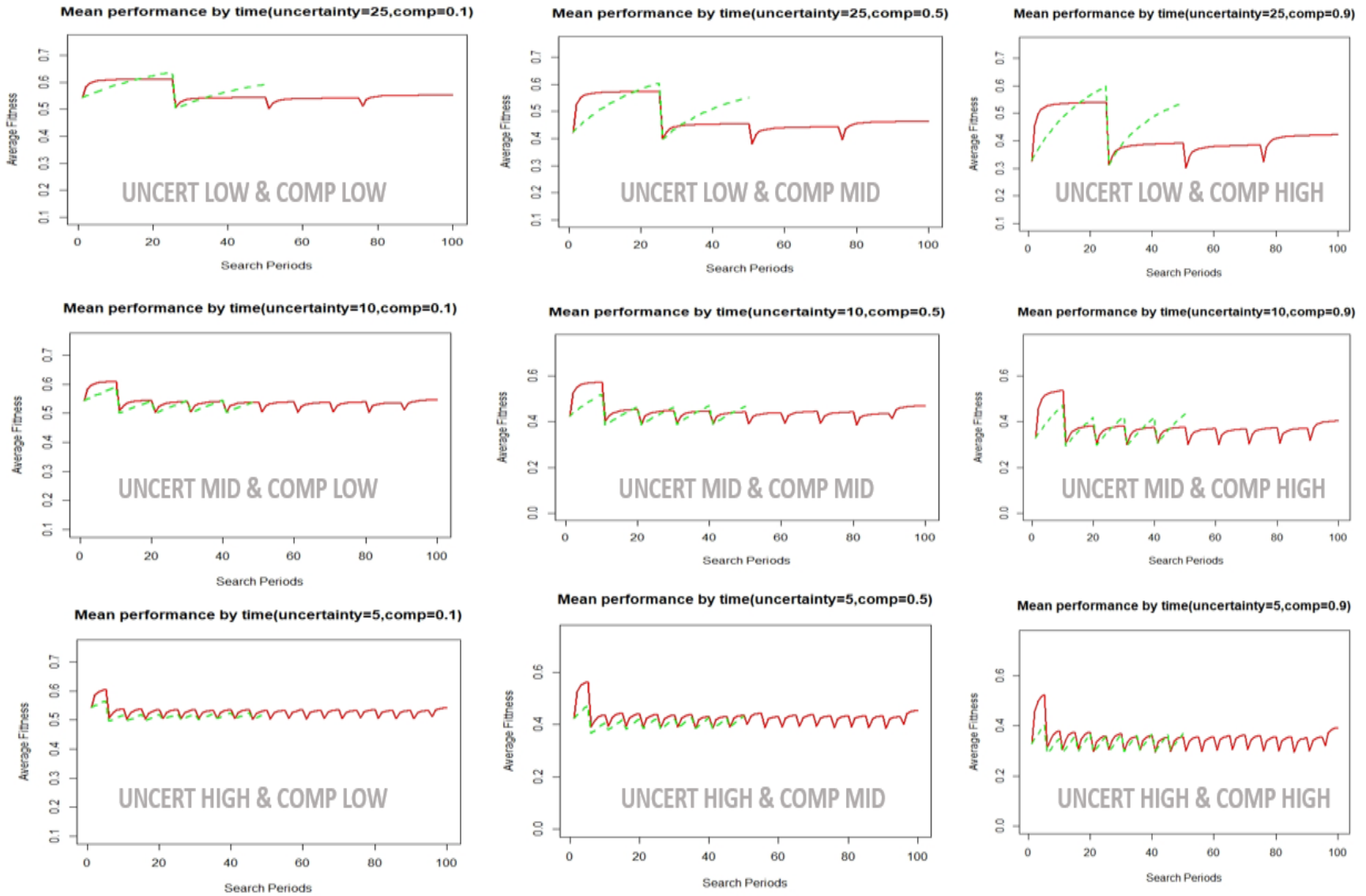


Figure 2-15 Mean Performances by Time: Various Combinations of Aleatory Uncertainty and Dynamic Complexity



CHAPTER 3: ESSAY TWO

A MODULAR VS. A PARALLEL NEW PRODUCT DEVELOPMENT STRATEGY UNDER CONDITIONS OF DYNAMIC COMPLEXITY – A PSEUDO-NK SIMULATION STUDY

3.1. INTRODUCTION

Knightian uncertainty, a central variable of entrepreneurship research, plays a complex role in entrepreneurship (Knight, 1921; McMullen & Shepherd, 2006; Sarasvathy, 2001; Foss & Klein, 2017). At the macro-level (i.e., the environmental level), Knightian uncertainty is a critical source and environmental condition that can be used to explain entrepreneurial profits, mainly because insuring against future outcomes is almost impossible due to its real indeterminism. Such real indeterminism creates new profitable opportunities that entrepreneurs can capture by creating new products and services (Knight, 1921). However, at the firm level, such dynamic environmental conditions generate various knowledge problems (e.g., dynamic complexity) that firms should resolve in order to capture entrepreneurial opportunities (Busenitz & Barney, 1997; Davis, Eisenhardt, Bingham, 2009; McMullen & Shepherd, 2006; McKelvie, Haynie, & Gustavsson, 2011; Milliken, 1987; Townsend, Hunt, McMullen, & Sarasvathy, 2018).

Thus, entrepreneurship scholars have examined what types of entrepreneurial strategies are most likely to enable entrepreneurs to capture opportunities effectively (e.g., Camuffo, Cordova, Gambardella, & Spina, 2020; Felin, Gambardella, Stern, & Zenger, 2019; Gans, Stern, & Wu, 2019; McDonald & Eisenhardt, 2020; Pontikes & Rindova, 2020; Zellweger & Zenger, 2021). Among the multiple dimensions of entrepreneurial strategy, the number of new product development opportunities to be considered simultaneously at a time has recently become an essential topic in the entrepreneurial strategy literature (e.g., a new product development strategy)

as recent entrepreneurship studies began researching whether pursuing multiple entrepreneurial opportunities simultaneously (i.e., a parallel strategy) can be effective and how (Bakker & Shepherd, 2017; Barreto, 2012; Gruber, MacMillan, & Thompson, 2008; McDonald & Eisenhardt, 2020) even though pursuing a single potential opportunity at a time (i.e., a modular strategy) has been assumed to be a typical entrepreneurial strategy in most of the early entrepreneurship studies primarily due to bounded rationality of actors assumptions (Shepherd & Wiklund, 2019).

Nevertheless, the quantitative entrepreneurship research regarding the new product development strategic choice between focusing on a single product at one time (i.e., a modular strategy) and handling multiple product opportunities simultaneously (i.e., a parallel strategy) is still lacking. In particular, it is unclear whether the entrepreneurial strategic choice to pursue multiple opportunities simultaneously (i.e., a parallel strategy) is superior to the choice to pursue a single opportunity at one time (i.e., a modular strategy). Furthermore, the existing entrepreneurship literature has failed to consider dynamic complexity as one of the critical decision environmental conditions for new product development. In most prior entrepreneurship studies, the construct of ‘environmental uncertainty’ has often been operationalized and measured to indicate all the sources of indeterministic yet dynamic environments (Packard & Clark, 2020; Townsend et al., 2018). That is, uncertainty has been dubiously assumed to subsume dynamic complexity, aleatory uncertainty, or even ambiguity (Townsend et al., 2018). More specifically, extant entrepreneurship studies have failed to consider dynamic complexity, one of the key sources of environmental uncertainty, as a key knowledge problem in entrepreneurship, although it can shape the value of entrepreneurial opportunities.

Therefore, to address these critical issues, the purpose of this study is twofold. First, this study compares and tests the performance (i.e., the product-market fit)⁹ of entrepreneurial strategic choices regarding the number of product development opportunities for entrepreneurs to pursue. Second, this study focuses on whether such relationships are moderated by dynamic complexity. In other words, both environmental conditions and the entrepreneurial strategic choices regarding the number of opportunities to pursue simultaneously (e.g., whether focusing on a single product development opportunity at one time versus developing multiple product developments at once) are expected to shape the magnitude of the product-market fit. Specifically, a parallel strategy -- considering and developing multiple new product development opportunities simultaneously -- is expected to help hedge the bets and to leverage various future contingencies, but with less depth on any one product opportunity. On the other hand, a modular strategy -- pursuing a single product development opportunity at one time -- enables entrepreneurs to deepen product development opportunities, but at the expense of exploring multiple potential product opportunities simultaneously (Ott & Eisenhardt, 2020). However, it is possible that the value of these entrepreneurial choices would be contingent upon the key nature of the knowledge problems and the internal decision contexts the entrepreneurs are facing (Packard & Clark, 2020; Townsend et al., 2018). For example, if the level of dynamic complexity -- multiple environmental contingencies and their complicated interactions -- is high, it is likely that the parallel strategy attains the product-market fit more effectively than the modular strategy due to the creation of a set of multiple products that are sophisticatedly interconnected. However, such effectiveness of a

⁹ Performance in this model is determined by the product-market fit of every venture that reflects the degree to which a set of products/services they create satisfies the multiple yet interconnected needs (e.g., complicated multiple standards demanded by the market) that are held constant at the environment level

parallel strategy could also be reduced by resource coordination cost, as a parallel strategy requires more resources to coordinate multiple opportunities at once.

To investigate these research questions, this study uses a pseudo-NK simulation method (Valente, 2014). Specifically, this simulation-based NK-like model will analyze the influence of dynamic complexity on the performance (i.e., product-market fit) of the new product development strategies (e.g., Levinthal, 1997; McKelvey, 1999; Siggelkow & Rivkin, 2005; Welter & Kim, 2018). Specifically, my NK-like model focuses on analyzing the impact of dynamic complexity on the effectiveness of the entrepreneurial choice regarding amounts of new product development opportunities pursued at one time. That is, by varying both the degree of dynamic complexity at the environmental level and the number of new products simultaneously developed by a firm at a time in the pseudo-NK model, I attempt to study specifically under what specific conditions (i.e., both the level of dynamic complexity and the degree of resource coordination cost) and to what extent new product development opportunities should be pursued simultaneously at one time for effective opportunity capture.

Overall, this study contributes theoretically and methodologically to entrepreneurial theories of uncertainty and the entrepreneurial strategy literature. First, this study is one of the few studies that operationalize and measure dynamic complexity, which has been largely ignored in an entrepreneurship context. This study attempts to identify the role of dynamic complexity in the new product development process. Second, this study is one of the first that directly theorizes, tests, and compares the product-market fit of entrepreneurial strategic choices as to whether focusing on a single product opportunity at one time (i.e., a modular strategy) or multiple product opportunities simultaneously at once (i.e., a parallel strategy) is more (or less) effective and how

many new product opportunities should be developed simultaneously for higher product-market fit under varying conditions of dynamic complexity.

3.2. THEORETICAL BACKGROUND

An increasing volume of recent work in entrepreneurial strategy literature talks about an essential dimension of entrepreneurial strategic choice: the number of new entrepreneurial opportunities considered at a time (Bakker & Shepherd, 2017; Gruber et al., 2008; McDonald & Eisenhardt, 2020; Ott & Eisenhardt, 2020). The strategic choices regarding the number of entrepreneurial opportunities are critical because ventures often want to hedge their bets by pursuing multiple opportunities due to a high level of ‘unknowingness’ in entrepreneurial environments. Since ventures cannot predict *a priori* what types of products/services will make profits in the future, they typically hope to develop and release multiple products to hedge the bets while attempting to optimize resource coordination costs. Moreover, in an environment that is characterized by a high level of dynamic complexity, the market likely imposes multiple standards for new product creation (Greenwood, Raynard, Kodeih, Micelotta, and Loundsbury, 2011). This challenge becomes more complicated when the dynamic interactions of competitive actions and new technologies create various customer demands that need to be satisfied as a whole at once for effective opportunity capture (Battilana, Leca, and Boxenbaum, 2009). Hence, startups want to develop a sophisticated solution set of multiple products/services (i.e., a new business model) ultimately rather than just a single product/service so that they can effectively tackle different levels and types of knowledge problems they face during the entrepreneurial journey.

More specifically, entrepreneurs develop new products/services under varying conditions of ‘unknowingness’ (Townsend et al., 2018). In the new product development process, multiple requirements for new product development (e.g., product designs, market standards, new technologies, technical standards, etc.), various components of the market economy (e.g., demand, supply, competitive actions, institutions, etc.) and the dynamic interactions of these factors -- dynamic complexity -- are often high, creating *a priori* ‘unknown’ decision context. In other words, dynamic complexity, one of the key sources of ‘unknowingness,’ generates challenges for entrepreneurs to resolve in order for them to capture opportunities (Simon, 1959; Siggelkow & Rivkin, 2005; Townsend et al., 2018). However, at the same time, since dynamic interactions of these multiple factors are often *a priori* indeterminate, they could also serve as a precursor to future entrepreneurial profits that can be captured by entrepreneurs who can develop a set of interconnected multiple products/services -- a sophisticated business model (Knight, 1921; McMullen & Shepherd, 2006). In sum, the dynamic interrelatedness of the multiple decision environments -- dynamic complexity -- creates an opportunity-obstacle paradox. Entrepreneurs who can develop and commercialize a set of new products/services that can address these paradoxical challenges generated from decision environments (i.e., market) effectively are likely to realize entrepreneurial opportunities (Davis et al., 2009; Hunt, Townsend, Manocha, & Simpson, 2023; Ott & Eisenhardt, 2020; Packard & Clark, 2020; Siggelkow & Rivkin, 2005; Townsend et al., 2018). Under these circumstances, therefore, the success of ventures would be primarily determined by the ‘alignment’ among the entrepreneurial choices (e.g., specifications of new products/services), organizational resource constraints, and the degree of dynamic complexity where new products/services are developed and commercialized (Agrawal, Gans, & Stern, 2021;

Daft & Macintosh, 1981; Eisenhardt & Tabrizi, 1995; Galbraith, 1978; Davis et al., 2009; Gans et al., 2019; Gruber et al., 2008; Packard & Clark, 2020; Zellweger & Zenger, 2021).

Hence, entrepreneurial strategy scholars have developed frameworks (e.g., scientific entrepreneurship) that help entrepreneurs improve venture performance by increasing the fit between the market and the products/services they create (e.g., Bakker & Shepherd, 2017; Gans et al., 2019; Ott & Eisenhardt, 2020; Pontikes & Rindova, 2020; Ries, 2011; Zellweger & Zenger, 2021). Since a set of new products/services that align well with the market is likely to capture entrepreneurial opportunities, entrepreneurship research has focused on increasing the product-market fit as a critical mechanism through which ventures enhance their new product performance (Hunt et al., 2023; Packard & Clark, 2020; Zellweger & Zenger, 2021). Product-market fitness level, by definition, operationalizes the extent to which the products a venture develops fit into the market. The fitness level between the product configurations and the market demands can indicate the new product performance of a venture because product-market fit demonstrates to what extent the new products a venture develops and commercializes satisfy the needs and demands of the customers in the market. Accordingly, product-market fit is chosen as the primary dependent variable of this study.

In sum, entrepreneurial strategy researchers have explored a variety of tools, frameworks, and methods that entrepreneurs can employ to enhance product-market fit by addressing critical challenges from the entrepreneurial environments (Davis et al., 2009; Eisenhardt & Bingham, 2017; Gans et al., 2019; Ries, 2011; Zellweger & Zenger, 2021). One of the popular frameworks that have been advocated by the majority of entrepreneurship scholars and practitioners is ‘product experimentation.’ Product experimentation has generally been suggested as a useful product development strategy to increase the product-market fit due to the indeterminism that prevails in

entrepreneurial environments. Since the entrepreneurial environments are *a priori* ‘unknown’, experimentation has generally been recommended to gain more information about the product-market fit (e.g., Andries et al., 2013; Bakker & Shepherd, 2017; Felin, Gambardella, & Zenger, 2020; Felin & Zenger, 2009; Gans et al., 2019; Kerr, Nanda, & Rhodes-Kropf, 2014; McDonald & Eisenhardt, 2020).

However, what is still unclear in the existing studies is how the product experimentation should be designed to achieve higher product-market fit. That is, little has been studied about how many new products should ideally be simultaneously tested for new product success. Although entrepreneurial strategy scholars have recently advanced a more sophisticated experimentation process that builds on robust and scientific approaches (Felin et al., 2020; Felin & Zenger, 2009; Zellweger & Zenger, 2021), studies that examine precisely how new product experimentation processes should be designed for new product success are still lacking. Further, it is unclear whether and under what conditions the simultaneous development of multiple new product opportunities is more effective than the development of a single opportunity, even though recent studies have acknowledged that entrepreneurs often pursue multiple opportunities simultaneously (Bakker & Shepherd, 2017; Barreto, 2012; Gruber et al., 2008; McDonald & Eisenhardt, 2020)

Hence, the key premise of this study centers on the effectiveness of entrepreneurial choice regarding the number of new products simultaneously developed that would hinge upon both the level of environmental (e.g., dynamic complexity) and internal conditions (e.g., resource constraints). Given that such research questions require robust models that measure the product-market fit that is shaped by entrepreneurial strategic choices, market conditions, and internal conditions (Agrawal, Gans, & Stern, 2021; Eisenhardt & Tabrizi, Galbraith, 1978; Davis et al., 2009; Gans et al., 2019; Packard & Clark, 2020; Siggelkow & Rivkin, 2005; Rivkin, 2000;

Zellweger & Zenger, 2021) with real-valued numbers used, I use a pseudo-NK simulation model (Valente, 2014). In the following sections, I depict how the simulation model is designed to address this research question.

3.3. ANALYTICAL MODEL

To address the research question of this study, I utilize a pseudo-NK simulation method (Valente, 2014). Simulation methods allow for addressing critical limitations in empirical studies that fail to directly and robustly measure the level of environmental contexts (e.g., dynamic complexity) (Levinthal, 1997; Siggelkow & Rivkin, 2005; Rivkin, 2000). An NK-like model is a model of complexity where both dynamic complexity and product-market fitness levels can be precisely and robustly operationalized and measured. Further, this simulation model computes and records how the product-level decisions are aggregated to the firm and the market levels. In this model, product-market fitness levels are robustly calculated after accounting for both entrepreneurial strategic choices regarding new product development and the environmental conditions (i.e., the level of dynamic complexity). Additionally, the longitudinal data simulated from this model make it possible to examine the long-term trends of product-market fitness levels, which are very difficult to be collected. Moreover, unlike a regular NK model, this pseudo-NK model uses real-valued numbers instead of binary numbers (0 or 1), allowing it to reflect the real-world decision process more precisely. To be specific, the real-valued number for each product in my model represents its product specification. That is, the precise product specifications of multiple products and their configuration are simulated with real-valued numbers instead of binary numbers to reflect realistic product experimentation processes.

Model Assumptions

In my pseudo-NK model of this study, the N parameter represents a firm's quantity of products, and the A parameter represents the degree of dynamic complexity. In this model, the decision landscape of each firm has a total of 10 ($=N$) products, and each product is randomly assigned a unique number that represents its product specification, varying from 98 to 102 with an interval of 0.05 (following Valente's (2014) modeling). Specifically, each venture is represented as a set of products (each firm has 10 products that could be developed), reflecting its business model. Each product's unique value usually ranges from 98 to 102, reflecting the individual specification of each product.

The pseudo-NK model (also referred to as an NK-like model) allows using the real-valued numbers to represent each product's unique value. This modeling is impossible in the canonical NK models that only allow a binary value (0 or 1) to represent each decision dimension. In my pseudo-NK model, however, each firm has ten (10) products, and each product has its unique real number that reflects its specification. For instance, every product of a firm can have its unique value that represents the specification of a product in a specific time ($T=3$, the third experimentation round) as follows: (98.0, 99.55, 101.35, 100.0, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50) at $T=3$. Under the assumption of my model, each firm develops its product using either a systematic or an adaptive approach each time. Since the number of new products developed at one time is a key focus of study, I assume that there are 50% of the ventures in the entire landscape take a systematic approach to new product development/experimentation, and the rest of the ventures - 50% - take an adaptive approach. In this way, the effect of the product development method itself is controlled in the model. For both approaches, the basic algorithm for a pivot is as follows: a pivot occurs if the update of the product configuration of a firm generates

a higher product-market fit than the existing product-market fit. If the expected update of the product configuration of a firm will produce the same or lower product-market fit than the current product-market fit, then all the values of the firm products, including the number of the focal product(s), will stay the same as the current product-market fit in the next experimentation round (i.e., no pivot). If I demonstrate this algorithm with a set of decision vectors, then it will be represented as follows: (98.0, 99.55, 101.35, **100.0**, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50) in the current period (T=3) will change to (98.0, 99.55, 101.35, **100.05**, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50) if the product-market fit of the decision vectors of (98.0, 99.55, 101.35, **100.05**, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50) is computed to be higher than the product-market fit of the decision vectors in the current period: (98.0, 99.55, 101.35, **100.0**, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50). If the product-market fit of the decision vectors of (98.0, 99.55, 101.35, **100.05**, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50) is computed to be equal to or lower than the product-market fit of the decision vectors in the current period: (98.0, 99.55, 101.35, **100.0**, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50), the pivot will not occur, and the same decision vectors of firm will remain in the next round (T=4) (i.e., 98.0, 99.55, 101.35, **100.0**, 99.05, 98.95, 102.0, 101.75, 100.40, 97.50).

Additionally, I constrain the degree of product development per experimentation round to the incremental pivot by limiting the degree of changes to each product specification by either - 0.05 (the parameter Delta to the negative direction) or + 0.05 (the parameter Delta to the positive direction) per experimentation round. In this model, I assume that each product value can be changed by one step (Delta =0.05) due to the limited rationality assumption of entrepreneurs. However, if a venture encounters a new reasonable opportunity that resembles the experiential knowledge the venture has experienced in the previous experimentation rounds (i.e., the

accumulated stock of knowledge in the past and the current market), then the venture is allowed to move beyond 0.05 ($\geq \delta$).¹⁰

Also, like a canonical NK simulation model, an NK-like model maps a set of product specification values -- a business model of a firm (i.e., it is assumed that ten products constitute each venture) -- onto the product-market fitness level by randomly picking a number from the uniform distribution, $u[0,1]$. First, before a venture starts the product experimentation process, each venture has a starting product-market fit level randomly assigned because I assume that every venture has a set of multiple products (i.e., ten products) when it initiates the product experimentation process. At least some of them will be further innovated throughout the product development process. However, my NK-like model measures dynamic complexity using the parameter “A,” which varies from 0.1 to 0.9, with an interval of 0.1, unlike a traditional NK model. The parameter “A” for dynamic complexity in my model refers to the intensity of interconnectedness among ten vector elements in the market. Overall, every venture working in the same landscape is equally challenged by the same level of dynamic complexity -- the intensity of interrelatedness (the parameter “A”) – that is held constant for every venture within each market landscape. A total of nine different dynamic markets are simulated, depending on the magnitude of dynamic complexity ($A=0.1, 0.2, \dots 0.9$).

Modeling Venture Product Performance: Product-Market Fit

In my model, venture new product performance is measured by the product-market fitness level of a firm that reflects the degree to which a set of products they develop satisfies the demands

¹⁰ Please note that I assume that a venture will use its experience knowledge when it takes an adaptive approach to new product development instead of a systematic approach to new product development. Also, please note that every interval of the possible move is still set to 0.05, even if they move beyond 0.05. For instance, their move will be like 0.10, 0.15, 0.20..., but not like 0.09 or 0.16.

of the dynamically complex market in each landscape. Therefore, dynamic complexity varies at the environmental level. A higher dynamic complexity requires a set of higher interrelated products -- a more sophisticated business model for new product success.

Modeling Resource Coordination Costs

In addition, I limit the number of product experimentation rounds (i.e., the quantity of product development opportunities) assigned depending on the number of products developed at the same time by using the quadratic time complexity theory. Time complexity refers to the amount of time needed to process as a function of the input. First, to find a reasonable equation of time complexity, I assume that the resource coordination cost function could never be linear because the information needed to tackle the potential interactions (e.g., possible combinations) between multiple focal products that are being developed increases non-linearly as the number of focal products considered for the new product development of a venture increases. For example, I assume there will be no additional information variable when only one focal product is developed. However, once two focal products are developed simultaneously, one variable that accounts for the possible interactions between the two focal products emerges. Furthermore, if the quantity of the focal products simultaneously developed becomes three (3), there can be three two-way interactions and one three-way interaction. Thus, it turns out that at least four additional information variables that can deal with the total of four possible interactions are needed. After taking both this computation logic and the quantity of the focal products themselves (i.e., one information variable needed for each product) into account for the calculation of the number of information variables needed, it follows that the number of information variables is a quadratic function of the number of focal products being developed. Hence, the following equation is

derived: $I = D^2$ where D is the number of focal products for new product development/experimentation, and I is the total quantity of information variables needed for the new product development. Based on quadratic time complexity theory, my model assumes that there can be 100 (one hundred) new product development opportunities – product experimentation (decision) rounds - at the maximum. Therefore, the approximate number of decision rounds allocated is calculated depending on the number of focal products (D) simultaneously developed. Table 3-2 shows that 100 product decision rounds are allowed for $D=1$, but only 25 product decision rounds/opportunities are allocated for $D=2$. Following this logic, I assume that up to seven (7) products can be developed simultaneously, and only two product decision rounds/opportunities are allowed for $D=7$.

Modeling Modular versus Parallel New Product Development Strategies

Since the number of focal products being developed simultaneously (D) is measured and varied across thousands of landscapes in my model, modeling a modular vs. a parallel product development strategy becomes straightforward. Suppose the number of focal products developed simultaneously is one ($D=1$). In my study, this refers to a modular product development strategy, as only a single product is focused on and developed at one time. However, if D is over one (1), it refers to a parallel strategy because more than one product is considered and developed simultaneously in each experimentation round. In my model, D can vary from two (2) to seven (7) due to the assumption of quadratic time complexity where product experimentation rounds/opportunities are permitted up to 100 rounds, a maximum of total product experimentation rounds in my model. I also investigate the relationship between D (i.e., the number of focal

products) and the product-market fitness level of a firm because there is a variation in terms of D (i.e., the number of focal products developed at once) within parallel strategies.

Controlling for both Adaptive and Systematic methods for New Product Development Strategies

Although the product development method itself is not the main focus of this study, my modeling controls for the effect of new product development tools. Given that ventures can use either adaptive methods or systematic tools in order to develop new products, I model both approaches and assign them to all the ventures equally to control for the effect of the new product development method on venture new product performance. In my model, a venture that takes an adaptive approach to new product development continues to update focal products by one step (the Delta (=0.05)) with either direction (+ or -) at a time unless the venture faces the same circumstances that match with the accumulate stock of experiential knowledge accessible to the venture. In other words, when the selected possible product specifications for the experimentation are not similar to any experiential knowledge a venture can access, a venture will create a new specification of focal products to experiment with, leaving all the other non-focal products to remain in the same specifications. Once a venture tests a new version of focal products and obtains market feedback (i.e., the actual product-market fitness level) after experimentation, the venture will decide whether to revise the focal products or not for the subsequent experimentation round. If the updated product specification generates a higher product-market fit after the experimentation, the venture will choose to update the focal products for new product development. Otherwise, the venture will not decide to pivot. However, the radical pivot will happen in my model whenever any available experiential knowledge is the same as the potential product specification chosen for product experimentation. For instance, the current product

configuration of a firm is (99.05, 100.80, ... 99.95), and the venture happens to select the following potential product specifications of focal products (99.00, 100.85, ..., 99.95) for the upcoming experimentation (Please note that the firm develops two focal products simultaneously at each time in this example). If these values of product specifications are equivalent to any set of experiential knowledge, the venture can access at that moment, radical pivoting – the entire business model change - will happen in the direction suggested by the extant stock of knowledge.

On the other hand, a venture can take a systematic approach to new product development¹¹. In my modeling for a systematic method, a venture first explores half of the possible combinations of the focal product configuration by revising each focal product specification by only one step (i.e., the parameter delta: either +0.05 or -0.05) in each experimentation round. Given that there are only two possible directions to pursue in each decision round due to the bounded rationality assumptions, $\frac{2^D}{2}$ (where D is the number of focal products that are developed at once) is the number of possible combinations to choose from for the new product experimentation. That is, a venture that employs a systematic approach to new product development first explores the potential product configurations that are feasible at that point and estimates their product-market fit levels roughly, resulting in several new product configurations that have similar product-market fit estimates. As the product-market fit estimates are rounded to the nearest 1,000th to reflect the limited rationality of a venture that takes a systematic approach within the entrepreneurship context, there are always product configuration options that share the same product-market 'rough fit estimates.' Once a venture obtains a small set of good-enough product configurations that share the same value of the product-market fit estimate, it will select the first product configuration it

¹¹ The theoretical background of this method – the key focus of the essay 1 – is explained in the chapter 2 (Essay 1)

encounters for new product experimentation. The selected product specification will actually be updated if the newly chosen product configuration produces a higher product-market fit than the current product configuration. Otherwise, the newly elected product configuration will not be updated further. Instead, the current product specification will remain in the following period. This product development procedure will iteratively be repeated until the last experimentation round allocated.

3.4. RESULTS & IMPLICATIONS

Using the simulation procedures demonstrated above, I simulated the longitudinal data by following the procedure described below: First, given N , Δ , and A (i.e., dynamic complexity), the starting configuration of all of the products of a venture (i.e., a business model) is randomly assigned. Second, every 200 ventures as a cohort start developing their focal products by taking either an adaptive or a systematic method until its entire product development opportunities (i.e., experimentation rounds) are depleted. A product-market fitness level is computed and recorded in each experimentation round. Finally, these procedures are reiterated for the nine dynamic market landscapes (i.e., A =from 0.1 to 0.9). To gain the final results for the analysis, I ran the model about 1,024 times for each set of parameters, obtaining 102,400 data points of product-market fitness level each experimentation round per each level of dynamic market conditions. This amount of longitudinal dataset ensures more than 99% statistical significance of the average product-market fitness level.

As mentioned earlier, I used a pseudo-NK model to compute the product-market fit determined by both the magnitude of the external condition -- dynamic complexity -- and the

number of focal products considered to develop simultaneously -- a parallel versus a modular strategy. Using the simulation model, I investigated the relationship between the number of focal products developed simultaneously (D) and the product-market fit (i.e., the new product performance of a venture). I further examined specifically under what external condition (i.e., the level of dynamic complexity) and internal condition (i.e., resource coordination cost) such relationship is moderated. Hence, my first analysis was conducted without considering the internal condition (i.e., resource coordination costs). I analyzed what kind of relationship exists, manipulated the magnitude of dynamic complexity that varies from 0.1 to 0.9, and analyzed how this relationship changes depending on the level of dynamic complexity. After conducting the first set of analyses, I examined the second set of results after accounting for the resource coordination costs. I used time complexity theory to reflect this resource coordination expenditure for the second set of analyses by constraining the total number of product decision rounds allocated depending on the number of focal product opportunities pursued and developed simultaneously at the same time (i.e., the variable “D”).

Model Performance Results: Final Product-Market Fit

Given the assumption of the limits in the rationality of human beings (Simon, 1972; 1990), it has typically been assumed that entrepreneurs tend to focus on one new product opportunity at a time (Gans et al., 2019; McGrath, 1999; Sarasvathy, 2003). Hence, entrepreneurs are assumed to use a modular strategy in order to create and develop a novel product quickly because the intensive learning opportunity toward a single product opportunity can be obtained at an affordable cost by implementing this strategy (Baldwin & Clark, 2000; Blank, 2013; Hannah & Eisenhardt, 2018; Ott & Eisenhardt, 2020). A modular strategy helps a venture quickly deepen the chosen

product opportunity with numerous iterations. On the contrary, however, entrepreneurs with a parallel strategy can enhance multiple alignments across various product dimensions (e.g., specifications) through integrated product development despite its relatively high coordination costs and slow process (Eisenhardt & Bingham, 2017; McDonald & Eisenhardt, 2020; Ott & Eisenhardt, 2020). Furthermore, a parallel strategy helps a venture hedge its bets against a variety of future contingencies that could arise unexpectedly (Chen, Wang, Cui, & Li, 2021; McGrath, 1999; Fernhaber & Patel, 2012; Ott & Eisenhardt, 2020).

However, if the primary source of uncertainty that ventures encounter is dynamic complexity, the market will likely have multiple requirements (e.g., multiple technical standards, complicated venture policies, various customer demands, etc.) for new product development (Greenwood et al., 2011). Moreover, these requirements are likely to be complicatedly interrelated (Battilana et al., 2009), demanding a more sophisticated set of multiple products/services with the optimal configuration altogether. Hence, under this dynamically complex environment, I expect that a parallel strategy has the edge over a modular approach in general because a parallel strategy is expected to address this multiplicity of requirements and their interactions (i.e., dynamic complexity) more effectively than a modular strategy. In other words, a modular strategy is weak in tackling dynamic complexity, as this type of strategy does not handle multiple factors integratively and holistically. A modular strategy can be strong if the low resource coordination costs and speed advantages are critical in resolving the surrounding knowledge problem, as this strategy allows a venture to develop and deepen a single new product quickly. However, a modular strategy is likely to be weak for configuring multiple factors holistically at once to enhance the alignment levels among different components (e.g., features/dimensions) that make up the business model (i.e., a set of products/services) of a venture.

Furthermore, the total new product performance of each product development strategic approach is examined from the simulation model. As figure 3-1 presents, the average final total product-market fitness levels are calculated for both a modular and a parallel product strategy, assuming a venture can have one hundred (100) product development opportunities – a maximum amount of experimentation rounds permitted in my baseline simulation model - regardless of which strategy between modular and parallel strategies is employed. The orange dotted line in figure 3-1 represents the product-market fitness levels attained by the parallel method, and the solid red line in the figure represents the product-market fitness levels achieved by the modular strategy. The standard error of the point estimates is too tiny to draw the vertical lines in the figure, ensuring 99% confidence intervals. As Figure 3-1 reports, a parallel strategy's final total product-market fitness levels are consistently higher than those of a modular strategy under every level of dynamic complexity.

In addition, since the resource coordination cost of a modular product development strategy is low and the product development process is fast due to its intensive learning towards a single product opportunity, ventures with a modular strategy are likely to have more product development experimentation rounds (i.e., product development opportunities) than those with a parallel strategy primarily, *ceteris paribus*. As noted earlier in the previous sections, I use quadratic time complexity theory to allocate the experimentation rounds differently for a parallel strategy compared with a modular strategy (Sipser, 2012). As the number of experimentation rounds permitted for each strategy is computed for my simulation model in Table 3-2, a parallel strategy can have a far smaller number of new product development opportunities than a modular strategy due to the resource coordination cost difference, *ceteris paribus*. If a venture with a modular strategy allows pursuing one hundred new product development opportunities (i.e., a total of 100

periods/decision rounds), then a venture with a parallel strategy can have less than or equal to twenty-five (25) new product development opportunities (i.e., less than or equal to 25 experimentation rounds in total) depending on the number of focal products developed simultaneously.

Moreover, ventures that employ a parallel strategy are more likely to suffer from higher new product development costs than those that use a modular strategy (Bakker & Shepherd, 2017; Gruber et al., 2008; Shepherd & Gruber, 2021). More specifically, as the number of focal products simultaneously developed at once increases, resource coordination costs are likely to increase. The simultaneous development of multiple products needs extra means (i.e., resources for coordinating and multitasking) to test and build the products. That is, arranging a set of multiple products/services to find the optimal configuration would require sophisticated and costly methods. Hence, as I mentioned earlier in the previous sections, I use the quadratic time complexity theory (Sipser, 2012) to account for these potential resource coordination costs. Nonetheless, as figure 3-2 reports, a parallel strategy's final product-market fitness levels are still constantly higher than a modular strategy, even after controlling for the relevant product development costs.

Although the magnitude of the performance difference between a modular and a parallel strategy becomes smaller after controlling for the coordination resource expenditures, the results from my simulation model confirm the relative advantage performance of a parallel strategy over a modular strategy. In other words, my simulation results indicate that the total performance of a parallel strategy compared with a modular strategy is strong enough to overcome the potential resource coordination costs associated with the number of focal product opportunities simultaneously developed at a time. Further, the relative strength of a parallel strategy over a

modular strategy is unlikely to change because a parallel strategy will still allow entrepreneurs to counterbalance some possible product failures that might occur due to dynamic complexity. Thus,

Proposition 1: In an environment characterized by dynamic complexity, firms that use a parallel strategy will outperform those that use a modular strategy, even after controlling for resource coordination costs.

Model Performance Results: Dynamic Complexity to Product-Market Fit

One of the critical questions in entrepreneurship is how increasing degrees of uncertainty affect new product performance (McMullen & Shepherd, 2006; Packard & Clark, 2020). Among various sources of uncertainty, dynamic complexity is one of the key sources of uncertainty that has been little investigated in previous entrepreneurship research (Busenitz & Barney, 1997; Townsend et al., 2018; Zahra, Neubaum, & El-Hagrassey, 2002). Figure 3-1 presents how final product-market fitness degrees (i.e., new product performance) of both strategies -- a parallel versus a modular -- change as dynamic complexity increases. As the results of the baseline model in the figure 3-1 report, the total final product-market fits of a parallel strategy consistently remain at a similar level across every possible degree of dynamic complexity. In contrast, the total fitness level of a modular strategy tends to decrease as the magnitude of dynamic complexity increases.

This result is consistent with theoretical arguments in a few extant entrepreneurship studies that investigate the relationship between the number of entrepreneurial opportunities and firm performance (Atuahene-Gima & Li, 2004; Gruber et al., 2008). Even though the main research context of these existing studies is at the pre-entry market stage, and they do not directly examine the link between uncertainty and performance, these previous studies highlight that identification

of multiple opportunities before the first market entry leads to higher performance because of the wide availability of alternative solutions that a firm can create (Gruber et al., 2008).

In addition, a higher level of dynamic complexity will require a more elaborate set of products/services (i.e., a business model) that are sophisticatedly interconnected for new product success. A business model becomes sophisticated when the components (e.g., all the product features) of a business model (i.e., a set of products/services) are optimally arranged and interconnected. More specifically, the interactions among the elements of a business model should be effectively dealt with to maximize the positive function of each component (e.g., product feature/dimension) and to minimize the conflicts among the elements. Ventures with a parallel strategy are more likely to manage the potential interaction effects than those with a modular strategy largely because ventures that use a parallel strategy take an integrated approach to new product development (McDonald & Eisenhardt, 2020; Ott & Eisenhardt, 2020). Parallel strategies help entrepreneurs think about the optimal fit among the various components of a business model holistically as a whole when they develop a new product. In contrast, modular strategies are helpful for intensive learning towards the selected single product domain, which can even perpetuate myopic decisions. Thus, it follows that a modular strategy is likely to be more vulnerable to a high level of dynamic complexity (i.e., the interconnectedness of multiple factors of the entrepreneurial environments) compared with a parallel strategy, as modular strategies cannot aid in handling multiple dimensions (e.g., products and their specifications) holistically in parallel.

Figure 3-2 reports that a parallel strategy's effectiveness remains higher than a modular strategy, even after controlling for the relevant costs associated with the number of focal products developed simultaneously. The results shown in figure 3-2 indicate that the magnitude of the product-market fit difference between a parallel and a modular strategy is large enough to

overcome the challenges of resource coordination expenditures. Taking all of these results and theoretical reasoning together, a parallel strategy is generally less vulnerable to a higher dynamic complexity than a modular strategy. Hence,

Proposition 2: Dynamic complexity amplifies the relative weakness of a modular strategy compared with a parallel strategy. That is, the effectiveness of a parallel strategy over a modular strategy tends to become more prominent as dynamic complexity increases.

Model Performance Results: The Relationship Between the Number of Focal Products Developed Simultaneously (the variable “D”) and the Final Product-Market Fit

I further examine how many focal products should be developed simultaneously for new product success. The effectiveness of ventures that use a parallel strategy over a modular strategy is backed by the classical decision theory that emphasizes the importance of the wide availability of options (Chen et al., 2021; Fernhaber & Patel, 2012; Gruber et al., 2008). A parallel strategy can help entrepreneurs expand the possible decision space that they can utilize by considering multiple products so that novel combinations of resources (e.g., knowledge) are more likely to occur (McDonald & Eisenhardt, 2020). Further, a parallel strategy helps strategically reduce, bear, or even thrive on the ‘unknowingness’ in which the range of potential entrepreneurial opportunities is wide yet indeterminate (Andries, Debackere, & Looy, 2013; Knight, 1921; McGrath, 1999). More specifically, dynamically complex environments can be viewed as the decision space where numerous unpredictable opportunities exist (Townsend et al., 2018; Townsend & Hunt, 2019; Zahra et al., 2002). In this environment, at least several opportunities are likely to emerge unexpectedly due to complicated interactions between them. As a parallel strategy develops multiple new products simultaneously while a modular strategy focuses on developing a single

new product, a parallel strategy is more effective in hedging against such unexpected challenges than a modular strategy. Given that a group of multiple new products is developed from parallel strategies, some of the new products in this set can also be used as fallback options for opportunity capture even when other new products fail in the market.

As seen in figures 3-3, my baseline model results confirm that, under conditions of dynamic complexity, the aggregated mean product-market fit improves as the number of focal new products simultaneously developed increases. As long as a venture has sufficient capital to experiment with the potential new products they want to develop, the following proposition will generally be held true.

Proposition 3: In the baseline model (i.e., without controlling for resource coordination costs), there is a positive relationship between the number of products simultaneously developed and the product-market fitness level.

As described above in the prior sections, one of the downsides of a parallel strategy is that the resource coordination costs may increase exponentially as the number of focal products increases (Bakker & Shepherd, 2017; Gruber et al., 2008; Shepherd & Gruber, 2021). Previous entrepreneurship studies also note that the effectiveness of a parallel strategy might be subject to decreasing marginal returns (Bakker & Shepherd, 2017; Gruber et al., 2008)¹². Once the limited resource availability -- resource coordination costs -- is considered (i.e., the second set of an analytical model for this study), a parallel strategy can suffer from cognitive constraints (Gruber et al., 2008), time limits, or any escalating challenges from the resource coordination. Specifically, as shown in figures 3-4, when entrepreneurs deal with multiple products beyond the particular

¹² This study does not investigate the product development/experimentation processes. Instead, it focuses on the amount of firms' technological resources before first entering the market

number of focal products simultaneously developed, a venture might likely be overwhelmed by the dynamically complex environment. If the number of factors (e.g., products and their interactions) that entrepreneurs should coordinate passes a particular threshold, entrepreneurs likely become incapable of analyzing the complex interaction of the multiple components primarily due to cognitive and resource constraints, failing to enhance product-market fit. The extant studies on cognitive abilities demonstrate that the highest interaction that a human individual can effectively process is a three-way interaction (Halford, Wilson, Guo, Gayler, Wiles, & Stewart, 1994). Consistent with this previous finding, my simulation results also change the direction of product-market fit achieved after D (i.e., the number of focal product opportunities simultaneously developed) is over three (3). Before D becomes 4, there is a positive relationship between D and the performance, but once D is above 4, the relationship starts to change to a negative relationship, as Figure 3-4 reports. Thus,

Proposition 4: After accounting for resource coordination costs, there is an inverted U-shape relationship between the number of simultaneously developed products and the product-market fitness level.

3.5. DISCUSSION & CONCLUSION

Although it is widely known that ventures often develop various entrepreneurial opportunities simultaneously (Bakker & Shepherd, 2017; Barreto, 2012; Gruber et al., 2008; McDonald & Eisenhardt, 2020), whether and under what conditions a parallel new strategy should be formulated for new product success has little been investigated in previous entrepreneurship research. This study attempts to address this question and contributes significantly to the

entrepreneurial strategy and theory of uncertainty in the entrepreneurship literature. By using the NK-like simulation model (Valente, 2014) first for entrepreneurship and strategy research to reflect the realistic new product development process, I analyze the relationship between the number of focal entrepreneurial opportunities pursued at the same time and the product-market fit in the environment that is characterized by dynamic complexity. Overall, this study takes a contingency approach to entrepreneurial strategic choice regarding the number of focal product opportunities and confirms that a key characteristic of the decision environment under which a venture acts (i.e., the level of dynamic complexity), the primary internal condition of a venture (i.e., resource coordination cost), and entrepreneurial strategic choice (i.e., a modular versus a parallel strategy) should all be well aligned in order to enhance venture new product success (Davis et al., 2009; Galbraith, 1973; Hunt, Townsend, & Jin, 2021; Gruber et al., 2008; Lawrence & Lorsch, 1967; Townsend et al., 2018).

The simulation results from this study suggest that it is systematically more effective to employ a parallel strategy than a modular strategy, especially when ventures experiment with (a) new product(s) in the face of a high level of dynamic complexity. Although the results indicate that resource coordination cost is likely to attenuate the effectiveness of a parallel strategy, the model also finds that the performance of a parallel strategy is systematically higher than that of a modular strategy, even after controlling for high resource coordination costs. However, a parallel strategy can become less effective if the number of focal product opportunities simultaneously created (the variable “D” in my simulation model) becomes very high, particularly if a venture has too limited capital to pursue numerous product development opportunities over the entrepreneurial journey. Suppose a venture suffers from huge resource coordination expenditures (like resource coordination costs according to the quadratic time complexity theory shown in this study) while

the venture's capital for new product development is too limited to cover the expenses. In that case, firms cannot handle a large number of focal products (the variable "D") for new product experimentation. More specifically, my model results suggest that about three (out of ten) is the optimal number of focal products tested simultaneously for a parallel strategy.

Overall, my study contributes to the literature on entrepreneurial strategy and theories of uncertainty. First, this study is one initiative that directly tests and compares the effectiveness between a modular and a parallel strategy. Even though prior studies acknowledge that multiple opportunities are often simultaneously pursued by a venture (Bakker & Shepherd, 2017; Barreto, 2012; Gruber et al., 2008; McDonald & Eisenhardt, 2020), few studies have investigated the value of simultaneous new product development and relevant entrepreneurial strategic choices. Specifically, few previous studies have tested how new products should be strategically experimented with and developed after entrepreneurs entered the market by accounting for the effects of both internal and external conditions on new product success, even though not only the market conditions but also firm-specific conditions have often been theorized to determine the firm performance (Barron & Tang, 2011; Gnyawali & Fogel, 1994; Forbes, 2007; Gartner, 1995). My simulation results show that the simultaneous development of multiple new products is systematically more effective than the development of a single product in the face of increasing levels of dynamic complexity and that three focal products would be an ideal number for simultaneous experimentation unless resource coordination cost is low. Moreover, according to my results, such comparative effectiveness of parallel strategies over modular strategies can even overcome the challenges of high resource coordination costs. By implication, if a venture develops a set of products/services (i.e., a business model) that are modularly decomposable (Ethiraj & Levinthal, 2004; Sarasvathy, 2003; Simon, 1969), which will likely require far less resource

coordination costs, a parallel strategy can become increasingly effective (i.e., the ideal number of focal products for simultaneous experimentation would increase) as the new product development process will be built on robust information about product-market fit with fewer diminishing returns.

Second, this study reveals the key environmental mechanisms that explain how dynamic complexity is likely to be tackled by entrepreneurial strategic choices regarding the number of focal products tested and developed simultaneously. My simulation results indicate that a parallel strategy is stronger in dealing with a higher level of dynamic complexity than a modular strategy. In other words, a parallel strategy can generally be a robust product experiment design, particularly if the market is characterized by a high level of dynamic complexity, because this strategy helps consider multiple product features and their interconnectedness holistically and develop various new products as a product portfolio to hedge against the indeterministic market (Chen et al., 2021; Fernhaber & Patel, 2012). By implication, my study recommends that entrepreneurs investigate the nature of decision environments (i.e., knowledge problems) and the magnitude they encounter in the new product development process before making a strategic choice as to how many new possible products should be tested simultaneously for new product development.

Lastly, my study is one of the first to introduce pseudo-NK simulation modeling (Valente, 2014) to the fields of entrepreneurship and strategy. Such pseudo-NK simulation modeling overcomes the inherent constraints of a canonical NK simulation model by allowing real-valued numbers (instead of binary values) for each decision vector element and avoiding a substantial computational burden. I used this advanced tool to simulate the decision landscapes in which actors employ different decision logics that reflect more realistic new product experimentation processes by using real-valued numbers.

Limitations and Future Research

Nevertheless, my model does not yet focus on the ways in which entrepreneurs should manage and leverage a variety of environmental contingencies effectively when they pursue product opportunities, even though this study effectively examines when and to what extent entrepreneurs should develop new product opportunities simultaneously under conditions of dynamic complexity for new product success. Future research might study to clarify how entrepreneurs tackle various knowledge problems (e.g., ambiguity, equivocality) that could emerge throughout the venturing process (Hunt et al., 2023; Townsend et al., 2018). More specifically, future entrepreneurship studies should continue to analyze how the value of various decision logic changes depending on different types of entrepreneurial environments by disaggregating the entrepreneurial environment into various types (e.g., different knowledge problems).

Second, my model in this study focuses on simulating the decision landscapes in which ventures utilize either systematic or adaptive approaches to new product development under the key assumption that entrepreneurs use intendedly rational logics. Since my dissertation examines how entrepreneurial “strategies” (the deliberate decision logic that has its intended ends) work, my model does not reflect non-rational entrepreneurial choice processes (e.g., impulsive-driven decision logic). However, it would also be interesting to study whether a parallel strategy is still more effective than a modular strategy when entrepreneurs rely on non-rational decision logic. Future research models might want to reflect and compare various entrepreneurial choice processes, including a-rational decisions (e.g., impulsive-driven decisions) without any intended purposes (e.g., specific goals) that are predetermined (Lerner et al., 2018).

Third, in this essay, I used the NK-like simulation model, which allows for robustly measuring decision environments (e.g., dynamic complexity) and generating simulated longitudinal data that could better reflect the realistic decision logics and their outcomes (i.e., the product-market fit). Future studies could use real-world empirical data (e.g., resource expenditures) to see if the findings of this study hold true.

Conclusion

In recent years, entrepreneurship scholars started acknowledging that entrepreneurs often pursue multiple opportunities simultaneously (Bakker & Shepherd, 2017; Barreto, 2012; Gruber et al., 2008; McDonald & Eisenhardt, 2020). Furthermore, entrepreneurial strategy scholars advanced product experimentation processes by “carefully formulating the underlying problem the startup is seeking to solve . . . and only then crafting a costly set of experiments” (Felin et al., 2019, p. 4). Nevertheless, it is still less clear how the new product experimentation process should be precisely designed to enhance the product-market fit. This study fills this gap by studying the entrepreneurial choice of how many new products should be simultaneously developed for new product success. In particular, this paper studies how such entrepreneurial choices regarding new product development work in dynamically complex environments. By first using the NK-like simulation method for entrepreneurship and strategy research, I examine how both specific internal (i.e., resource coordination costs) and external decision context (i.e., the magnitude of dynamic complexity) shape the product-market fit of these entrepreneurial strategic choices on new product development. This study suggests that a parallel product development strategy is systematically superior to a modular strategy under conditions of dynamic complexity unless resource coordination costs are incredibly high, and yet the choice on the number of new focal products

simultaneously developed should be carefully made by taking firm-specific internal factors (e.g., resource expenditures) into consideration. Overall, my study confirms that entrepreneurial strategic choice should be aligned well with both external (e.g., specific knowledge problems) and internal conditions (e.g., resource coordination costs) to enhance new product success (Davis et al., 2009; Galbraith, 1973; Gnyawali & Fogel, 1994; Gruber et al., 2008; Hunt et al., 2021; Lawrence & Lorsch, 1967; Townsend et al., 2018).

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Table 3-1 An NK-like model Parameter and Assumption Summary

Parameter	Description	Values used for the simulation	Underlying assumptions	Possible Empirical proxies
N	Total number of the products of a venture	10	The total number of products a firm can use is fixed at 10 for every model simulated for parsimony.	Total number of decisions that can be made regarding product specifications
D	The number of focal new products tested and developed simultaneously at the same time	From 1 to 7	Due to the quadratic time complexity assumption, the maximum value of D is 7 (please see Table 3-2 for more detailed explanations). A venture can handle up to seven (7) focal new product experimentation at once, according to the quadratic time complexity theory and its function. If D is 1, then it denotes a modular strategy. However, if D is over 1 (i.e., 2, 3, 4, ..., 7), it represents a parallel strategy.	The number of new focal products tested and developed simultaneously at a time
A	The intensity of linkages among a set of products (i.e., dynamic complexity) that each market(landscape) requires.	From 0.1 (low) to 0.9 (high)	All of the products developed by a venture are interrelated. The intensity of these linkages reflects the level of dynamic complexity, so A is fixed to a specific value for all ventures in each landscape run to ensure it is measured at the market level.	Dynamic Complexity
Delta	The degree to which entrepreneurs can update a focal new product specification per experimentation round when not matched with the stock of experiential knowledge	0.05	As long as the venture does not encounter the same situation that matches with the accumulated stock of experiential knowledge that exists in the market at each experimentation round, a venture will revise the specification of a focal new product by +0.05 or -0.05 (i.e., Delta) per product in each experimentation round.	Bounded rationality
Total number of experimentation rounds	To reflect resource coordination costs (e.g., new product development costs), a different amount of product experimentation opportunities is allocated according to 'D' (The number of focal new products tested and	Please see Table 3-2 for details.	Depending on the resource coordination costs (e.g., new product development costs) associated with D (i.e., the number of focal product opportunities of a firm that are developed simultaneously), the total number of experimentation rounds is assigned differently. I used a quadratic time complexity theory to calculate the total number of experimentation opportunities allocated.	Total product development costs (especially concerning resource coordination costs)

	developed simultaneously at the same time)			
Total number of simulated firms per experimentation round	To ensure obtaining much less than 1% statistical errors for the point estimate, my model simulates 100 firms with 1,024 replication per experimentation round	102,400		

Table 3-2 Experimentation Round Allocation

Under the Quadratic Time Complexity Assumption

D (The number of focal new products simultaneously developed)	1	2	3	4	5	6	7
The number of experimentation rounds (new product experimentation opportunities) assigned	100	25	11	6	4	3	2

Figure 3-1 Final Performance by Dynamic Complexity
(No Resource Coordination Costs)

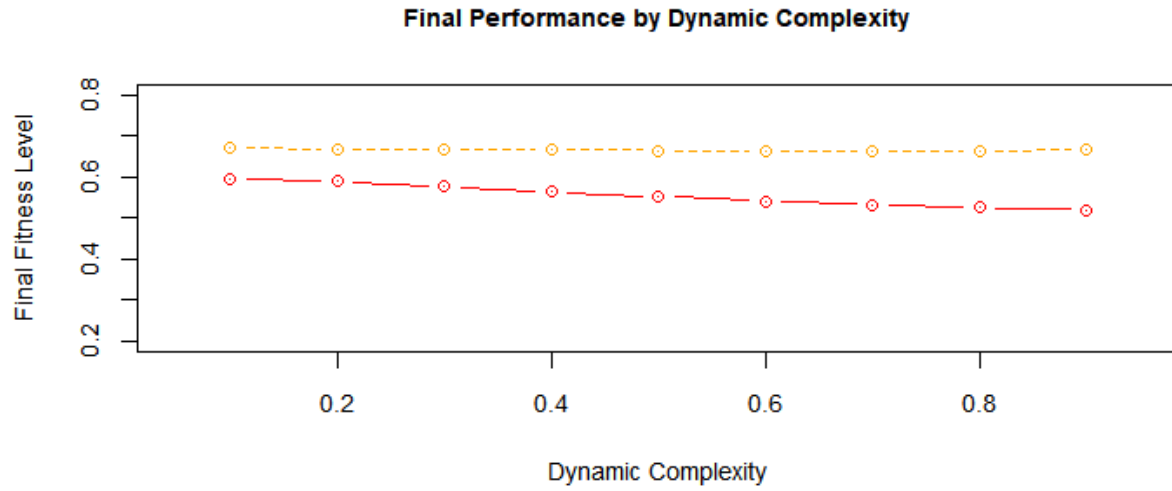
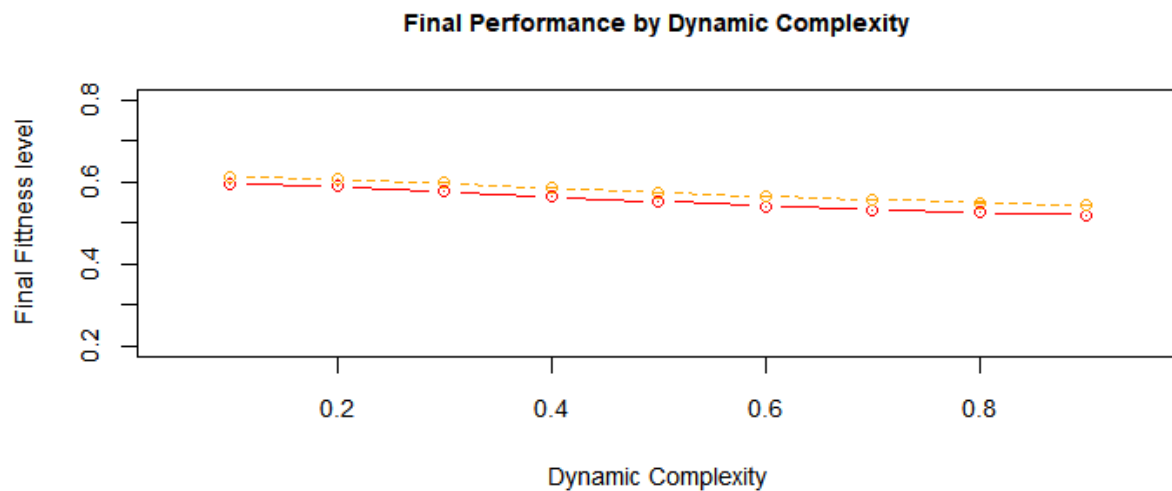
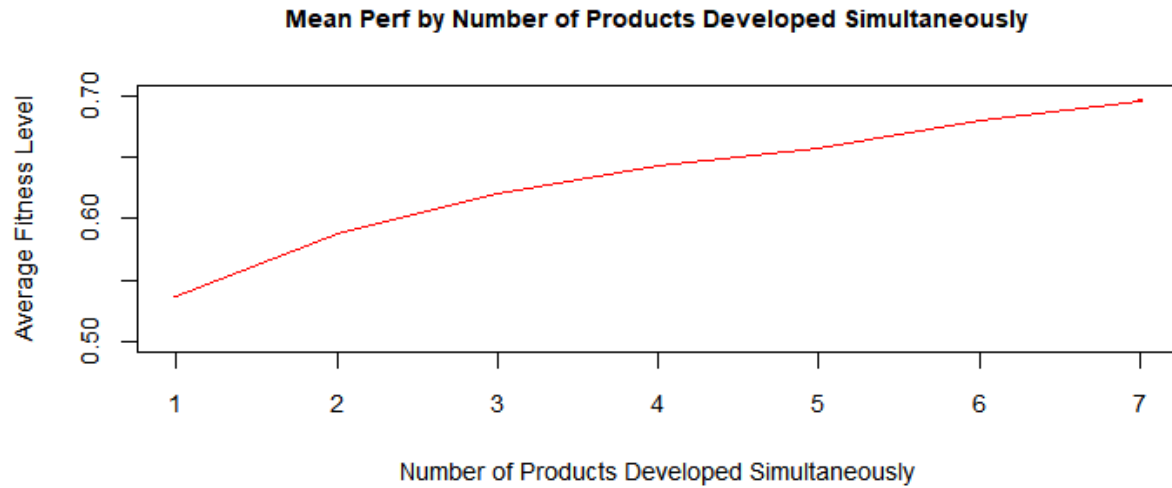


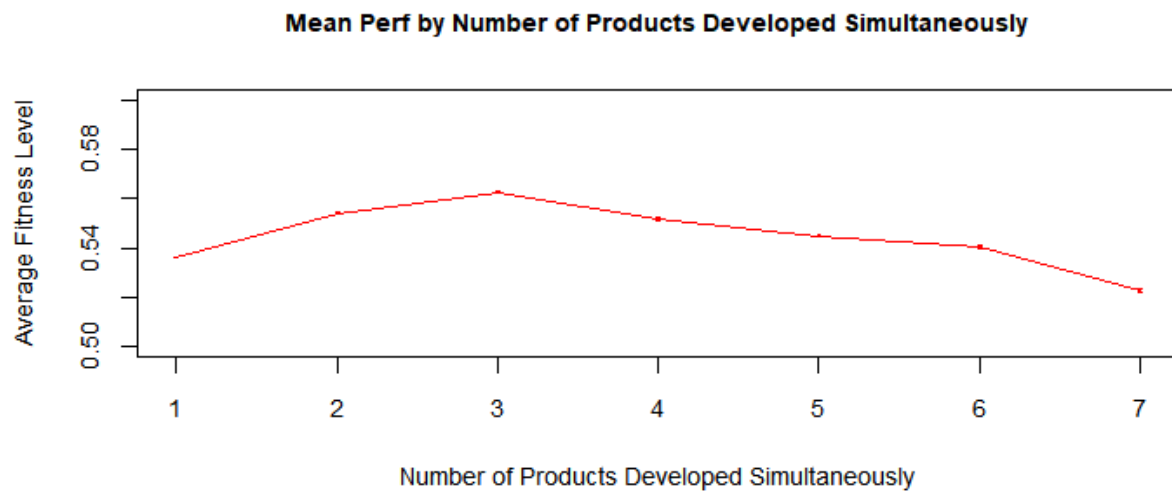
Figure 3-2 Final Performance by Dynamic Complexity
(Controlling for Resource Coordination Costs)



**Figure 3-3 Mean Performance by Number of New Products Developed Simultaneously
(No Resource Coordination Costs)**



**Figure 3-4 Mean Performance by Number of New Products Developed Simultaneously
(Controlling for Resource Coordination Costs)**



CHAPTER 4: ESSAY THREE

A SYSTEMATIC AND META-ANALYTIC REVIEW OF THE PERFORMANCE OF DECISION SPEED AND DECISION COMPREHENSIVENESS FOR ENTREPRENEURIAL STRATEGY

4.1. INTRODUCTION

Entrepreneurs venture into the unknown (e.g., environmental dynamism and Knightian uncertainty) with limited resources, requiring entrepreneurs to strategically utilize scarce resources and explore new entrepreneurial ideas in pursuit of new possibilities for creating and capturing value (Kier & McMullen, 2018). To date, a growing volume of entrepreneurship studies has explored how entrepreneurs often make efforts to speed up their decision-making process (e.g., using heuristics) to tackle high levels of uncertainties effectively (e.g., Busenitz & Barney, 1997; Forbes, 2005; Manimala, 1992). A key premise in many of these studies is that in the face of an unknowable and unpredictable future, “failing fast” (McGrath, 1999) can even be an effective entrepreneurial strategy (e.g., Bakker & Shepherd, 2017; Khanna, Guler, & Nerker, 2016).

The prevalence of “fail fast” perspectives in entrepreneurship is rooted in the logic that entrepreneurs will be able to obtain immediate critical feedback about the uncertain market rapidly; thus, entrepreneurs can use them for a fitness-enhancing strategy (Bingham & Eisenhardt, 2011; Eisenhardt & Tabrizi, 1995; McGrath, 1999) by making available means (e.g., new products being developed) to be constantly updated to satisfy the demand of the currently evolving market. Nevertheless, the utility of entrepreneurial strategies that rely on decision speed has been questioned because fast decision processes often produce biases and errors (Busenitz & Barney, 1997; Holcomb, Ireland, Holmes, & Hitt, 2009; Shepherd, Williams, & Patzelt, 2015), suggesting a more deliberate approach might have to be preferred for opportunity capture (Felin, Gambardella,

Stern, & Zenger, 2019; Zellweger & Zenger, 2021). Moreover, there are mixed findings regarding the effectiveness of entrepreneurial strategies that leverage “decision speed,” lacking evidence to support the fast entrepreneurial decisions and to falsify the benefits of more deliberate approaches in the entrepreneurship context (e.g., Bingham & Eisenhardt, 2011; Busenitz & Barney, 1997; Eisenhardt, 1989 versus Felin et al., 2019; Perlow, Okhuysen, & Repping, 2002).

In recent years, entrepreneurial strategy scholars started to develop and present a more deliberate decision procedure for entrepreneurial decision-making (e.g., Gans, Stern, & Wu, 2019; Zellweger & Zenger, 2021). They proposed a more scientific approach by arguing that entrepreneurial opportunities can be found, evaluated, and exploited through more systematic/analytic methods (e.g., Felin et al., 2019; Gans et al., 2019; Gans, Scott, & Stern, 2018; Kornish & Ulrich, 2011). This approach helps the efficient use of available resources largely due to its benefits in exploring and investigating broader entrepreneurial ideas/opportunities (i.e., new alternatives) and in systematically analyzing them (e.g., systematically generating and analyzing possible product candidates for new product development) (Gans et al., 2019), which can be referred to as “decision comprehensiveness.”

Further, recent entrepreneurship studies started to suggest that the general assumption about the entrepreneurial decision context (e.g., uncertainty) should be disaggregated into different sub-types (Packard & Clark, 2020; Packard, Clark, & Klein, 2017; Townsend, Hunt, McMullen, & Sarasvathy, 2018), suggesting that some particular entrepreneurial decision strategies are likely to, in fact, be more (in)effective depending on the different types of the entrepreneurial decision contexts (e.g., specific environmental conditions—Knightian uncertainty versus environmental dynamism—and business life cycle) under which entrepreneurs make decisions.

Nevertheless, few studies systematically review, elaborate, synthesize, and examine the effectiveness of these two decision strategies and the boundary conditions within the *entrepreneurship context*. As a result, several important questions remain unexplained in the literature. First, the current literature is less clear about whether, how, and why decision speed and decision comprehensiveness work as decision strategies in entrepreneurship, given the unique challenges of entrepreneurial decision environments. This set of questions is essential in the field of entrepreneurship because prior empirical research reports mixed findings on the conditions in which strategies that leverage decision speed and/or decision comprehensiveness are effective in entrepreneurship. Regarding decision speed, although prior research has predominantly assumed decision speed is an essential attribute of entrepreneurial decision-making (Baum & Wally, 2003; Busenitz & Barney, 1997; Forbes, 2005; Judge & Miller, 1991; Khanna et al., 2016), prior studies on decision speed have even been contradictory and fragmented, failing to confirm the effectiveness of decision speed for entrepreneurship (Judge & Miller, 1992 versus Capelleras, Greene, Kantis, & Rabetino, 2010; Perlow et al., 2002 versus Bakker & Shepherd, 2017). In addition, although some studies suggest decision comprehensiveness can be effective within the *entrepreneurship context* (e.g., Atuahene-Gima & Li, 2004; Fleming & Sorenson, 2004; Heavey, Simsek, Roche, & Kelly, 2009; Katila & Ahuja, 2002), empirical findings are mixed and often contradictory (e.g., Atuahene-Gima & Li, 2004; Priem, Rasheed, & Kotulic, 1995; versus Fredrickson & Mitchell, 1984; versus Heavey et al., 2009; versus Miller, 2008). Further complicating these questions is the recognition in a growing number of studies that the relative effectiveness of decision strategies (e.g., decision speed and decision comprehensiveness) is contingent upon the specific knowledge problems entrepreneurs must contend with in different decision environments (e.g., Knightian uncertainty—Townsend et al., 2018).

A second problem in existing research stems from a lack of construct clarity, which creates numerous inconsistencies in the operationalization strategies for each variable. For example, one common operationalization strategy for decision comprehensiveness is primarily based on the assumption that firms conduct an extensive external search to gather and analyze market information to respond and adjust to the market effectively (e.g., Forbes, 2007; Fredrickson, 1984). Alternatively, other studies operationalize decision comprehensiveness by assuming that firms can generate and analyze multiple alternatives (e.g., new product ideas) by thoroughly processing and analyzing extensive information (e.g., Atuahene-Gima & Li, 2004; Slotegraaf & Atuahene-Gima, 2011; Talaulicar, Grundei, & Werder, 2005; Zahra, Neubau, & El-Hagrassey, 2002) rather than just reacting to the environmental stimuli. In addition, prior studies offer conflicting perspectives on the relationship between decision speed and decision comprehensiveness. In some studies, these decision strategies are treated as complementary strategies (e.g., Bartkus, Mannor, & Campbell, 2022; Burgeois & Eisenhardt, 1988; Talaulicar et al., 2005). However, in other studies, these decision strategies are theorized to function in opposite ways, as incompatible approaches to decision-making (e.g., Arend, Cao, Grego-Nagel, Im, Yang, & Canavati, 2016; Atuahene-Gima & Li, 2004; Baum & Wally, 2003; Capelleras et al., 2010; Fredrickson & Mitchell, 1984).

Using multi-level meta-analytic tools (Cheung, 2014; 2015), this study addresses these problems by systematically reviewing, analyzing, and disentangling the roles of decision comprehensiveness and decision speed in entrepreneurship. In doing so, my study offers three important contributions to extant research on the roles of decision speed and comprehensiveness in entrepreneurship. First, by clarifying a key mechanism through which decision speed and decision comprehensiveness can systematically be effective within *the entrepreneurship context* and integrating the relevant studies, I provide a systematic framework for researching the

contingent roles of decision speed and comprehensiveness within the entrepreneurship context. Second, through my systematic review and analysis of existing research, my study disentangles the decision comprehensiveness and decision speed constructs by identifying the different ways in which these decision strategies impact new venture performance. A lack of construct clarity may be one of the reasons why the literature created fragmented theories and produced mixed evidence concerning the value of decision comprehensiveness and decision speed for *entrepreneurship*. Third, this study analyzes the role of decision comprehensiveness and decision speed for entrepreneurship by synthesizing the previous studies and their existing findings, whose effect size would be contingent upon the type of entrepreneurial environment (e.g., environmental dynamism versus Knightian uncertainty) upon entrepreneurial life cycle (e.g., opportunity exploration versus exploitation stage; financial versus non-financial pursuits) under which entrepreneurs act, and upon how the construct (e.g., decision comprehensiveness) is operationalized and measured.

4.2. THEORY & HYPOTHESIS

Entrepreneurial Strategy and Venture Performance

Entrepreneurs venture into the unknown (McGrath, 1999; McMullen & Shepherd, 2006; Packard et al., 2017; Townsend et al., 2018) with limited resources available. Thus, they should make strategic decisions regarding how to use their available resources effectively and efficiently to create and capture value. Since the resources accessible to entrepreneurs are often limited, entrepreneurs should strategically utilize the accessible resources to develop or create means (e.g., a solution set of a venture, such as a group of new products/services produced by a venture) that achieve the intended ends (Ireland, Hitt, & Sirmon, 2003).

The common goal of entrepreneurs is to make higher than normal profits. However, capturing entrepreneurial value is usually possible when entrepreneurs are involved in both opportunity-seeking behavior (e.g., exploring new opportunities to create new products/services) and advantage-seeking behavior (e.g., exploiting new opportunities by using appropriate methods/strategies) (Ireland et al., 2003) and when the new products/services entrepreneurs offer match well with the future environments (e.g., future demands and wants) (e.g., contingency theory) (Daft & Macintosh, 1981; Eisenhardt & Tabrizi, 1995; Galbraith, 1978).

However, the entrepreneurial environment is flooded with many kinds of uncertainties (e.g., environmental dynamism and Knightian uncertainty) (Packard & Clark, 2020; Packard et al., 2017; Townsend et al., 2018). Hence, entrepreneurs should formulate and implement different strategies to contend with different types of entrepreneurial environments (Townsend et al., 2018), which generate unique challenges that are distinct from non-entrepreneurial environments (Busenitz & Barney, 1997; Foss & Klein, 2012; McMullen & Shepherd, 2006; Sarasvathy, 2001)

Therefore, in this study, I focus on the contingency theory under different entrepreneurial decision contexts, how and why decision speed and comprehensiveness can enhance decision performance. First, I illustrate a key mechanism for how and why both strategies can be effective within *entrepreneurial environments* and can be considered an effective approach in terms of types of rationality—a fundamental concept in organizational decision theory. Specifically, these two entrepreneurial strategies—decision speed versus decision comprehensiveness—differ in how bounded rationality is modeled. Hence, it can be assumed that actors can still be somewhat thorough and deliberate regarding investigating the accessible resources through decision comprehensiveness (i.e., *procedural rationality*) despite their fundamental limits. On the contrary, “bounded rationality” can also be interpreted by the framework that agents cannot be thorough and

rational enough (i.e., limited cognitive capacities) when making decisions. Instead, they can rely on fast decisions to obtain new information/feedback directly from their environment and update the available means to match well with this feedback (i.e., *adaptive rationality*). Such speedy adaptation is likely to help capture value quickly due to increased fit between the solution sets (e.g., a group of products/services developed by a firm) that actors offer and the actual demands of the environment (Daft & Macintosh, 1981; Eisenhardt & Tabrizi, 1995; Galbraith, 1978; Hunt, Townsend, Manocha, & Simpson, 2023). Second, I review and analyze the decision comprehensiveness and decision speed constructs to disentangle how each of these decision strategies works and interacts within the *entrepreneurship context*, as a lack of construct clarity might have been why the prior literature on decision comprehensiveness and decision speed have been fragmented. To do so, my theoretical focus is on *entrepreneurial decision contexts* (e.g., *entrepreneurial environments* and *entrepreneurial life cycle*), which are far different from non-entrepreneurial contexts, upon which the relationships between the entrepreneurial strategy and the performance are contingent.

Bounded Rationality: A Fundamental Basis of Entrepreneurial Strategy

Different assumptions of rationality inform a good decision strategy. Within the concept of rationality, defined as an instrumentality to purposeful goals, there are two major competing views (Weirich, 2004). The first view rests on the fundamental assumption that the end goal is always to maximize the utility function (i.e., *substantive rationality*) by using perfect knowledge of the future environment and employing the perfect rationality of actors (Simon, 1976). However, the second view believes there is not necessarily an established and fixed end goal of utility maximization. However, decision-makers instead tend to search for, choose, employ, or design

acceptable methods that are good enough to tackle challenges that originate from the unknown environment or attain their local goals (e.g., local problems or the improvement of fitness in the local environment). This phenomenon is conceptualized as “bounded rationality” and “satisficing” (Simon, 1972). Moreover, substantive rationality is meaningless, particularly within the entrepreneurship context, because entrepreneurs generally make decisions under conditions of uncertainties where pure optimization strategy is usually impossible and because actors do not necessarily pursue optimal outcomes but tend to satisfice with good enough results. Hence, bounded rationality is the baseline of entrepreneurial rationality and how bounded rationality is modeled under yet unknown environments becomes an appropriate model of *entrepreneurial* rationality and, therefore, a fundamental basis of an *entrepreneurial* decision strategy. Hence, in this essay, I propose a framework that helps understand a key mechanism of how and why decision speed and decision comprehensiveness can be deemed effective within *the entrepreneurship context* by using the theoretical lens of bounded rationality.

A Fundamental Mechanism of Decision Comprehensiveness versus Decision Speed for Entrepreneurial Strategy: Procedural versus Adaptive Rationality

In my systematic review of the extant literature, there can be two general approaches to model bounded rationality—a baseline of entrepreneurial strategy in terms of rationality—that are conducive to *the entrepreneurship context*: procedural rationality and adaptive rationality. March (1978) notes, “the search for intelligence in decision-making is an effort to rationalize apparent anomalies in behavior. In a general way, that effort imputes either calculated or systemic rationality to observed choice behavior,” and he points out that there is a different type of organizational intelligence other than calculated rationality: systemic rationality, such as adaptive rationality.

Adaptive rationality emphasizes experiential learning by individuals or collectives (Cyert & March, 1963; Day & Groves, 1975), whereas calculated rationality, such as procedural rationality, emphasizes estimations of the actions by using computational tools (March 1978).

According to the APA Dictionary of Psychology, “Procedural rationality” is “the rationality of the processes used in arriving at a decision, as opposed to the rationality of the decision itself.” Simon (1976) elaborates on this as the decision is “procedurally rational when it is the outcome of appropriate deliberation” and compares it with *substantive rationality*, which takes place when the decision choice itself is “appropriate to the achievement of given goals within limits imposed by given conditions and constraints” (Simon, 1976b, p. 130). Hence, procedural rationality adequately follows deliberative and structured decision-making processes, whereas a decision is deemed *substantively rational* if a decision choice itself, independent of the procedures the decision choice is made by, effectively produces optimal outcomes. More specifically, a rational choice theory of *substantive rationality* assumes that an actor’s ultimate goal is clearly to maximize utility function and that an actor can correctly predict all of the outcomes of their decision paths available by understanding the future environment system and its functions/constraints. To wit, by using *substantive rationality*, it is argued that actors are able to correctly calculate the expected outcomes of every option to choose from and pick the best option that is going to fit incredibly well with the future environment, which clearly produces the optimal result. However, procedural rationality focuses on finding, deploying, or designing systematic and deliberative ways (e.g., computational tools) that are good enough to approximately locate or understand where good options could lie, and that help explore possible choices and various contingencies. Therefore, the theory of procedural rationality mainly concerns when and how

systematic methods (e.g., computational tools and rule-based procedures) should be employed to improve firm capabilities and performance.

Procedural Rationality: A Key Mechanism that Explains Why and How Decision Comprehensiveness Can be Effective within Entrepreneurship

Specifically, procedural rationality could help explore broader possible options and estimate which decision options are unlikely to produce better results than other routes. If the chosen decision option is coherent with the market and agents' knowledge, then that decision option will likely have better results than other options. Although future demand cannot be predicted accurately, procedural rationality can help agents investigate the possible choice sets more efficiently and effectively. Simon (1976) illustrated that actors could efficiently deal with uncertainties with procedural rationality. He pointed out that procedural rationality could help increase the range of possible alternatives that could mitigate uncertainties, reduce significant errors, decrease the susceptibility to competitors' actions, and improve data management and estimating models (Simon, 1976).

Hence, 'decision comprehensiveness,' a key relevant construct of procedural rationality, has been considered one of the good corporate strategies for established firms in the prior research because managers in established large firms, compared with entrepreneurs, usually have many more resources to afford high costs (Forbes, 2007). Thus, firm strategies that leverage decision speed rather than decision comprehensiveness have typically been considered a viable strategy for entrepreneurs, who should navigate yet unknown environments with very limited resources (Baron, 1998; Busenitz & Barney, 1997; Holcomb et al., 2009; Kiss & Barr, 2017; Manimala, 1992; Ries, 2011).

Yet, the emergence of advanced technologies has recently started transforming the general landscape of entrepreneurial strategies (Townsend & Hunt, 2019). The overall costs for utilizing new technologies that were overwhelmingly high for startups have become much lower than in the past (Bughin et al., 2017). The affordability of these advanced computational tools allows entrepreneurs to take a more comprehensive approach with relatively high processing speed throughout business venturing processes. Overall, I believe that the potential value of decision comprehensiveness within the *entrepreneurship context* is becoming more viable and critical, motivating to highlight the utility of decision comprehensiveness for *entrepreneurship*.

Hence, in the following paragraphs, I further conduct a conceptual review of the construct of decision comprehensiveness and decision speed in the extant literature and then analyze whether there are any clarity issues regarding the constructs (e.g., their dimensions) that do not lend themselves to *entrepreneurship*. Second, I clarify the fundamental mechanisms through which decision comprehensiveness and speed can be effective within *entrepreneurial environments*, which are different from the organizational information environment.

A Lack of Construct Clarity on Decision Comprehensiveness

My systematic review and analysis of this construct of decision comprehensiveness in the extant management literature indicate that this construct was first developed in the field of corporate strategy, but it lacked clarity, creating numerous inconsistencies in its definition and operationalizations. Even though such inconsistencies make it difficult for me to analyze the existing operationalization strategies clearly, I found that two common types of operationalization strategies were employed for decision comprehensiveness in the prior studies. One common definition of decision comprehensiveness in the previous literature is “The extensiveness with

which an organization's top executives systematically gather and process information from the external environment in making strategic decisions" (Forbes, 2007, p. 362). The other common type of its definition is "Several alternatives are considered, comprehensively examined, and evaluated on multiple criteria before a decision is made" (Talaucar, Grundei, & Werder, 2005) or "Conducting an exhaustive consideration of multiple approaches" (Slotegraaf & Atuahene-Gima, 2011). As can be noticed from these definitions, some studies operationalize decision comprehensiveness as the thorough external search for market information, whereas others operationalize it by focusing much less on external market search but rather on the deliberate and comprehensive decision-making process itself—the extensive production and systematic analysis of possible alternatives (e.g., potential new product candidates).

However, the theoretical background of these existing definitions is typically drawn from the organizational information environment, defined as "information about actors and events in the external environment that is available to organizations in that environment" (Forbes, 2005; 2007) rather than *entrepreneurial environments*. Specifically, it has been commonly assumed that sufficient quality market information is available in this organizational information environment. Hence, one of the key issues not addressed in the extant literature is that the key mechanisms through which decision comprehensiveness is effective that are explained in the literature heavily rely on the assumptions of the general organizational information environment, which is quite different from the entrepreneurial environment. In particular, within entrepreneurial environments, there is not enough (or even very little) quality information available for entrepreneurs, which makes a comprehensive external market search minimally effective. Since entrepreneurs attempt to create future novel products that have not been released yet, the critical entrepreneurial environment under which entrepreneurs take action lacks quality market information (e.g.,

potential future customer segments), making it impossible for entrepreneurs to accurately predict the future value of their products/services that they develop (i.e., Knightian uncertainty) (Knight, 1921). Moreover, market responses to the new products/services produced by entrepreneurs are often so fast and nonlinear (i.e., environmental dynamism) that it challenges entrepreneurs to accurately compute the expected future value of the novel products/services they are developing (Duncan, 1972). Furthermore, the entrepreneurial environment also suffers from the problem of isotropy—which refers to “the fact that in decisions and actions involving uncertain future consequences, it is not always clear *ex-ante* which pieces of information are worth paying attention to and which not” (Sarvasvathy & Dew, 2005, p. 539) making it difficult for entrepreneurs to determine whether the information they could obtain is relevant for their entrepreneurial pursuits even if the extensive external market search could be successfully conducted.

Overall, my analysis of the existing construct of decision comprehensiveness reveals a lack of construct clarity, which has generated multiple inconsistent operationalizations. Furthermore, the operationalization that puts emphasis on extensive external market search is not conducive to entrepreneurship, as a lack of environmental information and the problem of isotropy characterize the entrepreneurial environment. That is, in entrepreneurial environments, there is little or no quality environmental information that can be searched for. Additionally, the available market information can even become useless as long as the problems of isotropy remain (i.e., if there are no good ways to distinguish the relevant market information from irrelevant information for an actor, more quantity of environmental information even becomes useless). Hence, the indicator/dimension of decision comprehensiveness operationalized as “extensive external market search” is expected to have no or minimal efficacy in entrepreneurship. Overall, such inadequate operationalization of decision comprehensiveness might have been one of the key reasons the

decision comprehensiveness generated fragmented theories and mixed findings regarding the effectiveness of decision comprehensiveness within the entrepreneurship contexts.

In contrast, another common indicator of decision comprehensiveness that is operationalized as “the exhaustive and systematic decision process itself that produces and analyzes a wide range of possible alternatives (e.g., generation and analysis of possible product candidates for new product development)” is likely to be effective for entrepreneurship, because such a dimension of decision comprehensiveness lends itself to entrepreneurial environments. More specifically, entrepreneurs who generate and conduct a systematic analysis of a wide range of potential alternatives (e.g., multiple new product ideas/candidates that the focal entrepreneur can feasibly and desirably develop) for entrepreneurial pursuits are likely to identify various potential alternatives that help overcome or even leverage unexpected contingencies that often arise throughout venturing processes (Mohan, Voss, & Jiménez, 2017; Sarasvathy, 2008; Townsend & Hunt, 2019). Moreover, increased investigation and systematic analysis of potential alternatives that an entrepreneur can possibly pursue due to such dimension of decision comprehensiveness are likely to help find novel recombination of knowledge and to develop a diverse product portfolio (e.g., numerous fallback options) (Foss & Klein, 2012; Katila & Ahuja, 2002; Kogut & Zander, 1992), both of which ultimately lead to actualizing entrepreneurial opportunities. Moreover, the systematic analysis of the resources/knowledge and the entrepreneurial ideas/opportunities that are available to an entrepreneur due to such dimension of decision comprehensiveness are likely to help effectively identify which ideas/opportunities (e.g., new product candidates) are less (or more) desirable and feasible to pursue by reducing ignorance and doubt. Overall, decision comprehensiveness can enhance venture decision performance by leveraging the procedural rationality that is endogenous to venturing processes. Further, I also

conducted a post hoc meta-analysis that computes each effect size of these two dimensions of decision comprehensiveness separately to test and corroborate the key role of such an indicator of decision comprehensiveness within entrepreneurship contexts and to suggest a clear direction for a reconceptualization of this construct for future entrepreneurship research.

Adaptive Rationality: A Key Mechanism that Explains Why and How Decision Speed Can be Effective within Entrepreneurship

Of course, it does not necessarily mean that decision comprehensiveness, informed by procedural rationality, is always an effective entrepreneurial strategy. Since entrepreneurs venture into the unknown and have to cope with various types of uncertainties frequently over the entrepreneurial journey, there can be several decision contexts (e.g., opportunity exploitation stage) when a much less systematic approach, such as a quick decision process (Busenitz & Barney, 1997; Khanna et al., 2016), is incredibly beneficial. Existing entrepreneurial strategy literature has thus dealt with how quick decisions—decision speed—could be helpful for entrepreneurs to act in an entrepreneurial environment that is rapidly and nonlinearly changing (i.e., environmental dynamism) (Bakker & Shepherd, 2017; Baum & Wally, 2003; Choi et al., 2008; Eisenhardt, 1989; Forbes, 2005). That is to say, entrepreneurs who make fast decisions can achieve high performance mainly because entrepreneurial strategies that leverage rapid decision-making are informed by *adaptive rationality*.

Adaptive rationality models “bounded rationality,” a basis of entrepreneurial rationality, differently from *procedural rationality* in that it sees the limited rationality of entrepreneurs as “the glass half empty” instead of “the glass half full” (Bendor, 2010, p. 1). It assumes that bounded rational actors cannot be rational enough to effectively use systematic approaches for both choice

procedures and optimal outcomes. Instead, it is assumed that bounded rational actors are likely to rely on their rapid actions to obtain immediate feedback and new information directly from their environment so that their available means (e.g., new products that are launched) being developed can be quickly updated to be fitted into the current environment. In this way, entrepreneurs do not have to worry about collecting more quality market information, which is mostly unavailable (i.e., Knightian uncertainty) in entrepreneurial environments, about distinguishing *ex-ante* which pieces of information are irrelevant or not (i.e., isotropy), and about the relevant costs.

In other words, *adaptive rationality* informs a rapid and simplistic decision strategy that leverages speedy entrepreneurial actions to gain real-time information/feedback that allows entrepreneurs to update the means (e.g., new products being developed) to satisfy the current market demands (i.e., market information/feedback) (Eisenhardt, 1989; Judge & Miller, 1991; McGrath, 1999). Hence, ‘failing fast’ has even been regarded as a good entrepreneurial strategy because it provides entrepreneurs with up-to-date information on the product-market fit (e.g., Khanna et al., 2016).

A Lack of Construct Clarity on Decision Speed

My review of the decision speed construct in the extant strategy and entrepreneurship literature indicates that ‘fast decisions’ have been assumed to be a key characteristic of entrepreneurial decision-making processes (Baum & Wally, 2003; Busenitz & Barney, 1997; Forbes, 2005; Judge & Miller, 1991; Khanna et al., 2016) without robust operationalization and assessment of decision speed. In a few studies where decision speed is directly operationalized, decision speed has been a fixed feature of entrepreneurial firms, which does not vary across different decision stages within a firm. For example, Forbes (2005, p. 355) defines decision speed

as “how quickly organizations execute all aspects of the decision-making processes, spanning from the initial consideration of alternative courses of action to the time at which a commitment to act is made.” However, Bakker and Shephard (2017) recently critique such operationalization, showing that decision speed actually varies across different types of entrepreneurial decisions. Such lack of conceptual development is likely to be one of the main reasons why existing literature suffered from mixed evidence regarding the performance of decision speed.

Conflicting Views on the Relationship Between These Constructs in the Extant Literature

My comprehensive review of decision comprehensiveness and decision speed constructs also reveals an additional key problem in the literature that prevents advancing strategy and entrepreneurship research. Specifically, most prior studies are unclear about the fundamental relationship between decision comprehensiveness and decision speed. Whether one approach must be sacrificed for the other due to the unavoidable tradeoffs between decision comprehensiveness and decision speed, whether and how the tradeoffs can be balanced/managed, or whether and when these two approaches can be synthesized into a unified process remains unanswered in the literature. Furthermore, only a few extant studies mention about the fundamental relationship between the two. Moreover, these previous studies suffer from conflicting perspectives on the relationship between decision comprehensiveness and decision speed, which may also have thus generated fragmented theories and inconsistent/contradictory findings (e.g., both approaches are assumed to be effective despite the opposite ways in which each strategy is assumed to work).¹³ That is, three groups of previous studies share similar views on the relationship between decision speed and decision comprehensiveness. First, several studies implicitly assume that these two

¹³ Please see Appendix E for details.

strategies function in opposite ways and that the unmanageable tradeoffs between the two force entrepreneurs to choose only one approach (Arend, Cao, Grego-Nagel, Im, Yang, & Canavati, 2016; Atuahene-Gima & Li, 2004; Baum & Wally, 2003; Capelleras et al., 2010; Fredrickson & Mitchell, 1984). For instance, Atuahene-Gima & Li (2004) mention that “strategic decision comprehensiveness slows down decision making and interferes with real-time information flow in an environment in which information is perceived as unanalyzable and responses as uncertain” (p.591). According to Baum and Wally (2003), “decision-making may be fast because time-consuming comprehensive research and discovery have little value” (p. 1112). In this view, these two strategies are incompatible and mutually exclusive, and they commonly assert that decision speed is effective for environmental instability (e.g., dynamic and high-velocity markets) (except for a few, like Capelleras et al. (2010)).

Second, some other scholars share the perspective that these decision strategies can be complementary and compatible by appropriate sequencing of decisions (e.g., the higher number of alternatives pre-identified due to decision comprehensiveness increases decision speed) even though fundamental tradeoffs between the two strategies always exist and one approach should thus be selected over the other at a time (Bakker & Shepherd, 2017; Eisenhardt & Tabrizi, 1995; Judge & Miller, 1991; Lin, Shi, Prescott, & Yang, 2019). However, these studies usually contend that decision speed is more effective for tackling dynamic and high-velocity markets than decision comprehensiveness in general.

Such common argument within these two groups of prior research may have been theorized largely due to the fundamental assumption that either one should be sacrificed for the other at each time by focusing on the rapidly changing market contexts rather than the internal conditions of a firm at the decision level. In dynamically changing environments, if heterogeneous internal

conditions of a venture manifested at each decision point are not taken into account, it follows that decision speed appears to be systematically more effective than decision comprehensiveness primarily because decision speed is far better aligned with the rapid pace of the external market change than decision comprehensiveness due to the nature of temporal dimension. In fact, the true value of these strategies would be contingent upon firms' internal contexts as well as environmental conditions.

Third, in very few studies, it is argued that both decision speed and decision comprehensiveness can be balanced and utilized simultaneously to enhance performance in high-velocity environments (Bartkus et al., 2022; Burgeois & Eisenhardt, 1988; Talaulicar et al., 2005). Overall, my systematic review reveals that there are conflicting perspectives on the relationship between decision speed and decision comprehensiveness that has been neither clearly explained nor tested in the extant literature.

In this essay, therefore, I synthesize the prior studies and thus develop and test a contingency model of decision comprehensiveness and decision speed whose magnitude of performance would be dependent on internal decision contexts such as the entrepreneurial lifecycle stage and external conditions such as type of entrepreneurial environments (i.e., knowledge problems) the entrepreneur is facing, under the key assumption that there is an unavoidable tradeoff between decision comprehensiveness and decision speed. That is, at least several decision points (e.g., opportunity exploitation stage) in time and space during the venturing process, ventures have to choose only strategy between decision comprehensiveness and decision speed, particularly when the venture has very limited resources to make it impossible for them to employ both strategies simultaneously.

Of course, in some circumstances, as the third group of studies points out, it is possible that decision comprehensiveness is not necessarily an inverse of decision speed, but instead, both can actually be complementary to each other. If a focal venture can figure out good ways to employ decision comprehensiveness, but at the same time leverage decision speed with their available resources,¹⁴ then simultaneous use of these two strategies may become the most effective.

Nevertheless, even though I agree with the third group's view, which assumes that it is possible that decision comprehensiveness and decision speed can simultaneously be combined into a unified process, I develop my contingency model and meta-analyze it by focusing on and limiting to the circumstances when there is an inescapable tradeoff between decision comprehensiveness and decision speed. As most previous studies have implicitly assumed that there is a fundamental, unavoidable tradeoff between decision comprehensiveness and decision speed, a contingency theory is an adequate framework to integrate the prior studies on decision comprehensiveness and/or decision speed (see Appendix E for more details). Furthermore, my contingency model will help identify when (e.g., for different decisions) and how (e.g., different ways) each of these strategies is more (or less) likely to enhance new venture performance whenever either one should only be selected or mainly focused.

Hence, the following sections will focus on developing a contingency model that synthesizes and meta-analyzes the previous findings to show that the value of decision comprehensiveness and decision speed is contingent upon the entrepreneurial lifecycle stage and the type of knowledge problems (i.e., decision environments) the ventures encounter.

¹⁴ If an entrepreneur has enough resources to utilize tools/methods (e.g., AI tools) that shorten the processing time of decision comprehensiveness significantly.

The Performance of Decision Comprehensiveness and Decision Speed

According to contingency theory, the decision performance of an entrepreneurial decision strategy is primarily determined by fitness levels among a focal entrepreneur, the knowledge and resources that are accessible to the entrepreneur, the solution sets (e.g., a set of new products/services an entrepreneur develops or releases) the entrepreneur offers, and the market conditions (e.g., future market demand) where new products/services will be released and produced (Daft & Macintosh, 1981; Galbraith, 1978; Hunt et al., 2023).

My review of prior strategy research on decision comprehensiveness indicates that decision comprehensiveness is positively related to entrepreneurship because decision comprehensiveness enables entrepreneurs to reduce their ignorance and doubt (Heavey et al., 2009), to carefully recognize and thoroughly evaluate opportunities to (re)use or (re)combine existing resources and capabilities for novel entrepreneurial pursuits (Fleming & Sorenson, 2004; Henderson & Clark, 1990; Katila & Ahuja, 2002; Schumpeter, 1939; Xiao, Makhija, & Karim, 2021), and to “connect the dots” between supposedly independent artifacts/incidents (Baron, 1998; Eisenhardt, 1989; Hsieh, Nickerson, & Zenger, 2007).

In other words, entrepreneurs who employ decision comprehensiveness are likely to enhance the alignment between the knowledge/resources an entrepreneur possesses and a set of new products/services they create because entrepreneurs who extensively create multiple potential entrepreneurial ideas to pursue (e.g., candidates of product designs for new product development) and systematically analyze them using multiple criteria (e.g., roughly estimate and compare their value)—decision comprehensiveness—will help carefully identify and investigate what would be feasible and desirable entrepreneurial ideas/opportunities that can be accessed, designed, and recombined by them. If the entrepreneurial ideas/opportunities (e.g., new product ideas) are

outside the scope of an entrepreneur's identity, knowledge, and resources, these ideas/opportunities will not be considered "possible" new entrepreneurial ideas/opportunities to the entrepreneur (Foss & Klein, 2012; Sarasvathy, 2008; Sarasvathy & Dew, 2013; Savage, 1954) as the entrepreneur cannot reduce doubt and ignorance of them (Choi et al., 2008; McMullen & Shepherd, 2006; Shepherd, McMullen, & Jennings, 2007). Even though the decision comprehensiveness may not necessarily enhance the fit between the market (e.g., demands and wants of customers) and a set of new products/services (i.e., the solution sets) they create primarily due to the key characteristics of the *entrepreneurial environments*—where there is not enough quality information about the future market and the future market cannot be predicted accurately, that decision comprehensiveness likely increases the fit between an entrepreneur and entrepreneurial ideas/opportunities (e.g., novel products) that the entrepreneur can create due to the *procedural rationality* it leverages, leading to the overall achievement of the goals of decision performance (Foss & Klein, 2012; Gruber, MacMillan, & Thompson, 2008; Sarasvathy, 2008). Therefore,

H1a: There is a positive relationship between decision comprehensiveness and decision performance.

Alternatively, quick decisions enable entrepreneurs to rapidly design and test chosen entrepreneurial ideas/opportunities and gain up-to-date information about the environment and immediate market feedback on the actual value of entrepreneurial ideas/opportunities (e.g., new products/services being developed). This real-time information/feedback helps the entrepreneurial ideas/opportunities update to fit the current market better—*adaptive rationality* (Eisenhardt, 1989; Judge & Miller, 1991). Although the decision speed may not necessarily help explore what would

be a possible set of new product opportunities that can be created by using the resource and knowledge accessible to an entrepreneur, decision speed could encourage entrepreneurs to rapidly settle on, develop, and design a new product/service, experiment with it quickly, and thus swiftly obtain the real-time feedback on the product-market fit, increasing the current fit between a set of products/services (i.e., the solution sets) that the entrepreneur creates and the “real-time” current market conditions (Baum & Wally, 2003; Eisenhardt, 1989; Judge & Miller, 1991). Furthermore, decision speed allows entrepreneurs to test their products frequently with reiterations, which will be beneficial in rapidly enhancing the *product-market* fit (Ries, 2011). Therefore, I suggest the following:

H1b: There is a positive relationship between decision speed and decision performance.

Based on the review of the literature on bounded rationality and entrepreneurial strategy, as explained in the previous sections, I believe that *procedural rationality* (e.g., decision comprehensiveness) and *adaptive rationality* (e.g., decision speed) are enabling key mechanisms that facilitate firms to address contingencies that emerge in entrepreneurship and better adapt to the circumstances they face throughout the venturing process (Busenitz & Barney, 1997; Forbes, 2007; Gigerenzer & Todd, 1999; Packard & Bylund, 2021; Sarasvathy, 2001). However, what is unclear in the extant literature is whether the extent to which decision comprehensiveness and decision speed are effective depends on the decision type of intentional pursuit of entrepreneurial function. Given that “the intentional pursuit of new economic value” (Packard, 2017, p. 544) is a common entrepreneurial function, investigating the general role of decision comprehensiveness and decision speed for financial versus non-financial pursuit, therefore, becomes an important question. Furthermore, non-financial performance, such as decision quality, has already been

introduced and emphasized in the prior research on this topic because financial performance is not necessarily interchangeable with decision quality (i.e., non-financial performance) (Atuahene-Gima & Li, 2004; Forbes, 2007). In fact, decision comprehensiveness likely enhances a variety of internal entrepreneurial decisions, such as firm capability building and new product development quality (e.g., innovation performance), as studied in the prior studies (Mohan et al., 2017; Rovelli, Massis, & Gomez-Mejia, 2022; Slotegraaf & Atuahene-Gima, 2011). More specifically, as noted in the previous hypothesis development, since entrepreneurs with decision comprehensiveness would extensively produce and systematically analyze what new entrepreneurial ideas/opportunities may possibly be developed by themselves rather than what entrepreneurial opportunities are already manifested in the current market, decision comprehensiveness is likely to be more effective for achieving non-financial objectives (e.g., R&D on new product opportunities, innovation, firm capability building) than financial goals (e.g., the current return on investment). That is, decision comprehensiveness can essentially be effective within the *entrepreneurship* context because it helps entrepreneurs deliberately investigate what entrepreneurs can possibly know and do but is ineffective in predicting the *entrepreneurial environments* (Katila & Ahuja, 2002; Kornish & Ulrich, 2011; Sarasvathy, 2001; 2008), where the amount and quality of market information are low. In other words, since the future entrepreneurial environments cannot be adequately analyzed and predicted due to the lack of helpful *market* information available and random changes in the entrepreneurial environments (e.g., Knight, 1921; McMullen & Shepherd, 2006; Sarasvathy, 2001; Venkataraman, 1997), decision comprehensiveness does not necessarily increase the *product-market* fit even if ventures try to collect any external market information as comprehensively as possible. Instead, since ventures can employ decision comprehensiveness to deliberately and comprehensively analyze and

generate what *the entrepreneurs can possibly do with the resources and knowledge that are accessible to them* (Foss & Klein, 2017; Sarasvathy, 2001, 2008), I expect there is a high *entrepreneur-product* fit than product-market fit, and non-financial performance (e.g., R&D on new product opportunities, firm capability building) rather than financial performance is more likely to increase.

Additionally, prior studies have examined how decision speed can shape non-financial performance, such as venture growth (Capelleras, Greene, Kantis, & Rabetino, 2010), new product success (Chen, Reilly, & Lynn, 2005), and decision quality (Elbanna, Thanos, & Colak, 2014), in addition to financial performance (Eisenhardt, 1989; Souitaris & Maestro, 2010). Even though decision speed can influence financial and non-financial performance, as indicated by previous literature, what is unclear in the extant literature is which type of pursuits—financial versus non-financial pursuits—decision speed works more (or less) effectively. I predict that decision speed generally works better for financial goals than non-financial pursuits primarily due to the key strength of decision speed in adapting to the changing market. By making fast decisions, entrepreneurs can gain real-time information about the current market so that they can make a quick adaptation to the current market (Baum & Wally, 2003; Eisenhardt, 1989; Eisenhardt & Tabrizi, 1995). In other words, strategic decision speed focuses on quickly collecting real-time information about what entrepreneurs need to do to enhance *the product-market fit* rather than the *entrepreneur-product* fit. Thus, I predict that decision speed is more helpful for capturing financial goals than non-financial pursuits. Therefore, the following hypotheses are developed:

H2a: Performance type (i.e., Financial versus non-financial performance) moderates the positive relationship between decision comprehensiveness and decision performance. That

is, the positive performance of decision comprehensiveness is higher for non-financial performance than for financial performance.

H2b: Performance type (i.e., Financial versus non-financial performance) moderates the positive relationship between decision speed and decision performance. That is, the positive performance of decision speed is higher for financial performance than for non-financial performance.

The prior entrepreneurship research on decision speed has mostly focused on identifying factors that enhance decision speed under the general assumption that decision speed is a fixed characteristic of a firm. It has been widely believed that entrepreneurs typically speed up their decision processes to tackle dynamic and uncertain environments (Baum & Wally, 2003; Busenitz & Barney, 1997; Eisenhardt, 1989; Forbes, 2005; Judge & Miller, 1991; Kownatzki, Walter, Floyd, & Lechner, 2013). However, recent studies on decision speed critiqued this questionable assumption and started to suggest that decision speed is not “a fixed attribute but rather an attribute that varies by the type of decision and the internal and external contexts in which the decision is made” (Bakker & Shepherd, 2017, p. 4). Bakker and Shepherd (2017) show that ventures in the Australian mining industry at the early prospecting stage are faster in terminating potential alternatives yet slower in the latter stage when ventures need to advance their decisions. They argue that ventures are not necessarily fast or slow in every decision they make, but decision speed varies depending on the type of decision and its specific decision contexts. In a similar logic, the magnitude of decision comprehensiveness performance would also be contingent upon its internal decision context. In a few previous studies that examine the impact of internal firm conditions on the performance of decision comprehensiveness, Heavey et al. (2009) argue that the effectiveness

of decision comprehensiveness depends on the inner firm characteristics (e.g., risk-taking propensity). Additionally, Friedman and Carmeli (2017) show that the effectiveness of decision comprehensiveness becomes stronger when TMT connectivity is high.

Overall, my systematic review of the previous literature suggests that the value of decision comprehensiveness and decision speed would be contingent upon critical internal decision contexts (e.g., entrepreneurial lifecycle). Thus, in this essay, I focus on two critical entrepreneurial lifecycle stages widely theorized in organizational decision literature (March, 1991)—opportunity exploration versus opportunity exploitation stage. I see this lifecycle as a good moderator that could have a significant impact on the effectiveness of decision comprehensiveness and decision speed in entrepreneurship, as these stages need different levels of stakes and commitments and have different temporal dimensions (e.g., windows of opportunity). Using this lifecycle as a moderator, therefore, my study can offer general guidelines as to specifically when it is significantly better to use decision comprehensiveness and decision speed at the critical venturing stages. Building on the recent suggestion by entrepreneurship scholars that the role of decision speed is more nuanced than supposedly assumed (Bakker & Shepherd, 2017; Choi et al., 2008), I expect that the performance of decision speed is higher in the opportunity exploitation stage than the exploration stage whereas that of decision comprehensiveness is higher in the opportunity exploration stage than in the opportunity exploitation stage.

According to the seminal paper presented by March (1991), opportunity exploitation is clearly distinct from opportunity exploration. Opportunity exploration includes “search, variation, risk-taking, experimentation, play, flexibility, discovery,” whereas opportunity exploitation refers to “refinement, choice, production, efficiency, selection, implementation, and execution” (p. 71). More specifically, entrepreneurs at this opportunity exploration stage try to examine and identify

potential entrepreneurial ideas/opportunities (e.g., recognizing possible new product ideas) for them to pursue (Ardichvili, Cardozo, & Ray, 2003), whereas entrepreneurs in the exploitation stage focus on finding good ways to monetize entrepreneurial ideas/opportunities (e.g., commercializing and selling new products). Since value creation (e.g., creating new products) does not always lead entrepreneurs to capture value (i.e., making profits from the new products they developed) (Lepak, Smith, & Taylor, 2007; Lerner, Hunt, & Verheul, 2018), entrepreneurs at the opportunity exploitation stage will focus on launching their newly developed products/services into the market and on increasing a *product-market fit* as quickly as possible. In this way, they are more likely to achieve first-mover advantages and/or promptly realize profits that exist in the current market, at least a decent amount of profit for a venture to survive and grow.

Overall, I expect that decision speed is more effective for the opportunity exploitation than the opportunity exploration stage largely because quick decision-making processes will expedite the decision processes for entrepreneurs to commercialize the new products/services that they have been developing and to thus attain at least a good enough *product-market fit* due to the *adaptive rationality* this fast decision process leverages before fleeting profit opportunities disappear (e.g., before the competitors release similar products that a focal entrepreneur has been developing) (Lieberman & Montgomery, 1988). More importantly, at the opportunity exploitation stage, entrepreneurs make irreversible commitments (Choi et al., 2008; Gans et al., 2019). That is, in this stage, entrepreneurs fully operate to launch and commercialize a set of novel products/services to sell and monetize by significantly committing their resources and knowledge at hand. Particularly, if the entrepreneurial opportunities (e.g., new product development) that are being pursued (by a focal venture) are not at high degrees of novelty, the exploitation process should be more expedited because competitors are more likely to appear and launch their product/service that is similar to

the new product/service a focal venture plans to release (Choi et al., 2008). By speeding up decision processes at the opportunity exploitation stage, entrepreneurs are more likely to realize profits necessary to survive and/or even to help enjoy first-mover advantages, at least temporarily. Moreover, whenever entrepreneurs shift from the opportunity identification stage to the opportunity exploitation stage, the time horizon of the decision is likely to end (or becomes much shorter) (Choi & Shepherd, 2004; Choi et al., 2008), also indicating that speeding up the entrepreneurial decisions is crucial to capturing opportunities at the opportunity exploitation stage. In this opportunity exploitation stage, since ventures are actively associated with full-scale production and actual sales of the new products that have recently been developed (Choi et al., 2008; Gans et al., 2008), quickly taking advantage of the recently developed new product/service(s) at hand to monetize and generate revenues at least temporarily is much more important than trying to detect and identify impactful entrepreneurial opportunities.

Alternatively, I expect that decision comprehensiveness is more effective for the opportunity exploration stage than for the exploitation stage, mainly because the primary goals of ventures in the opportunity exploration stage are probing and finding new product opportunities and values that are feasible and desirable to pursue (McMullen & Shepherd, 2006). More specifically, in the opportunity exploration stage, creating and investigating various entrepreneurial ideas (e.g., new product concepts) becomes one of the main tasks. In this stage, entrepreneurs focus on reducing ignorance and doubts about what types of opportunities can potentially and reasonably be pursued by the resources/capabilities at hand (e.g., Who am I? What product opportunities are feasible and desirable with the resources/capabilities at my hand? What types of stakeholders do I know? What are possible new combinations of resources available?) (Choi et al., 2008; Foss & Klein, 2011; Sarasvathy, 2001, 2008; Shepherd et al., 2007) and to

accumulate, analyze, and generate knowledge regarding a set of future possible new product candidates (e.g., trying to find out what types of new products are likely to be (un)promising in the future) that can be created by them (Gans et al., 2019; McMullen & Shepherd, 2006). Hence, decision comprehensiveness—where new knowledge and various possible entrepreneurial ideas/opportunities (e.g., candidates of new product designs for new product development) are deliberately explored, generated, and analyzed—is likely to be more effective in the opportunity exploration stage than in the opportunity exploitation stage in general.

Furthermore, at the opportunity exploration stage, it is likely that entrepreneurs partially commit their resources, and such commitments are not necessarily irreversible. That is, identified possible entrepreneurial ideas (e.g., new ways/methods to use the resources that are accessible) can be saved and (re)utilized easily later in the venturing process, and a set of knowledge generated can also be stored and (re)used in the future. Additionally, the time horizon of the decisions is relatively longer in the opportunity exploration stage than those in the opportunity exploitation stage (Choi et al., 2008); thus, time pressure is relatively lower, suggesting that decision comprehensiveness—the strategy whose key strengths are extensiveness and deliberateness—is likely to be more efficacious for the opportunity exploration than for the opportunity exploitation.

In short, the central goal of ventures at the opportunity exploration stage is to accumulate knowledge concerning *entrepreneur-product* fit rather than *product-market* fit. Specifically, by taking a comprehensive approach to new product development, ventures can identify as many potential future product alternatives (e.g., new product candidates) as possible to choose from. Furthermore, a broader choice set of entrepreneurial ideas/opportunities (e.g., new product ideas) that a venture can reasonably pursue is more likely to increase new product development success ultimately because broad potential alternative sets (e.g., fallback options for new product

development) identified due to decision comprehensiveness enable the venture to overcome or even leverage contingencies that often arise during the venturing processes and because the wide availability of alternatives makes it possible for the venture to take a portfolio approach to product development (Foss, Foss, Klein, & Klein, 2007; Gruber et al., 2008).

On the contrary, by being agile to new product opportunities (i.e., decision speed) at the opportunity exploitation stage—when irreversible full commitment toward production and sales of products/services typically occur and when the product-market fit is important, entrepreneurs will make efforts to capitalize on the novel products that have recently been developed because the agility and quick adaptability of ventures will help entrepreneurs not to miss a fleeting window opportunity of profit that is likely to exist in the current market. Due to the *adaptive rationality* that decision speed leverages, the product-market fit of a venture is likely to increase, and the real-time enhancement of the product-market fit will help exploit the opportunities and capture values at the given moment when a venture is at the opportunity exploitation stage. Moreover, due to the decision speed and fast adaptation, entrepreneurs will likely gain and enjoy first-mover advantages, at least temporarily. Hence, the following hypotheses are developed:

H3a: The positive relationship between decision comprehensiveness and decision performance is higher in the opportunity exploration stage than in the opportunity exploitation stage.

H3b: The positive relationship between decision speed and decision performance is higher in the opportunity exploitation stage than in the opportunity exploration stage.

Additionally, my systematic review of the literature on decision comprehensiveness and decision speed reveals that the effectiveness of these strategies would also be contingent upon

different types of environments a venture encounters (Atuahene-Gima & Li, 2004; Baum & Wally, 2003; Eisenhardt, 1989; Forbes, 2007; Fredrickson, 1984; Powell, 1992). Nevertheless, the extant empirical findings from these contingency models are mixed, conflicting, and fragmented. For instance, Atuahene-Gima and Li (2004) show that the positive impact of decision comprehensiveness on new product performance flips to the negative relationship when technology (i.e., unanalyzable) uncertainty becomes high (from low), while the positive influence of decision comprehensiveness becomes prominent when analyzable (demand) uncertainty (e.g., environmental dynamism) becomes high. However, Heavey et al. (2009) reveal that the utility of decision comprehensiveness in corporate entrepreneurship is amplified when environmental dynamism decreases. Forbes (2007) further points out that decision comprehensiveness literature is characterized by conflicting views on the contingent effect of the information environment on the relationship between decision comprehensiveness and its performance, calling for the disaggregation of the decision environment into different types. Moreover, the decision speed literature suffers from similar issues. For instance, Judge and Miller (1992) present that decision speed increases firm performance only in the highly dynamic market, while Capelleras, Greene, Kantis, and Rabetino (2010) show that the venture decision speed is negatively associated with the subsequent venture growth. Bakker and Shepherd (2017) recently presented that the decision speed varies depending on the different levels of decision environment context—environmental dynamism. Specifically, their empirical results indicate that the performance of decision speed in venture advancement decisions at the exploration (e.g., prospecting) stage decreases more when the level of environmental dynamism becomes high. Overall, the existing strategy literature on decision comprehensiveness and decision speed is highly fragmented and inconclusive, particularly in regard to the contingent effect of decision environments.

Hence, this study attempts to resolve some of these issues by integrating the extant empirical findings by focusing on the entrepreneurship theories on environmental uncertainty presented by Knight (1921)—a primary decision environment context in entrepreneurship, as it may be the case that the moderators used in the previous studies were not precise and reliable enough to serve as a different contingency within the *entrepreneurship context*. Specifically, two common operationalizations of environmental uncertainty types in entrepreneurship are environmental dynamism versus Knightian uncertainty. Although many prior studies have been unclear about the theoretical difference between environmental dynamism and Knightian uncertainty, these two dimensions are conceptually distinct, according to Knight (1921). That is, while environmental dynamism is the construct that operationalizes a fast pace of change itself in an environment, which is often nonlinear (i.e., analyzable environment), Knightian uncertainty is the concept that operationalizes the immeasurability and unpredictability (i.e., unanalyzability) of the future environment. Since it is not the market change itself that creates unpredictability (Lawrence & Lorsch, 1973; Milliken, 1978), Knight (1921) perceives unpredictability and immeasurability as key dimensions of true uncertainty that explain abnormal profits rather than the environmental change itself. In his book, he points out,

“Dynamic changes give rise to a peculiar form of income only in so far as the changes and their consequences are unpredictable in character. It cannot, then, be change, which is the cause of profit, since if the law of the change is known, as in fact is largely the case, no profits can arise.” (Knight, 1921, p. 37)

Thus, I focus on this distinction—environmental uncertainty versus (Knightian) uncertainty—as a major categorical moderator for the effectiveness of decision comprehensiveness and decision speed in *entrepreneurship*. In this way, my meta-analysis will

adequately synthesize and integrate the existing empirical evidence on decision comprehensiveness and decision speed in a clear and systematic fashion for entrepreneurship research. By doing so, my meta-analytic results will offer guidance as to under what type of entrepreneurial environment conditions it is generally more effective for ventures to use decision comprehensiveness and decision speed, respectively.

As noted above, at the macro-level (i.e., environmental level), unpredictability, but not necessarily the dynamic change (i.e., environmental dynamism) itself, is a precursor to abnormal profits (Knight, 1921). In other words, as shown in Figure 4-1, it follows that the total availability of abnormal profit that a venture can capture is high under conditions of Knightian uncertainty, whereas that is low under conditions of environmental dynamism. Environmental dynamism in this study refers to “a type of entrepreneurial environment whose rate of change is fast and/or non-linear,” whereas Knightian uncertainty refers to “a type of entrepreneurial environment that is unpredictable *a priori* due to random change.”

However, the same environment type can play a different role at the micro (individual) level. Specifically, even though there are many abnormal profit opportunities within the environment that is Knightian uncertain, there is a high level of (objective) unpredictability and immeasurability in this type of environment, making it impossible for entrepreneurs to estimate the future market even roughly. In contrast, it is possible that entrepreneurs can estimate the future market at least approximately when they make decisions in a dynamic environment where the market is estimable (Knight, 1921; Packard & Clark, 2020). However, under conditions of environmental dynamism, “abnormal” profit opportunities rarely exist, mainly because the actors in the market will price, insure and hedge against estimated future risks associated with environmental dynamism (Knight, 1921). Since there is a low number of abnormal profit

opportunities in this type of environment, the average amount of firm profits that can be realized becomes much lower (as the prices of the newly developed products/services can even be quickly settled and fixed at only a small price premium) than the average firm profits under conditions of Knightian uncertainty.

Thus, I predict that decision comprehensiveness has a higher decision performance under conditions of Knightian uncertainty than environmental dynamism because *procedural rationality*—using deliberate processes (e.g., employing systematic methods)—is likely to help capture abnormal profit opportunities that prevail in the Knightian uncertainty. Specifically, a broad and wide possible set of potential future alternatives generated and analyzed by decision comprehensiveness will help effectively tackle future contingencies arising from Knightian uncertainty and environmental dynamism (Barreto, 2012; Gruber et al., 2008). Although decision comprehensiveness could analyze and estimate the future conditions of the market that is dynamic (i.e., dynamic environment) at least roughly and it may thus help a venture avoid entering into the market segments that are not likely to grow in the future (Gans et al., 2019), both the fact that the availability of “abnormal” profit in the dynamic environment is low and the reality that the future market cannot be accurately predicted/optimized lower the average firm performance of decision comprehensiveness under conditions of environmental dynamism (compared with that under conditions of Knightian uncertainty). Moreover, the market that is estimable—environmental dynamism—enables the competitors of the focal firm to estimate future environmental conditions, increasing the competition among the players within the market, which will decrease the average performance of the firms in this market in general (Knight, 1921; Zahra, Neubaum, & El-Hagrassey, 2002).

In contrast, there will be ample “abnormal” profit opportunities in the Knightian uncertain environment (Knight, 1921). Ventures are more likely to capture them if they can generate and analyze numerous potential future entrepreneurial ideas/opportunities (e.g., potential candidates of product designs for new product development)—decision comprehensiveness. The identified possible opportunities can also serve as a diversified portfolio of the potential products/services the venture develops and creates (Barreto, 2012; Gruber et al., 2008; Foss & Foss). Since the more a venture is decision comprehensive, the more quantity and the quality of new potential product/service opportunities for a venture to pursue, a venture that employs decision comprehensiveness is likely to increase the amount of the products/services achieving a premium price (i.e., “abnormal” profits) under conditions of Knightian uncertainty—the environment where there are enough price premium opportunities (i.e., abnormal profits) that can be matched with the new products/services ventures develop—rather than under conditions of environmental dynamism, where there exists a low number of price premium opportunities (i.e., “abnormal” profits) available in total (Knight, 1921, 1942). Hence, I posit the following hypothesis:

H4a: The positive relationship between decision comprehensiveness and decision performance is higher under conditions of Knightian uncertainty than environmental dynamism.

However, I acknowledge that decision speed ostensibly appears to be more effective for environmental dynamism than Knightian uncertainty. Given that decision speed facilitates the quick collection of real-time market information/feedback on the fitness of the products/services a venture is developing to the “current” market (Eisenhardt, 1989; Judge & Miller, 1991), decision speed may work more effectively in the environmental context when the real-time market information could be used to forecast the future market at least roughly (i.e., environmental

dynamism) than in the context when the real-time environmental information has nothing to do with the future market conditions due to random changes (i.e., Knightian uncertainty) (Packard & Clark, 2020). The recent information/feedback about the current product-market fit that can be gained from fast decision processes and experimentations helps develop and update the focal products/services to capture entrepreneurial opportunities if the *real-time* market information/feedback can be utilized to forecast the *future* market conditions—that is, under conditions of environmental dynamism (Busenitz & Barney, 1997; Eisenhardt, 1989; Judge & Miller, 1991; Khanna et al., 2016). On the contrary, decision speed might actually be less effective for Knightian uncertainty because the *real-time* information does not typically help forecast the “future” value or market conditions in this environment due to the frequent “random” changes. Within the entrepreneurship context, fast decision processes are enacted to quickly adapt to the current market conditions by fast and iterative product experimentations, but such rapid adaptation to the “current” market does not necessarily help enhance the fitness level of a venture to the “future” market that is characterized by Knightian uncertainty. As Knight (1942, p. 129) points out, however, “any business which is to remain successful. . . must constantly be adapting itself to and attempting to “forecast” such changes,” the failure to think about the “future” changes can lower the performance of a venture. Overall, it follows that decision speed appears to work more effectively for environmental dynamism than for Knightian uncertainty at the micro-level, under the simplistic yet dubious assumption that there is a similar total amount of abnormal profit opportunities between both environments at the macro-level.

Nevertheless, at the environment (macro) level, the amount of abnormal profit differs depending on the type of environment. As explained in the previous hypothesis development, the total availability of abnormal profit under conditions of Knightian uncertainty is disproportionately

higher than that under conditions of environmental dynamism. Thus, the low availability of abnormal profits in a dynamic environment offsets this advantage of decision speed on average firm performance. In contrast, the high availability of abnormal profits within a Knightian uncertain environment counterbalances the disadvantage of decision speed on average firm performance, as explained above. Taking these altogether, I posit the following hypothesis:

H4b (Null): The positive relationship between decision speed and decision performance is similar between environmental dynamism and Knightian uncertainty.

4.3. METHOD & DATA

One of the main objectives of this study is to synthesize cumulative quantitative evidence on the performances of both decision comprehensiveness and decision speed, whose magnitude would be contingent upon different entrepreneurial decision contexts. In the previous sections, I proposed a key mechanism framework that explains why decision speed and decision comprehensiveness can generally be effective within the *entrepreneurship* context using the rationality types—different views on bounded rationality. Additionally, I showed a lack of clarity regarding these constructs in the existing literature, which may thus have produced disjointed theories and mixed findings, and then developed a contingency model that could synthesize the existing findings. In the following sections, I will test this contingency model and present the generalized effect sizes by employing multi-level meta-analytic methods. To be specific, I use the multi-level meta-analysis to integrate the extant findings on the performance of these two strategies. Hence, this meta-analytic review will provide more inferential power on the general role of

decision speed and decision comprehensiveness and its boundary conditions for *entrepreneurship* and suggest the direction for future entrepreneurship research.

Data and Selection Criteria

I searched all empirical papers from 1950 to April 2022 that reported correlations between “decision comprehensiveness and decision performance” and “decision speed and decision performance.” To comprehensively review published and unpublished articles, I used three databases: the Web of Science database, the ProQuest Dissertations & Theses database, and Google Scholar. First, I used Web of Science to conduct a systematic search for articles, following the less strict search terms for 16 elite management and entrepreneurship¹⁵ as the search algorithm of the Web of Science seems to be different from that of other databases: For decision comprehensiveness, (correlate* OR procedural rationality OR decision comprehensive*). I used the following search terms for decision speed: (correlate* decision speed). This search using the Web of Science database generated 830 results for decision comprehensiveness and 758 results for decision speed (as of Apr 2022). Second, I used the ProQuest Dissertations and Theses database to include other relevant scholarly journals from management, decision-making, psychology, entrepreneurship, and behavioral science/economics, and Ph.D. dissertations in the field of management with the limit to “full text” and the following more strict search terms: (correlation AND (“decision comprehensive” OR “procedural rationality”)) for the literature on decision comprehensiveness, and (correlation AND “decision speed”) for the literature on decision speed.

¹⁵ Entrepreneurship Theory and Practice, Journal of Business Venturing, Journal of Small Business Management, Strategic Entrepreneurship Journal, Family Business Review, Entrepreneurship and Regional Development, Small Business Economics, Venture Capital, Academy of Management Journal, Administrative Science Quarterly, Journal of International Business Studies, Journal of Management, Journal of Management Studies, Management Science, Organization Science, Strategic Management Journal.

This search using the ProQuest Dissertations and Theses database produced 663 results for decision comprehensiveness and 984 results for decision speed (as of Apr 2022). Third, I tried to find both published and unpublished articles by using the search terms “decision comprehensiveness” and “decision speed,” respectively, with the following keywords added: “Babson College Entrepreneurship Research Conference,” “Frontiers of entrepreneurship research,” “Southern Management Association,” “Academy of Management,” and “Western Academy of Management.” This search using Google Scholar produced 980 results for decision comprehensiveness and 860 results for decision speed (as of Apr 2022). As a result, these initial searches generated 5,075 results (2,473 for decision comprehensiveness and 2,602 for decision speed).

This initial search produced a large volume of existing papers for the meta-analytic reviews, but many failed to meet the inclusion criteria. Although many papers discuss decision speed or a rational/systematic approach to entrepreneurship, they do not always measure them. I reviewed each paper and excluded articles from the analysis based on the following criteria: (a) both non-empirical articles (e.g., analytical studies such as simulation models) and conceptual articles were excluded and (b) no reported correlations between any variables of interest are removed. As various performance indicators are used to reflect the decision performance in the entrepreneurship literature, I included any correlation coefficients as long as the authors explicitly operationalize the performance. After excluding the articles that meet these two exclusion criteria, the final set of papers was reduced to 55 studies with 141 correlation coefficients with a total sample size of 11,454 firms. A complete list of all meta-analyzed articles is presented in Table 4-2.

Analytical Process

My meta-analysis followed prior meta-analysis studies that correct for statistical artifacts (e.g., Hunter & Schmidt, 1990) to calculate aggregated effect sizes. To be specific, measurement and sampling errors were corrected to calculate more accurate estimates of the true average and variance of generalized effect sizes.

Since many effect sizes selected for the analysis are from the same studies, I decided to use Cheung's (2014, 2015) multi-level meta-analysis that corrects for any dependencies that could produce large errors to test hypotheses rigorously. This method accounts for all the viable correlation coefficients included in the study and separate estimates of two error types that could be produced from either within or between studies. The multi-level model that Cheung (2015) developed is as follows:

$$\text{Level 1: } y_{ij} = \lambda_{ij} + \varepsilon_{ij}$$

$$\text{Level 2: } \lambda_{ij} = f_j + u_{(2)ij}$$

$$\text{Level 3: } f_j = \beta_0 + u_{(3)ij}$$

In this model, λ_{ij} is the correlation coefficients corrected for reliabilities and sampling errors. Because many articles failed to report the reliabilities of both predictor and criterion variables—some articles reported neither of them, I used the meta-analytic procedures suggested by Raju, Burk, Normand, and Langlois (1994). Their method proposes that estimates of ε_{ij} should take these different scenarios of unreported reliabilities into account, computing the corrected correlates, λ_{ij} , which sophisticatedly accounts for the unreliability individually. ε_{ij} is the sampling variance for the i th effect in the j th group. f_j is the estimated correlate for the group j , β_0 is the generalized estimate for the population; $u_{(2)ij}$ is the random error (heterogeneity) within each of

the groups, and $u_{(3)ij}$ is the random error within the population. The 95% confidence intervals were computed.

For the moderation analysis, I used the multi-level meta-regression (Cheung, 2014, 2015). Since all potential moderators in this study were categorical variables, they were dummy coded to calculate mean effect sizes for each correlation coefficient. Precisely, to capture performance type (financial versus non-financial pursuits), I look into the dependent variable of firm performance in each study. If the measure of firm performance uses an objective financial indicator (e.g., ROA), it is coded as financial performance. If not, it is coded as non-financial performance, such as decision effectiveness and innovation. In addition, to capture the opportunity exploration and opportunity exploitation stage, I used the popular framework presented by March (1991) to operationalize these two phases. I focused on the research context of each paper and coded each effect size according to its context. If the decision context of the paper and its effects have to do with opportunity exploration processes, new product innovation activities, or new products/service development procedures, then the paper is coded as the opportunity exploration stage. In addition, if the decision context of the paper and its effects directly have to do with economic profits or market outcomes while at the same time, they have nothing to do with the capability building/growth stages (e.g., alliance outcome, international performance, innovation outcomes), then it is coded as the opportunity exploitation stage. For the third moderator of environmental condition, I focused on the key description and measures of the empirical research context (e.g., the industry and its market features). Since numerous previous studies conflate between environmental dynamism and Knightian uncertainty theoretically, I code each paper according to its description of the empirical dataset/sample of the study to capture the type of environment where the firms/entrepreneurs (i.e., samples of the study) make decisions. If the industry where

sample firms act is typically considered a dynamic market only but not necessarily unpredictable (e.g., manufacturing industry),¹⁶ where the environmental change is likely to be fast or nonlinear but the future market demand is not inestimable, then I coded the environmental context as dynamic environment/industry (e.g., manufacturing industry, publishing industry). However, if the description of the empirical samples and their focal industry of the paper explicitly states that the empirical decision context is entrepreneurial (e.g., entrepreneurs, startups, young ventures, or new technology/new product development) and unpredictable, for instance, if the paper directly measures and reports the level of uncertainty/unpredictability or if samples the study uses for the analysis are only from particular industries that are typically considered highly unpredictable (e.g., high technology industries, “new” technology “ventures”¹⁷), then the data is coded as Knightian uncertainty. Also, if the randomness/unpredictability of the market change is explicitly demonstrated to describe the empirical context (e.g., sample/data) of the study but, at the same time, the paper clearly describes that the primary source of the unpredictability originates from environmental characteristics (e.g., cultures, relational uncertainty, behavioral uncertainty) that is not environmental dynamism, then it is also coded as Knightian uncertainty. This operationalization scheme enables testing theories by Knight (1921) and other scholars (e.g., Milliken, 1987) that the dynamic changes in the market should be discriminated from

¹⁶ Since numerous extant studies conflate between environmental dynamism and Knightian uncertainty and fail to measure both environmental conditions, I excluded studies whose empirical environment context is unclear, ended up having multiple studies that do fall under neither environmental dynamism nor Knightian uncertainty. For instance, I removed the studies whose samples that did not focus on specific types of industries are coded as NA (not available) unless it measures both indicators for environmental dynamism and Knightian uncertainty (e.g., predictability).

¹⁷ Technology intensive industries, particularly the businesses that are not very high performing (e.g., big techs), are characterized by technology and market uncertainty, but not dynamic (Haltiwanger, Hathaway, and Miranda, 2014; Mohr, 2001; Vaaler and McNamara, 2010). Particularly, the market to which technology “ventures” or “startups” offers a solution set (e.g., a set of products/services) is highly unpredictable, but the technology development and its diffusion process is neither fast nor nonlinear necessarily. That is, it typically takes time for the overall market to accept and utilize the technologies. Moreover, it is generally difficult to predict how and to what extent the technologies are accepted by the market.

unpredictable change (i.e., environmental uncertainty). However, depending on the existence of the measures (or clear operationalization) of environmental conditions in the study, I categorize the Knightian uncertainty into two groups: “assumed” uncertainty versus “operationalized” uncertainty. In this way, methodological questions can also be addressed by splitting from the theoretical issues.

4.4. RESULTS

As Table 4-3 presents, the observed effect sizes and the population effect sizes that correct for unreliability in the predictor and criterion variables, as well as multi-level sampling errors, were computed. The hypothesis H1a that there would be a positive generalized population effect size between decision comprehensiveness and decision performance is supported, $cr = 0.3386$, with a standard error of 0.0457 ($P < 0.001$ ***). Therefore, I expect that the performance of decision comprehensiveness would be generally positive for entrepreneurship. In addition, hypothesis H1b that there would be a positive generalized population effect size between decision speed and decision performance is supported, $cr = 0.2065$, with a standard error of 0.0613 ($P < 0.001$ ***).

In H2a, I expected that types of performance moderate the effectiveness of decision comprehensiveness. Specifically, I hypothesized that the positive performance of decision comprehensiveness is statistically lower for financial performance than non-financial performance. As the results shown in Table 4-4 indicate, the effectiveness of decision comprehensiveness is found to be statistically higher for non-financial pursuits, such that the positive relationship between decision comprehensiveness and decision performance attenuated when changed from non-financial performance to financial performance (Slope (β) = -0.0694 , standard error = 0.0240,

$P < 0.001$ **). However, as Table 4-5 shows, H2b is not supported. Although the mean estimate of the financial performance of decision speed is slightly higher than that of the non-financial performance, the difference is not significant enough to support H2b statistically. Further, H3a and H3b hypothesized that the effectiveness of decision comprehensiveness is higher in the opportunity exploration stage than in the opportunity exploitation stage (H3a), while that of decision speed is higher in the opportunity exploitation stage than in the opportunity exploration stage (H3b). As indicated by the results in both Table 4-4 and Table 4-5, the moderator analyses for H3a provide support for H3a (i.e., Slope (β) = -0.1720 , standard error = 0.078 , $P < 0.05$ *), but no support for H3b (i.e., Slope (β) = 0.0145 , standard error = 0.1439 , $P = 0.9196$) even though the mean performance of decision speed for the opportunity exploitation is found to be a little higher than that for the opportunity exploration stage.

In H4 and H4b, different entrepreneurial environment type—Knightian uncertainty (coded as 0) versus environmental dynamism (1)—was suggested as an appropriate moderator. For the analysis of decision comprehensiveness, the environmental context was divided into three subgroups—uncertainty assumed, uncertainty operationalized, and environmental dynamism operationalized because numerous articles considered Knightian uncertainty as a general research context but did not explicitly operationalize or measure Knightian uncertainty. For the moderator analysis that compares the effectiveness of decision comprehensiveness between operationalized Knightian uncertainty and environmental dynamism, there was statistically significant support for H4a (i.e., Slope (β) = -0.2018 , standard error = 0.0660 , $P < 0.01$ **). The effectiveness of decision comprehensiveness between Knightian uncertainty (both assumed and operationalized combined) and environmental dynamism is also marginally supported, as Table 4-4 shows. Moreover, the moderator analysis for H4b is also partially supported. Although the mean performance of decision

speed under conditions of Knightian uncertainty is not statistically different from that under conditions of environmental dynamism, my results interestingly indicate that the mean performance of decision speed is marginally significant ($cr = 0.1843$, standard error = 0.1100 , $P = 0.0938$) under conditions of environmental dynamism, whereas there is no positive performance of decision speed statistically under any conditions of Knightian uncertainty (i.e., under every possible condition: uncertainty [both assumed and operationalized combined], uncertainty [assumed], and uncertainty [operationalized]) in general. Therefore, it may be seen that the moderator—Knightian uncertainty versus environmental dynamism—could play distinct boundary conditions for the relationship between decision speed and decision performance, even though the results from this study cannot be conclusive because the robust operationalizations of environmental dynamism versus Knightian uncertainty are lacking in the extant literature. Most previous empirical studies fail to operationalize Knightian uncertainty correctly, which should have been discriminated from environmental dynamism.

In addition, I conduct a post hoc analysis to determine whether different operationalizations of decision comprehensiveness have differential effects. Although this analysis cannot be conclusive due to the lack of clarity of existing operationalization and its measures in the extant literature, the overall results suggest that decision comprehensiveness operationalized as an extensive generation and systematic analysis of possible alternatives is systematically more effective than decision comprehensiveness operationalized as a thorough external market search and analysis. Furthermore, decision comprehensiveness as an extensive generation and analysis of possible alternatives under conditions of Knightian uncertainty is found to be statistically significant with a large positive effect size, while decision comprehensiveness as a thorough external market search and analysis under conditions of Knightian uncertainty is found to be non-

significant. Hence, it may be the case that decision comprehensiveness operationalized as a thorough external search and analysis play no or minimal roles under conditions of Knightian uncertainty (i.e., a key representative entrepreneurial environment), whereas decision comprehensiveness in systematically generating and analyzing possible alternatives is highly effective within this environment in general.

4.5 DISCUSSION & CONCLUSION

In this essay, I systematically review, analyze, integrate, and test the effectiveness of decision speed and comprehensiveness within the entrepreneurship context. My systematic literature review reveals several problems regarding the extant decision speed and comprehensiveness constructs. First, the existing literature on decision comprehensiveness and decision speed is less clear about their strategic roles. It fails to consider the unique challenges of entrepreneurial environments, thus may have created disjointed theories and inconsistent findings. More specifically, the existing literature is unclear about the utility of decision comprehensiveness in entrepreneurship and is characterized by a controversy about the effectiveness of decision speed. In this study, I develop and present a key mechanism framework to explain how each strategy can generally enhance venture performance differently. The first set of my meta-analytic results also corroborates such systematic effectiveness of both strategies.

Second, my analytic literature review also reveals the unclarity of these constructs. Thus, I disentangle their roles in entrepreneurship by investigating different ways these decision strategies increase venture performance. Both my conceptual review and post hoc meta-analysis on decision comprehensiveness in this essay illustrate and confirm that the indicator of decision

comprehensiveness operationalized as external market search and analysis plays no role or a minimal one within entrepreneurial environments. Instead, it is found that the decision comprehensiveness operationalized as the production and systematic analysis of extensive potential alternatives (e.g., new product candidates) is a key indicator responsible for increasing venture performance within the entrepreneurship context. Additionally, these extant constructs have been conceptualized at the firm level, even though the efficacy of these strategies could vary depending on the decision contexts/types and should be measured at the decision level (Bakker & Shepherd, 2017).

Third, my comprehensive literature review also uncovers the conflicting views on the relationship between decision comprehensiveness and decision speed, which remains untheorized and untested in previous research. Future studies on this topic are necessary to advance entrepreneurship research as advanced information technologies, such as artificial intelligence (AI), have begun enabling entrepreneurs to leverage decision speed and decision comprehensiveness simultaneously. For instance, AI could significantly reduce the information processing time while processing extensive amounts of data at affordable costs. This way, it is possible that decision comprehensiveness and decision speed can be synthesized into a unified process in the entrepreneurial decision process (Townsend & Hunt, 2019).

Therefore, I suggest reconceptualizing these constructs to be conducive to entrepreneurship contexts for future entrepreneurship research. Since there is not much quality environmental information for ventures' decisions within the entrepreneurial environments, and since it is almost impossible for entrepreneurs to conduct a comprehensive market search and predict the future value of the opportunities/information, decision comprehensiveness—operationalized as an external search and market analysis—cannot have efficacy within the entrepreneurship context.

Hence, my study suggests that the reconceptualized construct of decision comprehensiveness should remove an external market search dimension but focus more on a dimension of thorough procedures in generating and analyzing various potential alternatives. In addition, these constructs should be reconceptualized at the decision level to reflect their varying effects depending on decision types at a specific point in time and space (see Appendix C for more details).

Fourth, to properly synthesize prior studies, which depend on the fundamental assumptions that there are unavoidable tradeoffs between decision speed and decision comprehensiveness and that a venture should thus only choose a single strategy at one time, either decision speed or decision comprehensiveness, I developed a contingency model that can test if the relative value of these two strategies depends on the entrepreneurial lifecycle and the specific nature of knowledge problems a venture faces during the venturing process. Specifically, I integrate existing empirical findings on the performance of decision comprehensiveness and decision speed by using a meta-analytic technique and examine the extent to which and when decision speed and decision comprehensiveness are systematically effective in the entrepreneurial process. My results confirm that the effectiveness of decision comprehensiveness and decision speed is likely to be higher (or lower) depending on the specific decision contexts that the ventures encounter, even though some of these generalized effect sizes for boundary conditions may not be conclusive due to the lack of construct clarity in the existing literature as noted above, also calling for future research. In particular, my results confirm my theoretical reasoning that decision comprehensiveness is systematically more effective at the opportunity exploration stage than the opportunity exploitation stage, under Knightian uncertainty than environmental dynamism, and for non-financial pursuits more than financial performance. However, surprisingly, my results show that the decision speed is systematically effective for environmental dynamism, whereas Knightian uncertainty has no

statistical effect. In contrast, decision speed is similarly effective for the other focal moderators of this study. Hence, decision speed may work much more effectively for an environment that changes rapidly (i.e., environmental dynamism) than a market that changes randomly (i.e., Knightian uncertainty).

Overall, my meta-analysis offers a contingency model to present the degree to which and when decision comprehensiveness and decision speed, respectively, are generally more (or less) effective within the entrepreneurship context. Remarkably, my meta-analytic result on the moderating role of the entrepreneurial environment type aligns with Knight's theory (1921) that dynamic environmental change is distinct from Knightian uncertainty. My results suggest that environmental dynamism versus Knightian uncertainty can serve as a separate yet critical boundary condition, particularly for entrepreneurs who take a comprehensive approach, indicating that decision comprehensiveness is crucial to tackling Knightian uncertainty, especially at the opportunity exploration stage.

Further, my study also offers important practical implications. First, my results suggest that decision speed and decision comprehensiveness can generally improve venture performance. Thus, not only entrepreneurial strategies that leverage speed (e.g., lean approach)—quickly experimenting with the products developed to find and satisfy potential customers—but also those that leverage comprehensiveness—using deliberate methods to identify and analyze various product candidates/alternatives that can be created by the accessible resources—can also be recommended to entrepreneurs. Second, entrepreneurs may want to check their current entrepreneurial lifecycle stage—either the exploration or exploitation stage—if they need to choose (or focus more on) only one approach between decision comprehensiveness and decision speed. To be specific, if they are at the opportunity exploration stage, decision comprehensiveness

in producing and analyzing possible alternatives (e.g., extensive generation and systematic analysis of multiple product candidates [i.e., possible alternatives] for new product development) is likely to be beneficial to entrepreneurs, whereas expediting the decision process (e.g., speeding up the commercialization/release of the new products that have been developed) can be beneficial if a venture is at the opportunity exploitation stage where they should focus on monetizing current opportunities—making profits out of the products they have been developing. Third, if the industries in which entrepreneurs act suffer from a high degree of unpredictability (e.g., new tech industries)—where Knightian uncertainty is high, then ensuring to employ decision comprehensiveness to explore and analyze various product alternatives, at least in some stages in the venturing process, is likely to be essential.

Moreover, my study also has implications for entrepreneurship education. While rigid business planning itself may improve venture performance only minimally, entrepreneurial strategies that leverage decision comprehensiveness (e.g., using systematic tools such as AI) to imagine, simulate, and identify a variety of new potential product ideas and product candidates for new product development (Kier & McMullen, 2018) can be taught because this dimension of decision comprehensiveness is likely to directly enhance a venture's decision performance.

Limitations and Future Research

While my study offers a comprehensive review and systematic analysis of decision comprehensiveness and decision speed that provide important implications for entrepreneurship, I see some limitations that indicate future research opportunities. First, as I described above, my results from the meta-analysis might not be conclusive primarily due to the lack of construct clarity in the existing literature. Specifically, while many of the previous studies tend to use different

indicators of decision comprehensiveness that lend themselves to their research context, which enabled me to categorize two different operationalization strategies of decision comprehensiveness, the operationalization strategies of these constructs in the majority of the prior studies were inconsistent and unclear. For instance, the definition of decision comprehensiveness is conceptualized to include the dimension of external market search, yet its operationalization excludes the dimension of external search. Moreover, the existing literature has not theorized and operationalized clearly two environmental conditions that serve as key moderators in my study — Knightian uncertainty and environmental dynamism, even though Knight (1921) -- the scholar who theorized Knightian uncertainty -- differentiates Knightian uncertainty from environmental dynamism clearly.

Hence, future studies may reconceptualize all of these constructs robustly and develop precise measures with sufficient validity to be conducive to entrepreneurship decision contexts. In this way, rigorous research to robustly test the effectiveness of decision comprehensiveness and decision speed in the entrepreneurship context and the differential moderating effects of market conditions on such effectiveness will become possible.

Second, since very few previous studies explicitly theorized and tested the relationship between decision comprehensiveness and decision speed, my meta-analytic review was only able to develop and test a contingency model (instead of an integrative model that combines decision comprehensiveness and decision speed) by assuming that there are unavoidable tradeoffs between decision speed and decision comprehensiveness. However, due to the advancement of information technologies such as AI, a firm can integrate these two strategies into a unified decision process (e.g., Gans et al., 2019). It is increasingly possible that tradeoffs between decision speed and

decision comprehensiveness can be overcome by utilizing advanced information technology tools, enabling the simultaneous use of these two strategies.

Therefore, future research is needed to theorize and examine how and when these two strategies can be utilized simultaneously by analyzing and testing the relationship between decision speed and decision comprehensiveness. In this way, it will become more possible to disentangle the fundamental problems about why there have been inconsistent theories and mixed evidence regarding the effectiveness of decision comprehensiveness and decision speed in the extant literature. Furthermore, theorizing and testing the relationship between decision speed and decision comprehensiveness robustly by considering various entrepreneurial contexts will advance understanding of the nuanced role of AI (Artificial Intelligence) in entrepreneurship, as AI will help reduce processing time significantly (i.e., increase decision speed substantially) yet navigating and generating a massive set of possible alternatives (i.e., enhancing decision comprehensiveness considerably) at the same time.

Third, as with all meta-analytic reviews, my review is also constrained by the scope of the previous empirical studies in the extant literature. The limited scope of prior research constrained the further exploration of possible boundary conditions for the effectiveness of these two strategies. Moreover, all of the moderators in my meta-analysis are binary categorical moderators whose levels do not vary in degree and/or in multiple categories.

Therefore, future studies could explore the contingent roles of various moderators on new venture performance to offer new insights. More specifically, the value of decision comprehensiveness and decision speed would be contingent upon different entrepreneurial lifecycle stages (e.g., opportunity recognition, nascent entrepreneurial behavior, resource acquisition) (Lerner et al., 2018) and the magnitude of various knowledge problems (e.g., a high

level of complexity versus a low level of ambiguity, varying conditions of equivocality) (Townsend et al., 2018).

Last, my literature review on decision speed is relatively limited, primarily due to the lack of empirical data reported in extant studies compared with the review on decision comprehensiveness. Although fast decision-making processes have generally been assumed in entrepreneurship literature, many prior studies have not tested the role of decision speed in entrepreneurship. Moreover, it has been assumed that decision speed is a general attribute fixed at a firm level, even though it varies at the decision level, as recent entrepreneurship studies have pointed out (e.g., Bakker & Shepherd, 2017). Furthermore, my meta-analyses do not explore various criterion variables (e.g., different modes of entrepreneurial action that could vary at the decision level) that could be shaped by various indicators of decision speed and/or decision comprehensiveness, primarily due to limited data available in the literature.

To further understand the nuanced roles of decision speed and decision comprehensiveness in entrepreneurship, I urge future studies to investigate the various roles of each of these strategies by building on the results of my post hoc analysis that suggests the distinct roles of different indicators of decision comprehensiveness in entrepreneurship. In addition, future studies may want to delve into various mechanisms regarding the role of decision comprehensiveness and decision speed in entrepreneurship. For instance, different modes of entrepreneurial actions could also be shaped by decision speed and decision comprehensiveness.

Conclusion

My study makes a theoretical contribution to entrepreneurial strategy literature by disentangling the decision comprehensiveness and decision speed constructs for entrepreneurship

research. My systematic review and analysis of these constructs reveal that they need further development for entrepreneurship, where there are unique challenges in the decision environments.

Hence, I clarified a key mechanism through which these strategies can be effective within the entrepreneurship context and analyzed a lack of clarity in these constructs. I also develop and test a contingency model of these entrepreneurial strategies using meta-analytic techniques. My analyses reveal a specific dimension (i.e., external market search) of decision comprehensiveness that is not conducive to entrepreneurship and that the relationship between decision speed and decision comprehensiveness has been neither theorized nor tested in the extant literature.

Further, my meta-analytic results show that the effectiveness of each of these entrepreneurial strategies is contingent upon internal decision contexts such as entrepreneurial lifecycle and performance type as well as external conditions such as types of entrepreneurial environments. Overall, my study clarifies the role of these two strategies for entrepreneurship by analyzing several issues in these constructs in the extant literature and by developing and testing the contingency model of decision speed and decision comprehensiveness. Given the inconsistent theorizing and mixed findings in the previous studies on these two strategies, my study helps address these problems by synthesizing previous studies and findings and helps find future research opportunities to advance this research stream.

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¹⁸ Due to space limitations, I include all the citations of the empirical sample and tables on the last pages of this chapter. I report select references from the text of the paper here.

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Table 4-1 Review of Decision Comprehensiveness in the Existing Literature

Types of DC	Decision comprehensiveness as an extensive external search and systematic market analysis	Decision comprehensiveness as an exhaustive generation and deliberate analysis of possible decision options (e.g., variables, decision options like new product candidates for development)
Representative Example	“The extensiveness with which an organization’s top executives systematically gather and process information from the external environment in making strategic decisions” (Forbes, 2007)	“Several alternatives are considered, comprehensively examined, and evaluated on multiple criteria before a decision is made” (Talaucar, Grundei, & Werder, 2005) “Conducting an exhaustive consideration of multiple approaches (Slotegraaf & Atuahene-Gima, 2011)”
Key Argument	To what extent will market information gathered by firms help them to respond and adjust to the environment effectively	To what extent will information and knowledge that a firm thoroughly processes and analyzes help them comprehensively explore and analyze multiple possible alternatives so that the firm can leverage or overcome future contingencies
Key Mechanism	Systematically gathering sufficient environmental information is crucial because it helps a firm to respond and adapt to the environment (rather than to pioneer new possibilities)	Human beings process the information/knowledge they gain, creating novel integrative solutions (rather than just responding to environmental stimuli/feedback)
Key Characteristics	Extensive external search and analysis of environmental/market information—exogenous processes	Extensive generation and analysis of various new possible alternatives (e.g., new product candidates)—endogenous processes
Efficacy for Eship Context	This dimension of decision comprehensiveness is likely to be minimally effective within the entrepreneurship context because there is little quality external information that can be searched for. Its integrative search process and systematic analysis may help minimally enhance the alignment among the external information/feedback a focal entrepreneur gains, the focal entrepreneur (the focal venture), and the products/services the focal entrepreneur develops.	This dimension of decision comprehensiveness is likely to be effective within the entrepreneurship context (where there is no or little quality information about the environment/market and the future value of entrepreneurial ideas) because this decision comprehensiveness enables entrepreneurs to systematically explore and analyze new possibilities extensively for future contingencies and to remove unpromising alternatives through deliberate analysis. ¹⁹

¹⁹ Due to a lot of noise and rarity of the market information and the information regarding the future value of entrepreneurial ideas within the entrepreneurial environment, it is impossible for entrepreneurs to sort out promising

Figure 4-1 Environmental Dynamism versus Knightian Uncertainty

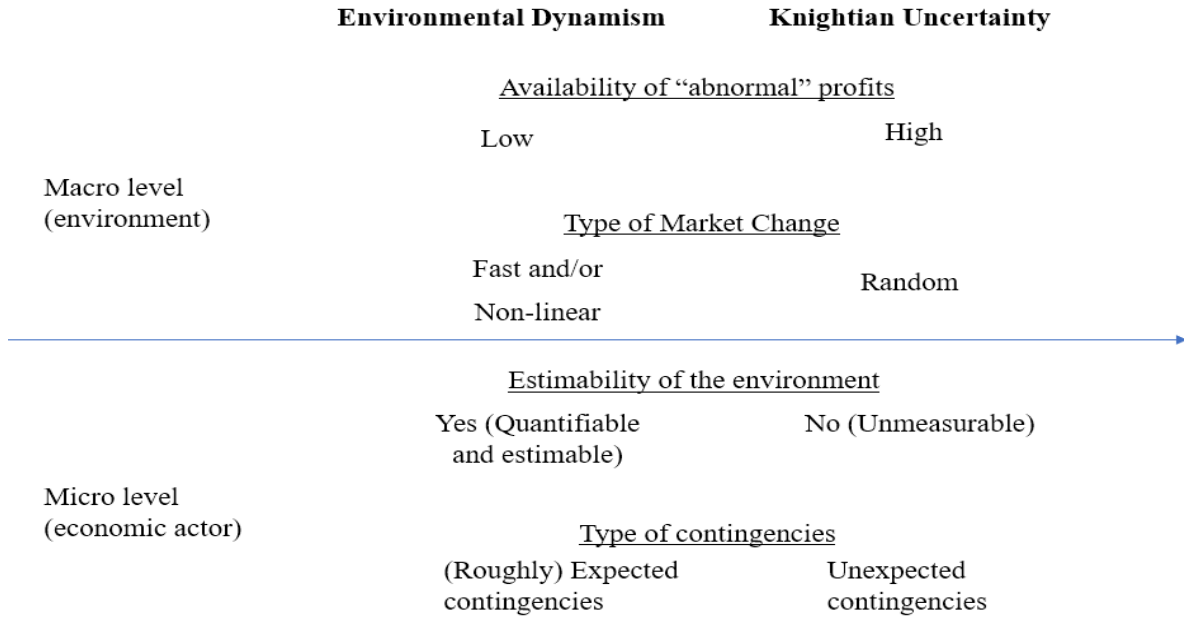


Table 4-2 List of Included Articles for Empirical Sample

Study	n	Decision Speed	Decision Comprehensiveness
Acharaya (2012)	53	X	O
Adomako et al. (2021)	269	O	X
Arend et al. (2016)	99	X	O
Argouslidis et al. (2015)	175	O	X
Atuahene-Gima and Li (2004)	260	X	O
Azam (2015)	91	O	O
Baum and Wally (2003)	105	O	X
Campos et al. (2015)	321	O	O
Capelleras et al. (2010)	647	O	X
Chen et al. (2005)	692	O	X
Chowdhury (2015)	79	X	O
Clark and Maggitti (2012)	211	O	X
Dean and Sharfman (1996)	61	X	O
Deligianni et al. (2016)	216	X	O
Elbanna and Child (2007)	169	X	O

alternatives. Instead, entrepreneurs with decision comprehensiveness are able to estimate what alternatives are likely to be unpromising (Gans et al., 2019).

Elbanna and Naguib (2008)	286	X	O
Elbanna et al. (2013)	169	X	O
Elbanna et al. (2014)	116	X	O
Eranova and Prashantham (2017)	110	X	O
Forbes (2005)	77	X	O
Francioni and Clark (2022)	202	O	O
Friedman et al. (2016)	149	X	O
Galanou and Farrag (2014)	140	O	O
Goll and Rasheed (1997)	645	O	X
Haines et al. (2010)	53	X	O
Heavey et al. (2009)	349	X	O
Hsu and Chang (2020)	111	O	X
Jiang et al. (2014)	265	O	X
Judge and Miller (1991)	10	O	X
Kaufmann et al. (2012)	150	X	O
Gemmell (2012)	202	O	X
Lee at al. (2017)	186	X	O
Lin et al. (2019)	463	O	X
Meissner and Wulf (2014)	184	X	O
Mohan et al. (2017)	172	X	O
Ven Den Oever & Martin (2019)	137	X	O
Onken (1998)	90	O	X
Powell (1992)	113	X	O
Priem et al (1995)	105	O	X
Rahimnia and Molavi (2020)	450	O	X
Ramos-Garza and Villalba-Moreno (2011)	29	O	X
Rovelli et al. (2022)	102(Sample 1)/198(Sample 2)	X	O
Samba (2016)	173(Sample 1)/28(Sample 2)	X	O
Seyr and Vollmer (2014)	67	X	O
Simons et al. (1999)	57	X	O
Slotegraaf and Atuahene-Gima (2011)	208	X	O
Souitaris and Maestro (2010)	129	O	O
Talaulicar et al (2005)	71	O	O
Thanos (2022)	103	X	O
Thomas and Ambroism (2015)	701	X	O
Walter et al. (2012)	103	X	O
Zahra et al. (2002)	228	X	O
Zehir and Ozsahin (2008)	73	O	X
Zehir et al. (2015)	703	O	X
Note: O = Available, X = Not available			

Table 4-3 Meta-Analyzed Generalized Effect Sizes Between Decision Comprehensiveness and Its Performance, and Between Decision Speed and Its Performance

	Ki	Kt	Ni	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z	Q	df	τ^2(w/i)	τ^2(btw)
DC- Perf	40	95	7203	0.2831	0.3386	0.0457	0.2491	0.4280	0.000***	7.4174	1398.386***	94	0.0004	0.07833***
DS- Perf	26	43	5777	0.1802	0.2065	0.0613	0.0864	0.3266	0.000**	3.3710	1188.736***	42	0.0000	0.0887**

Note: DC= Decision Comprehensiveness, DS: Decision Speed

Perf = Firm Performance

Kt = total number of samples (independent and dependent); Ki= number of independent samples; Ni= total sample size for the independent samples;

cr= estimated population correlation (corrected for unreliability in the predictor and criterion);

SE= Standard Error; CI= Confidence Interval; Q = Cochran's homogeneity test; pQ= probability of Q

Table 4-4 Moderating Effects for Decision Comprehensiveness

<u>Decision Comprehensiveness</u>	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z					
Uncertainty (Both Assumed and Operationalized Combined)	0.3655	0.4372	0.0649	0.3099	0.5646	0.0000***	6.7286					
Uncertainty Assumed	0.3149	0.3784	0.1323	0.1191	0.6378	0.00423**	2.8603					
Uncertainty Operationalized	0.3693	0.4415	0.0745	0.2954	0.5875	0.0000***	5.9255					
Dynamism (Operationalized)	0.2049	0.2445	0.0922	0.0639	0.4251	0.008**	2.6531					
	Ki	Kt	Ni	Slope (Beta)	SE	Lower 95% CI	Higher 95% CI	p-value	Z	Q	$\tau^2(w/i)$	$\tau^2(btw)$
Uncert (Both Assumed and Operationalized Combined) (0) vs Dynamism (1)	21	62	3210	-0.1927	0.1127	-0.4136	0.02824	0.0873†	-1.7095	642.1509***	0.0000	0.0551**
Uncert Operationalized (0) vs Dynamism (1)	17	55	2843	-0.2018	0.0660	-0.3312	-0.0723	0.002**	-3.0564	606.4631***	0.0000	0.0594**
Uncert Assumed (0) vs Dynamism (1)	11	32	1090	-0.1287	0.1145	-0.3532	0.0958	0.2611	-1.1238	93.0006***	0.0013	0.0269†
Uncert Assumed (0) vs Uncert Operationalized (1)	14	37	2590	0.0803	0.1597	-0.2326	0.3933	0.6149	0.5031	487.7021***	0.0000	0.0673*

	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z					
Opportunity Exploration Stage	0.3837	0.4626	0.0612	0.3426	0.5826	0.0000 ***	7.5559					
Opportunity Exploitation Stage	0.2448	0.2905	0.0582	0.1765	0.4046	0.0000 ***	4.9921					
	Ki	Kt	Ni	Slope(Beta)	SE	Lower 95% CI	Higher 95% CI	p-value	Z	Q	τ^2(w/i)	τ^2(btw)
Opportunity Exploration (0) vs Opportunity Exploitation (1)	20	51	3296	-0.1720	0.0784	-0.3257	-0.0185	0.0281*	7.5559	425.1795 ***	0.0001	0.0359**
	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z					
Nonfinancial Perf	0.3040	0.3625	0.0450	0.2743	0.4508	0.0000 ***	8.0508					
Financial Perf	0.2430	0.2931	0.0470	0.2010	0.3853	0.0000 ***	6.2336					
	Ki	Kt	Ni	Slope(Beta)	SE	Lower 95% CI	Higher 95% CI	p-value	Z	Q	τ^2(w/i)	τ^2(btw)
Nonfinancial (0) vs Financial Perf (1)	40	95	7203	-0.0694	0.0240	-0.1165	-0.0223	0.0038**	-2.8868	1398.386 ***	0.0000	0.0737 ***
Note: cr= estimated population correlation (corrected for unreliability in the predictor and criterion); SE= Standard Error; CI= Confidence Interval; Ki= number of independent samples; Kt = total number of samples (independent and dependent); Ni= total sample size for the independent samples; Slope(Beta) = regression estimate; *** p<0.001, ** p<0.01, * p<0.05, † p<0.10, Q = Cochran's homogeneity test, τ^2 (w/i): tau-q within study estimates, τ^2 (btw): tau-q between study estimates												

Table 4-5 Moderating Effects for Decision Speed

Decision Speed	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z					
Uncertainty (Both Assumed and Operationalized Combined)	0.0068	0.0104	0.0800	-0.1464	0.1673	0.8962	0.1304					
Uncertainty Assumed	0.0181	0.0244	0.1090	-0.1892	0.2381	0.8224	0.2244					
Uncertainty Operationalized	-0.0103	-0.0127	0.1455	-0.2979	0.2725	0.9306	-0.0871					
Dynamism (Operationalized)	0.1798	0.1843	0.1100	-0.0313	0.4000	0.0938†	1.6756					
	Ki	Kt	Ni	Slope(Beta)	SE	Lower 95% CI	Higher 95% CI	p-value	Z	Q	τ²(w/i)	τ²(btw)
Uncert (Both Assumed and Operationalized Combined) (0) vs Dynamism (1)	13	22	2537	0.1739	0.1364	-0.0934	0.4412	0.2023	1.2750	299.2566***	0.0000	0.0443†
Uncert Operationalized (0) vs Dynamism (1)	8	13	1312	0.1637	0.1830	-0.1950	0.5223	0.3712	0.8943	140.576***	0.0000	0.0813
Uncert Assumed (0) vs Dynamism (1)	10	18	2119	0.1467	0.1686	-0.1838	0.4772	0.3842	0.8702	285.6917***	0.0009	0.0592†
Uncert Assumed (0) vs Uncert Operationalized (1)	8	13	1643	-0.0030	0.0929	-0.1852	0.1792	0.9741	-0.0324	29.44547***	0.0015	0.007

	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z						
Opportunity Exploration Stage	0.2140	0.2484	0.1136	0.0258	0.4711	0.029*	2.1873						
Opportunity Exploitation Stage	0.2256	0.2629	0.0885	0.0895	0.4365	0.003**	2.9709						
	Ki	Kt	Ni	Slope(Beta)	SE	Lower 95% CI	Higher 95% CI	p-value	Z	Q	$\tau^2(w/i)$	$\tau^2(btw)$	
Opportunity Exploration (0) vs Opportunity Exploitation (1)	16	27	4211	0.01452	0.1439	-0.2675	0.2965	0.9196	0.1010	757.5041 ***	0.0000	0.0708**	
	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z						
Non-financial Perf	0.1751	0.1980	0.0652	0.0703	0.3258	0.0023**	3.0391						
Financial Perf	0.1847	0.2140	0.0641	0.0884	0.3396	0.0008***	3.3391						
	Ki	Kt	Ni	Slope(Beta)	SE	Lower 95% CI	Higher 95% CI	p-value	Z	Q	$\tau^2(w/i)$	$\tau^2(btw)$	
Nonfinancial (0) vs Financial Perf (1)	26	43	5777	0.0160	0.0391	-0.0606	0.0925	0.6828	0.4087	1188.736 ***	0.0000	0.0899**	
<p>Note: cr= estimated population correlation (corrected for unreliability in the predictor and criterion); SE= Standard Error; CI= Confidence Interval; Ki= number of independent samples; Kt = total number of samples (independent and dependent); Ni= total sample size for the independent samples; Slope(Beta) = regression estimate; *** p<0.001, ** p<0.01, * p<0.05, † p<0.10, Q = Cochran's homogeneity test, $\tau^2(w/i)$: tau-q within study estimates, $\tau^2(btw)$: tau-q between study estimates</p>													

Table 4-6 (Post-Hoc Analysis) Two Types of Decision Comprehensiveness

<u>Decision Comprehensiveness</u>	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z		
DC(External Search)	0.2388	0.2849	0.0982	0.0923	0.4775	0.0037**	2.8996		
DC(Possible Alternatives)	0.3258	0.3894	0.0521	0.2873	0.4915	0.0000***	7.4768		
DC(External Search)	r	cr	SE	Lower 95% CI	Higher 95% CI	p-value	Z		
Uncertainty (Operationalized) ²⁰	0.3187	0.3207	-0.3006	-0.3006	0.9420	0.3117	1.0117		
Dynamism (Operationalized)	0.1446	0.1717	0.2255	-0.2706	0.6132	0.4475	0.7596		
Opportunity Exploration	0.2702	0.3222	0.1312	0.0649	0.5796	0.0141*	2.4545		
Opportunity Exploitation	0.0775	0.0940	0.1161	-0.1336	0.3215	0.4182	0.8096		
Non-financial Perf	0.2824	0.3429	0.1090	0.1292	0.5566	0.0017**	3.1453		
Financial Perf	0.1852	0.2148	0.1089	0.0014	0.4282	0.0485*	1.9725		
DC(Possible Alternatives)²¹									
Uncertainty (Both Assumed and Operationalized Combined)	0.3586	0.4328	0.0852	0.2658	0.5997	0.0000***	5.0817		
Uncertainty Assumed	0.4484	0.5400	0.1395	0.2665	0.8135	0.0001***	3.8702		
Uncertainty (Operationalized)	0.3144	0.3795	0.0959	0.1915	0.5675	0.0000***	3.9572		
Opportunity Exploration	0.4008	0.4827	0.0500	0.3848	0.5806	0.0000***	9.6641		
Opportunity Exploitation	0.2009	0.2410	0.1020	0.0412	0.4409	0.0181*	2.3644		
Non-financial Perf	0.3451	0.4139	0.0469	0.3219	0.5059	0.0000***	8.8207		
Financial Perf	0.2570	0.3101	0.0593	0.1939	0.4264	0.0000***	5.2278		

²⁰ The data of DC operationalized as external search for assumed uncertainty were not available.

²¹ The data of DC operationalized as possible alternatives for environmental dynamism were not available.

DC(External Search)	Ki	Kt	Ni	Slope(Beta)	SE	Lower 95% CI	Higher 95% CI	p-value	Z
Uncertainty (0) vs Dynamism (1) ²²	3	10	363	0.1230	0.3276	-0.5190	0.7650	0.7073	0.3754
Opportunity Exploration (0) vs Opportunity Exploitation (1)	5	19	769	-0.2283	0.1293	-0.4817	0.0251	0.0775†	-1.7656
Nonfinancial (0) vs Financial Perf (1)	6	19	769	-0.1281	0.0422	-0.2110	-0.0452	0.0025*	-3.0298
DC(Possible Alternatives)²³									
Uncert Assumed (0) vs Uncert Operationalized (1)	6	16	926	-0.1604	0.1691	-0.4920	0.1710	0.3427	-0.9487
Opportunity Exploration (0) vs Opportunity Exploitation (1)	7	15	1383	-0.2417	0.1135	-0.4641	-0.0192	0.0332*	-2.1294
Nonfinancial (0) vs Financial Perf (1)	13	26	2527	-0.1038	0.0459	-0.1936	-0.0139	0.0237*	-2.2627
Note: cr= estimated population correlation (corrected for unreliability in the predictor and criterion); SE= Standard Error; CI= Confidence Interval; Ki= number of independent samples; Kt = total number of samples (independent and dependent); Ni= total sample size for the independent samples; Slope(Beta) = regression estimate; *** p<0.001, ** p<0.01, * p<0.05, † p<0.10									

²² Moderator analyses of the assumed uncertainty are not conducted because all the data of DC type-External Search available were within either operationalized uncertainty or operationalized environmental dynamism conditions only.

²³ Moderator analyses of Dynamism versus Uncertainty for DC type-Possible alternatives were not conducted because the data were not available for environmental dynamism. Thus, it follows that the mean estimate of DC type-Possible alternatives is the mean performance of decision comprehensiveness – possible alternatives under conditions of Knightian uncertainty.

4.7. APPENDICES

Appendix A: A Key Mechanism of Decision Comprehensiveness and Decision Speed on Decision Performance

	A Key Mechanism of Decision Comprehensiveness on Decision Performance in the Entrepreneurship Context:	A Key Mechanism of Decision Speed ²⁴ on Decision Performance in the Entrepreneurship Context:
	Procedural Rationality	Adaptive Rationality
Common Background (e.g., Assumptions)	<p>1. All these approaches (e.g., rationalities) attempt to model “bounded rationality” (Simon, 1976, 1990), although each model is basically different every other</p> <p>2. All these models agree that end-based rationality (i.e., accurate computations or predictions of the expected decision outcomes) is impossible due to a high level of uncertainty (e.g., you cannot accurately predict the future outcomes before taking entrepreneurial actions), which makes all of these rationalities—both procedural rationality and adaptive rationality distinct from substantive rationality (i.e., full means-end rationality) and from purely causal rationality (i.e., “to the extent you can predict the future, you can control it” [Saravasthy, 2001])</p> <p>3. Entrepreneurial environment manifests a high level of both means-based uncertainty (i.e., information on means is limited and thus what would be great means/tools cannot be correctly known) and end-based uncertainty (i.e., information on ends is limited and thus actual outcomes of decision choices cannot be calculated or be known before entrepreneurial actions)</p>	

²⁴ Decision speed in our study is also viewed as one type of decision strategy that a venture can formulate and implement, which has a purposeful agenda for the venture. Thus, any decision that happens to be fast without purposes preset by a firm is outside of the scope of this study. Therefore, I assume that decision speed as a decision strategy is informed by a certain type of rationality—adaptive rationality in this study.

<p>Fundamental Tradeoffs Between Decision Comprehensiveness and Decision Speed</p>	<p>A more comprehensive approach may require more time to reach a decision, meaning that the speed of decision-making is likely to decrease (e.g., Fredrickson & Mitchell, 1984; Janis, 1972; Mintzberg, 1994, p. 325).</p> <p>That is, it is always possible that the fundamental tradeoffs between the two can exist, and thus, these constructs can often be opposite, as most of the extant studies assumed, and thus my meta-analysis in this study uses the contingency model to contrast decision comprehensiveness and decision speed to integrate the existing studies.</p> <p>However, these two approaches are not necessarily mutually exclusive because it is possible that the tradeoff between decision comprehensiveness and decision speed may significantly decrease if each approach is taken by different people (e.g., at different levels) who work for the same firm or across different decision points in time (e.g., across various stages of venturing processes) (Bourgeois & Eisenhardt, 1988; Eisenhardt, 1989).</p>	
<p>Complementary Effects Between Decision Comprehensiveness and Decision Speed</p>	<p>Decision comprehensiveness can help enhance the speed of the subsequent decision-making process (i.e., decision speed) because the various possible alternatives generated from decision comprehensiveness are likely to help speed up the following decision process. Specifically, if various possible good alternatives are clearly identified, rapidly sequencing these alternatives becomes much more possible, and thus overall decision speed is likely to increase (Eisenhardt, 1989). For instance, if one alternative is unsuccessful, then a firm can rapidly pivot to another possible alternative (e.g., fallback option) if the wide choice set was already pre-identified. This pivoting procedure can also be rapidly reiterated.</p> <p>Additionally, due to the advancement of information technology, it becomes more possible that both decision comprehensiveness and decision speed can be utilized and even synthesized simultaneously. In particular, due to its affordable cost and process innovation, a comprehensive approach can be taken at a fast pace due to improved processing time. Moreover, different people across different levels within the firm can take each approach to the same decision simultaneously (Note: Such complementary effects between these two strategies fall outside of this study, as noted above. This paper focuses on testing a contingency model under what conditions each strategy is more effective and why.)</p>	
<p>Difference Between DC and DS</p>	<p>Focus on thoroughly processing information/knowledge and generating and systematically analyzing new possible alternatives (e.g., novel products, knowledge) by using systematic approaches (e.g., computational tools and rule-based procedures)</p>	<p>Focus on rapidly obtaining real-time market information/feedback by reaching a decision to act quickly</p>

A Type of Rationality It Leverages	Procedural Rationality: A deliberation in terms of decision processes that use systematic methods (e.g., rule-based procedures and/or computational/systematic tools) to attain the goals of a decision	Adaptive Rationality: A fast decision process to quickly gain real-time environmental feedback/information by taking relevant actions to adapt to the environment where the decision is made
How It Enhances the Decision Performance	Decision comprehensiveness enables an actor to broaden and increase the choice option sets that can possibly be pursued by an actor, increasing the fit between an actor and the products/services developed by the actor and helping tackle future contingencies. Specifically, the wide availability of possible alternatives (e.g., potential product designs) that are generated and analyzed from this comprehensive and thorough decision process makes it possible for a firm to shift/pivot to other possible alternatives (e.g., fallback options) whenever unexpected contingencies arise. A firm with procedural rationality has flexibility in terms of various possible options to choose from.	Strategic decision speed enables an actor to quickly act and obtain real-time environmental information and immediate market feedback on the existing product/service candidates that the actor has developed, deepening and updating them (i.e., the extant product/service(s)) to enhance the product-market fit at the given moment. Specifically, the real-time market information/feedback about the new product candidates gained from a rapid decision-making process and fast action allows a firm to respond and adapt their products/services to the current market quickly and effectively. A firm with adaptive rationality has flexibility in terms of rapid reactions and adjustments (pivoting) of an extant alternative (e.g., the chosen potential product candidates that have been selected)
Key Outcome	Entrepreneur-product fit is likely to be enhanced	Product-market fit is likely to be enhanced
What logic it uses	The logic of possibilities and rule-based decision procedure: Possible various alternatives are “broadly and thoroughly” explored, estimated, generated, and assessed by employing the systematic methods/tools in terms of accessible resources/knowledge and preferences of an actor (i.e., entrepreneur-product fit)	The logic of reactivity and action-based decision procedure: An actor makes decisions by reacting to the recent environmental feedback obtained and by updating and deepening their means according to the changing information/feedback and demands of the environment (i.e., product-market fit)

The Focus of the Decision Strategy	This strategy focuses on how actors use their systematic tools/means to identify a set of potential entrepreneurial options that an entrepreneur can possibly pursue	This strategy focuses on how actors can update means (e.g., new products being developed) that fit well with the environment
Interpretation of Bounded Rationality	<p>“The glass half full” (Bendor, 2010, p. 1):</p> <p>Bounded rational actors can still be somewhat rational in the procedures (although not substantively rational for the optimal outcomes) when efficient use of information is possible, which could lead to good enough decision outcomes.</p>	<p>“The glass half empty” (Bendor, 2010, p. 1):</p> <p>Bounded rational actors cannot be rational enough to use good estimation strategies for procedures and expected outcomes. Instead, they can rely on their actions to obtain real-time feedback/information from their environment and to update the means available to align with this real-time feedback/information obtained</p>
Focusing on Actor versus Environment	<p>Focuses more on the internal procedures that increase the entrepreneur-product fit</p> <p>(e.g., what can I possibly do? What opportunities can I create or capture at a particular time in space and time?)</p>	<p>Focuses more on adjustments to the external environment that increases the product-market fit</p> <p>(e.g., how can I quickly fit into the environment where the entrepreneurial opportunities emerge before it disappears?)</p>

Appendix B: Opportunity Exploration versus Opportunity Exploitation

	Opportunity Exploration Stage	Opportunity Exploitation Stage
Definition	<p>The entrepreneurial decision stage is when entrepreneurs try to explore and recognize potential entrepreneurial opportunities/ideas to pursue. Opportunity exploration includes “search, variation, risk-taking, experimentation, play, flexibility, discovery” (Choi et al., 2008; March 1991, p. 71).</p>	<p>The entrepreneurial decision stage is when entrepreneurs commit to realizing profits (i.e., monetizing the opportunity) from the actual commercialization (i.e., full commitment) of the new products/services they have developed so that they can survive and continue to engage in the venturing process. Opportunity exploitation includes “refinement, choice, production, efficiency, selection, implementation, and execution” (Choi et al., 2008; March 1991, p. 71).</p>
Key Characteristics	<ul style="list-style-type: none"> • Accumulation of knowledge regarding potential opportunities (e.g., Choi et al., 2008) • Reducing ignorance and doubt (Shepherd, McMullen, & Jennings, 2007) • First-person opportunity (knowledge: feasibility, motivation: desirability—personal identity) (McMullen & Shepherd, 2006) 	<ul style="list-style-type: none"> • Full commitment (e.g., full-scale operation yet irreversible commitment) to commercializing the new products/services being developed by a venture (Choi et al., 2008) • Monetizing focal opportunities—making profits (Lerner et al., 2018) • Satisfying the current demands of customers (i.e., achieving the current product-market fit) (Choi et al., 2008; Choi & Shepherd, 2004)

Relation to Decision Comprehensiveness	<ul style="list-style-type: none"> • Decision comprehensiveness helps generate wide and broad possible alternative choice sets for a decision • Decision comprehensiveness helps entrepreneurs recognize which alternatives are relevant (e.g., possible and desirable) to them (or their entrepreneurial pursuit) or not (e.g., impossible or undesirable), helping them to identify the opportunities that match well with their available knowledge, resources, and identity (McMullen & Shepherd, 2006; Sarasvathy, 2008) and helping entrepreneurs reduce doubts and accumulate knowledge to remove unpromising alternatives from the choice set (Gans et al., 2019; Shepherd et al., 2007) 	<ul style="list-style-type: none"> • Wide potential alternatives analyzed and generated by decision comprehensiveness allow a venture to choose the potential alternatives that are unlikely to harm the venture (Gans et al., 2019; Eisenhardt, 1989), but this advantage does not necessarily lead to capturing value • Wide potential alternatives generated by decision comprehensiveness reduce the turnaround time between each product release (particularly when one product is commercialized at a time but multiple product launches are scheduled) but this advantage does not necessarily increase product-market fit and firm profits ultimately.
Relation to Decision Speed	<ul style="list-style-type: none"> • Decision speed helps entrepreneurs to rapidly develop possible alternatives for a decision and settle on one (or a few) alternative(s) quickly, but it is possible that the chosen alternative(s) may suffer from errors and biases later (Tversky, & Kahneman, 1974). • Decision speed may help quickly recognize a few alternatives and their extensions (e.g., updated versions) so that the selected alternative(s) (i.e., the products candidates at hand) can be deepened and developed further afterward, but decision speed alone is difficult to identify a variety of alternatives that can serve as a diversified portfolio of products/services that might be developed further. 	<ul style="list-style-type: none"> • Decision speed helps quickly choose the alternative(s) (i.e., the new products/services that have been developed) to test them and commercialize in the market rapidly so that entrepreneurs can make a full commitment to make profits out of them (Choi et al., 2018; Choi & Shepherd, 2004, Ries, 2011) • Decision speed helps quickly deepen (e.g., test out in the market and revise) and commercialize the alternative(s) (i.e., the new products/services that have been developed) by obtaining real-time feedback so that the alternatives can increase the fit between the “current” market conditions (e.g., customer demand) and the new products/services quickly. (Eisenhardt, 1989)

Appendix C: Environmental Dynamism versus Knightian Uncertainty

	Environmental Dynamism	Knightian Uncertainty
Entrepreneurial Environment (Common features between the two environments)	<ul style="list-style-type: none"> • It is impossible to accurately predict the future environment in both environment types, and thus, optimization is impossible in both environments (Knight, 1921) • There is little or no quality information for entrepreneurial pursuits in entrepreneurial environments (McMullen & Shepherd, 2006) • The problem of isotropy exists for both environment types (Sarasvathy, 2008) 	
Definition	A type of entrepreneurial environment whose rate of change is fast and/or nonlinear (Knight, 1921)	A type of entrepreneurial environment that is unpredictable due to random change (Knight, 1921; Packard & Clark, 2020)
Key Characteristics	<p>The potential “abnormal” profits rarely exist at the macro (environmental) level because the dynamic change and its risk can be insured, hedged, and priced (Knight, 1921)</p> <p>The environment or the future value of entrepreneurial ideas can be roughly estimable at the micro (individual) level.</p> <p>Future contingencies can be expected and estimated roughly (Gans et al., 2019; Packard & Clark, 2020)</p>	<p>The potential “abnormal” profits clearly exist at the macro (environmental) level because the uncertainty cannot be hedged, insured, or priced (Knight, 1921)</p> <p>The environment is unmeasurable and inestimable at the micro (individual) level.</p> <p>Thus, a variety of unexpected contingencies can often arise in this environment (Sarasvathy, 2001)</p>

<p>Relation to Decision Comprehensiveness</p>	<p>The wide availability of potential alternatives generated and analyzed by decision comprehensiveness allows a venture to tackle or leverage contingencies at the micro (individual) level</p> <p>It is also possible that a venture estimates the future value of entrepreneurial ideas or the future environmental conditions roughly (Gans et al., 2019; Packard & Clark, 2020)</p> <p>However, such an estimable environment will also significantly reduce the potential “abnormal” profits that can exist at the macro (environment) level because the market can insure, hedge, and price risks associated with the dynamic change of the environment, ultimately reducing average firm performance readily available in the market (Knight, 1921)</p> <p>Overall, although decision comprehensiveness helps a venture to tackle a dynamic environment due to its deliberate decision-making processes and the generation of possible choice sets, the fact that “abnormal” profits rarely exist in the dynamic environment reduces the mean efficacy of decision comprehensiveness compared with under conditions of Knightian uncertainty</p>	<p>The wide availability of potential alternatives generated by decision comprehensiveness allows a venture to tackle or even leverage unexpected contingencies effectively (Eisenhardt, 1989; McGrath, 1999)</p> <p>Furthermore, Knightian uncertainty is the key source of “abnormal” profits, and thus “abnormal” profits often exist under conditions of Knightian uncertainty at the macro (market/environment) level (Knight, 1921)</p> <p>Both environmental conditions—the availability of abnormal profits—and the benefits of decision comprehensiveness—the wide availability of possible alternatives—make it possible for a venture to capture entrepreneurial opportunities</p>
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Relation to
Decision Speed

Decision speed helps a venture to tackle or leverage contingencies at the micro (individual) level because the real-time information/feedback obtained from quick decisions and experimentations enables entrepreneurs to estimate or expect future environments roughly and to update their products/services that align with the future environment

However, such an estimable environment will also significantly reduce the potential “abnormal” profits that can exist at the macro (environment) level because the market can insure, hedge, and price against risks associated with the dynamic change of the environment (Knight, 1921), ultimately offsetting the efficacy of decision speed on firm performance within the market (Eisenhardt, 1989; Judge & Miller, 1991).

Overall, although decision speed helps a venture to tackle dynamic environments due to its adaptability, the fact that “abnormal” profits rarely exist in the dynamic environment counterbalances the average efficacy of decision speed on performance

Decision speed can generally be efficacious in tackling or leveraging contingencies because entrepreneurs that leverage decision speed do not thoroughly analyze the environment but instead focus on quickly collecting real-time information about the market that is randomly changing

However, decision speed is more effective for environmental dynamism than Knightian uncertainty because the real-time information/feedback gained from quick decisions and experimentations in the “current” market can become less useful in the “future” time when they actually release the new products/services particularly if the environment change is random, unanalyzable, and inestimable (i.e., Knightian uncertainty) (Eisenhardt, 1989; Judge & Miller, 1991)

Specifically, since there is still a time gap between the time when entrepreneurs collect real-time feedback about the product-market fit and the time when they actually release the new products/services to the market after they continue to develop them, the real-time feedback is more helpful for entrepreneurs to enhance the “future” product-market fit when the market that is estimable and analyzable—environmental dynamism—than the market that is inestimable and unanalyzable—Knightian uncertainty

In other words, the real-time information/feedback that can be quickly obtained from decision speed and the following actions can be utilized to forecast the future market conditions if the market is estimable. Hence, entrepreneurs can update their products more effectively for the market that is foreseeable and analyzable (e.g., environmental dynamism) than the random market that is unforeseeable and unanalyzable (i.e., Knightian uncertainty) (Clark & Packard, 2020).

However, as Knightian uncertainty is the key source of “abnormal” profits, many potential “abnormal” profit opportunities exist under conditions of Knightian uncertainty (Knight, 1921), which counterbalance the weakness of decision speed on firm performance under conditions of Knightian uncertainty

Appendix D: Suggestions for Reconceptualization of Decision Comprehensiveness and Decision Speed

	Decision Comprehensiveness	Decision Speed
Representative Existing Definition/Operationalization that Needs to Be Reconceptualized	“The extensiveness with which an organization’s top executives systematically gather and process information from the external environment in making strategic decisions” (Elbanna & Child, 2007; Forbes, 2007)	“How quickly organizations execute all aspects of the decision-making processes, spanning from the initial consideration of alternative courses of action to the time at which a commitment to act is made” (Bourgeois & Eisenhardt, 1988; Bingham & Eisenhardt, 2011; Eisenhardt, 1989; Forbes, 2005: 355)
Conceptual Background of the Existing Construct	Organizational search theory (Cyert & March 1963) Organizational information environment (Forbes, 2005, 2007)	Organizational learning theory (Cyert & March 1963) Organizational information environment (Forbes, 2005, 2007)
Key Issues of the Existing Definition	<ul style="list-style-type: none"> • Inappropriate for entrepreneurship (e.g., Knightian uncertainty & Environmental dynamism) <ol style="list-style-type: none"> 1. There is little quality market information for firms’ strategic decisions regarding future opportunities in the entrepreneurial environments (Knightian uncertainty & Environmental dynamism); thus, systematic external search for market information cannot have high efficacy (Foss & Klein, 2012; Packard & Clark, 2020; Sarasvathy, 2001) 2. Entrepreneurs are not able to “accurately” predict the future value of the information/opportunities even utilizing probabilistic computations primarily due to the instability of the entrepreneurial environment; thus, the “external” market information search does not have a high efficacy (Knight, 1921) • Fail to operationalize decision comprehensively at the decision level (e.g., the product level) at a specific point in time and space instead of the firm level (e.g., TMT level)] 	<ul style="list-style-type: none"> • Does not allow decision speed to vary across nodes/points within a firm • Fail to operationalize decision speed at the decision level (e.g., the product level) at a specific point in time and space instead of a fixed attribute at the firm level (e.g., TMT level)]

Redefinition of the Construct	The breadth and depth of the possible decision space considered and analyzed by the focal entrepreneur relative to the entire decision space (e.g., all variables (e.g., existing knowledge space) and configurations of the knowledge and resources accessible to the focal entrepreneur) at a given decision point/node in time and space (Revised from the definition developed by Zahra et al., 2002)	How quickly (i.e., the duration of time) a decision-maker stops thinking about a choice to make from two or more decision options before taking any actions (e.g., irreversible commitments) or non-actions at a particular decision point/node in time and space
Conceptual Background of New Definition	Entrepreneurial choice theory (Gans et al., 2019) Entrepreneurial environment (Townsend et al., 2018) Possibility theory (Shackle, 1954)	Entrepreneurial choice theory (Gans et al., 2019) Entrepreneurial environment (Townsend et al., 2018) Organizational learning theory (Cyert & March, 1963; Levitt & March, 1988)
A Key Mechanism Through Which This Decision Strategy Increases Venture Performance	Procedural Rationality ²⁵	Adaptive Rationality ²⁶

²⁵ Please see A for more details

<p>How Redefined Construct Can Work within an Entrepreneurial Environment</p> <p>(Knightian Uncertainty and/or Environmental Dynamism)²⁷</p>	<p>If the construct of decision comprehensiveness is reconceptualized and operationalized through the lens of possible opportunity space (Shackle, 1954) (instead of probability space within an information environment) by focusing on possible new combinations of the resources and the knowledge that are potentially accessible to an entrepreneur at a specific point in time and space, then the reconceptualized construct of decision comprehensiveness will clearly capture</p>	<p>If the construct of decision speed is reconceptualized at the decision level instead of at the firm level, then the reconceptualized construct of decision speed will clearly capture the pace of decision-making processes at the decision level that could vary across different types of decisions at a specific decision point/node in time and space.</p>
	<p>(1) the extent to which entrepreneurs explore the possible opportunities thoroughly. Although firms are not able to accurately predict the future value of the information and utilize it through probabilistic computations in the entrepreneurial environment where there is a high level of Knightian uncertainty (Knight, 1921), entrepreneurs can still deliberately lay out new <i>possible</i> opportunities that align with both subjective values an entrepreneur (i.e., identity) pursues and the knowledge/resources that are potentially accessible to an entrepreneur at a specific point in time and space (i.e., the reconceptualized variable of decision comprehensiveness for entrepreneurship) (Gans et al., 2019; McMullen & Shepherd, 2006; Sarasvathy, 2001) This process is crucial because one of the primary roles of entrepreneurs is the judgment-maker who makes an entrepreneurial choice among the various combinations of heterogeneous resources for creating new artifacts (e.g., products) (Foss & Klein, 2012; Gans et al., 2019), as the new combination of resources can create novel products.</p> <p>Since it is likely that there are random changes between the past and future environment in the entrepreneurial context where there is a high level of Knightian uncertainty, a venture should not focus on predicting the future environment by collecting and utilizing the previous market information. Instead, a venture can make deliberate efforts to identify the multiple patterns that were interpreted to potentially exist in the past and current market without probabilistic inference (Baron, 1989) (i.e., decision comprehensiveness). This effort still does not generate</p>	

quantifiable expected values/outcomes, but it can still produce multiple potential future trajectories that may possibly occur in the future starting from a specific point in time and space.

Thus, the newly conceptualized decision comprehensiveness can also capture:

- (2) the extent to which entrepreneurs lay out possible patterns/trajectories that can emerge in the future by deliberate analysis (Baron, 1989)
- (3) the extent to which entrepreneurs identify potentially valuable opportunities. This process may involve the elimination of unpromising trajectories from the decision choice set through rough analyses and estimation processes (Gans et al., 2019). As a dynamic environment is estimable, such a process as removing unpromising options is possible despite its difficulty/imprecision and the lack of objective quality information available in the entrepreneurial environment. More specifically, entrepreneurs can be decision comprehensive as they can still deliberately lay out new possible opportunities that align with both subjective values an entrepreneur (i.e., identity) pursues and the knowledge/resources that are potentially accessible to an entrepreneur (Foss & Klein, 2012; McMullen & Shepherd, 2006; Sarasvathy, 2001), and then they remove unpromising alternatives from a choice set through a rough estimation process at a specific point in time and space.

Overall, the new definition of decision comprehensiveness will embrace such “subjectively possible” decision space (Shackle, 1954) instead of probabilistic space.

²⁷ Please see Appendix C for more clarity

Appendix E: Definitions of DC and DS and Assumed Relationships Between DC and DS in Prior Research

Authors	Year	Definition of DC	Definition of DS	Key Relevant Findings	Assumed Relationship Between the Two Constructs
Acharya	2012	"The extent to which the decision process involves the collection of information relevant to the decision and the reliance upon analysis of this information in making the choice"	N/A	With more decision comprehensiveness used, the supply chain management cost decreases.	Opposite (Unmanageable Tradeoffs): "Decision makers engaging in less rational decision processes are more likely to make decisions based on hunches or simple rules of thumb"
Adomako et al.	2021	N/A	"How quickly organizations execute all aspects of the decision-making process, spanning from the initial consideration of alternative courses of action to the time at which a commitment to act is made"	The positive relationship between DS and the international performance of SMEs is amplified for the firms operating in highly competitive environments.	N/A
Arend et al.	2016	"Managers consider multiple decision alternatives"	N/A	Entrepreneurs tend to use a less rational approach than managers.	Opposite (Unmanageable Tradeoffs): "... the logic that if entrepreneurs are more prone to certain heuristics ..., then the actual choices of entrepreneurs should be less rational"
Argouslidis et al.	2015	N/A	"(a) decision reaching speed as the reverse of the time that elapses from a firm's initiative to screen a product with elimination as an option to the time the firm reaches the decision to eliminate it and (b) implementation speed as	Organizational structures [e.g., centralization of product elimination decisions and power polychronicity], decision-specific factors (e.g., PLC stage), and environmental factors (e.g., turbulence) shape DS; That is, these factors are positively associated with DS	Opposite (Unmanageable Tradeoffs): "We shall side with the view that the consideration of more alternatives prolongs a decision process"

			the reverse of the time that elapses from decision reaching to the time a firm stops a product's manufacturing process and deletes it from product catalogues."		
Atuahene-Gima & Li	2004	"The extent to which an organization attempts to be exhaustive and inclusive in making and integrating strategic decisions"	N/A	There is a positive relationship between strategic decision comprehensiveness and new product performance; This positive relationship is contingent upon the nature of environment characteristics -- technology uncertainty (i.e., attenuates the positive relationship between DC and new product performance) versus demand uncertainty (i.e., amplifies the positive relationship).	Opposite (Unmanageable Tradeoffs): "Strategic decision comprehensiveness slows down decision making and interferes with real-time information flow in an environment in which information is perceived as unanalyzable and responses as uncertain"
Bakker & Shepherd	2017	N/A	"How quickly organizations execute all aspects of the decision-making process" "our measure of decision speed captures the duration of time a mining venture spends in a stage before a decision is made to act on the venture"	Decision speed (DS) varies depending on the type of entrepreneurial decisions - not always quick.	Opposite (yet Complementary by Sequencing): "Compared to firms more focused on the development and exploitation of opportunities, a firm with a higher degree of attention toward earlier-stage exploration activities is likely to need more time to collect information to assess the feasibility of a venture, ..., which likely decreases the speed of the decision advance a venture at the developing stage"
Bartkus et al.	2022	N/A	N/A	By using a configurational model, this study examines when certain types of TMT are able to attain the balance between DS and DC. The authors show that leader-team configurations determine the strategic	Complementary (Simultaneous Use of Both): "Our analyses show six different configurations through which leader characteristics combine with top management team structures to

				decision-making balance (i.e., intra-team debate, reconciliation of divergent ideas, and decision speed (DS)).	underlie balanced strategic decisions that are simultaneously fast and rigorous"
Baum & Wally	2003	N/A	N/A	Decision speed mediates between organizational (e.g., formalization of routine)/environmental (dynamism) characteristics and firm performance.	Opposite (Unmanageable Tradeoffs): "Decision-making may be fast because time-consuming comprehensive research and discovery have little value"
Burgeois & Eisenhardt	1988	N/A	N/A	Both DC and DS enhance performance in high-velocity environments; Simultaneous use of both DC and DS is effective.	Complementary (Simultaneous Use of Both): "We found an imperative (1) to make strategic decisions carefully, but quick,"
Campos et al.	2015	N/A	N/A	"Strategic decision-making speed (DS) mediates the relation between personal, organizational and environmental factors and performance." That is, personal, organizational, and environmental factors are antecedents to DS (Decision Speed).	Opposite (Unmanageable Tradeoffs): "The more analytical the TFM is in its decisions, the slower the strategic decision-making process"
Capelleras et al.	2010	N/A	N/A	"The venture creation speed (DS) is negatively associated with the subsequent venture growth." "Human (e.g., prior entrepreneurial and industrial experience) and social capital resources (e.g., support from network members) shape venture creation speed (DS)"	Opposite (Unmanageable Tradeoffs): "If they take the time to explore the market, understand the desired product, establish close relationships with potential customers and suppliers ..."
Chen et al.	2005	N/A	N/A	DS(Decision speed) is less important to new product success (NPS) under conditions of low market uncertainty. Also, technological uncertainty does not have an influence on the speed-NPS relationship.	N/A

Chowdhury	2005	"The extent to which an organization attempts to be exhaustive and inclusive in making and integrating strategic decisions"	N/A	Demographic diversity is not important for entrepreneurial team effectiveness. Demographic diversity of entrepreneurial teams does not contribute to DC at team level. However, this study finds that DC enhances entrepreneurial team effectiveness	N/A
Clark & Maggitti	2012	N/A	N/A	TMT potency (i.e., "a team's confident belief in its ability to be effective generally") partially mediates the relationship between TMT experience and knowledge/TMT interaction process and decision speed (DS). That is, TMT's background and interaction process are antecedents to TMT potency, and TMT potency enhances DS (Decision Speed).	N/A
Dean & Sharfman	1996	"The extent to which the decision process involves the collection of information relevant to the decision and the reliance upon analysis of this information in making the choice"	N/A	This study found that Procedural Rationality(DC) increases firm performance. But the hypothesis of "this positive relationship is amplified as the environmental instability increases" is not supported.	N/A
Deligianni et al.	2016	"The degree to which the top management of the firm searches and analyzes relevant information when making strategic decisions for its ventures abroad, and employs a systematic process with quantitative	N/A	The moderating effect of decision-making rationality (DC) on the EO–international performance link; EO (Entrepreneurial Orientation) with DC will improve international performance.	N/A

		techniques in these decisions"			
Eisenhardt	1989	N/A	N/A	<p>This study attempts to explain what factors helps increase DS (Decision Speed);</p> <p>This study argues that the more DC (e.g., the more alternatives developed), the more real-time information, the greater the use of experienced counselors.</p>	Opposite (yet Complementary by Sequencing): "The greater the number of alternatives considered simultaneously, the greater the speed of the strategic decision process."
Eisenhardt & Tabrizi	1995	N/A	N/A	<p>Decision speed (DS) on product development is usually effective.</p> <p>This study focuses on how firms develop products rapidly due to adaptive processes (i.e., improvisation, real-time information, and flexibility), especially under conditions of high level of uncertainty.</p>	Opposite (yet Complementary by Sequencing): "More time spent in testing throughout the development process is associated with shorter development time."
Elbanna & Child	2007	"The extent to which decision makers collect and analyse information relevant to the decision"	N/A	<p>Decision (e.g., decision importance), environmental (e.g., env uncertainty) and firm characteristics (e.g., firm size) affect DC (i.e., the rationality of decision processes).</p> <p>Specifically, the positive link between DC and performance becomes large when the firm size becomes large.</p>	N/A
Elbanna & Naguib	2008	N/A	N/A	"Strategic decision-making in high-performing firms is more rational and less intuitive and political."	N/A
Elbanna et al.	2013	N/A	N/A	"Decision uncertainty and firm size are related to the use of intuition; intuition significantly affect decision disturbance; and environmental hostility	N/A

				moderates the relationship between decision intuition and disturbance."	
Elbanna et al.	2014	N/A	"The time period needed in months from the start of the implementation process to its completion"	"Quality of decision implementation is positively related to trust, participation and past performance, and negatively to implementation speed and uncertainty." That is, DS (Decision speed) is negatively associated with the quality of decisions.	N/A
Eranova & Prashantham	2017	"The extent to which an organization attempts to be exhaustive or inclusive in making and integrating strategic decisions"	N/A	"The impact of paradoxical cognition on decision quality is positive, and the firms employing DC (Decision Comprehensiveness) and with a low degree of strategic flexibility benefit 'more' from paradoxical cognition." That is, DC helps a firm to gain benefits from paradoxical cognition.	N/A
Forbes	2005	"The degree to which organizations systematically scan, analyze, and plan when making decisions"	N/A	The firm's comprehensive process (DC) is positively associated with the level of entrepreneur's self-efficacy. This study focuses on what factors shape ESE (i.e., Entrepreneur's self-efficacy).	N/A
Forbes	2005	N/A	"how quickly organizations execute all aspects of the decision-making process, spanning from the initial consideration of alternative courses of action to the time at which a commitment to act is made"	The entrepreneurs with prior entrepreneurial experience use DS (Decision Speed). The author also points out that DS (Decision Speed) can increase organizational learning.	N/A

Forbes	2007	"A concept that captures the extensiveness with which an organization's top executives systematically gather and process information from the external environment in making strategic decisions"	N/A	This paper develops a contingency model of DC (Decision Comprehensiveness) by breaking the environmental instability into uncertainty versus ambiguity. DC is effective for uncertainty -- the quantity and determinacy of information is high -- but not for ambiguity.	N/A
Francioni & Clark	2020	N/A	"The time firms spend on all steps of the decision-making process, including identifying a problem or opportunity, collecting information, developing alternative options, assessing and valuing options, and selecting the best option"	Decision speed (DS) increases both financial and non-financial global sourcing performance.	Opposite (yet Complementary by Sequencing): "The greater the decision-maker's rationality, the faster the global sourcing strategic decision making process."
Fredrickson	1984	"The extent to which organizations attempt to be exhaustive or inclusive in making and integrating strategic decisions"	N/A	There is a positive relationship between comprehensiveness (DC) and performance in stable environments.	N/A
Fredrickson & Mitchell	1984	"The extent to which organizations attempt to be exhaustive or inclusive in making and integrating strategic decisions"	N/A	There is a negative relationship between comprehensiveness (DC) and performance in an unstable industry environment.	Opposite (Unmanageable Tradeoffs): "A firm that employs a comprehensive decision process will make discriminating decisions that can be integrated to ensure cohesive action. In contrast, a noncomprehensive firm is well-equipped for an unstable environment. Its decision speed and flexibility allow fast, low-cost action that can exploit and overcome a changing list of opportunities and threats that defy thorough understanding"

Friedman & Carmeli	2017	"The extent to which a firm's TMT identifies, scrutinizes and assesses a wider range of issues when making strategic decisions"	N/A	DC (Decision Comprehensiveness) enhances TMT innovative behavior; Such relationship becomes stronger when TMT connectivity gets higher.	N/A
Friedman et al.	2016	"The inclusiveness of decision makers in the process of making and integrating strategic decisions"	N/A	DC (Decision Comprehensiveness) helps for an organization to adapt. Transformational leadership facilitates TMT behavioral integration and comprehensiveness in the decision process among members of the top management team (TMT), which in turn increases the organizational capacity to adapt to environmental changes.	N/A
Galanou & Farrag	2014	"The degree to which an organization's executives systematically gather, analyze data, and thoroughly study all alternatives from the external environment in making strategic decisions"	"The velocity spent with which organizations perform all aspects of the decision process, from the initial attention of alternative courses of action to the time a commitment to act is made"	Both DC (Decision Comprehensiveness) and DS (Decision Speed) enhance organizational innovation.	Complementary (Simultaneous Use of Both): "Qatari managers' rationality in their decision-making is associated with more organizational innovation." and "Qatari managers' higher speed in their decision making is associated with more organizational innovation"
Gemmell	2012	N/A	N/A	Entrepreneurs who conduct experimentation are likely to increase DS (Decision Speed), which in turn, facilitate innovation process. DS generally has a positive role in enhancing performance	N/A
Glick et al.	1993	"The extent to which an organization attempts to be exhaustive or inclusive in	N/A	DC (Decision Comprehensiveness) increases firm performance in turbulent environments, but not in non-turbulent environments.	N/A

		making and integrating strategic decisions”			
Goll & Rasheed	1997	N/A	N/A	In high-discretion environment (i.e., dynamic and munificent environment), rational decision processes (DC) has a significant role in enhancing performance.	N/A
Heavey et al.	2009	"The extent to which decision-makers utilize an extensive decision process when dealing with immediate opportunities and threats"	N/A	DC (Decision Comprehensiveness) is positively associated with CE (Corporate Entrepreneurship); Yet such relationship is amplified when dynamism decreases; when risk-taking propensity and proactiveness of decision-makers increases.	N/A
Hough & White	2003	"The extent to which the decision process involves the collection of information relevant to the decision and the reliance upon analysis of this information in making the choice"	N/A	DC (Decision Comprehensiveness) is unrelated to quality of decisions.	N/A
Hsu & Chang	2020	N/A	N/A	DS (Decision Speed) is negatively associated with firm performance; Decision-making style is shaped by transformational leadership style.	N/A
Jiang et al.	2014	N/A	"The time it takes a firm to make a subsequent entry"	DS (Decision Speed) is negatively related with subsidiary survival. That is, the negative performance of DS aggravates under conditions of uncertainty and lack of vicarious learning.	N/A

Judge & Miller	1991	N/A	N/A	Only in high-velocity environment, decision speed (DS) increases performance.	Opposite (yet Complementary by Sequencing): "The simultaneous consideration of multiple alternatives accelerates cognitive processing and thus decision speed"
Kaufmann et al.	2012	"The extent to which the decision process involves the collection of information relevant to the decision, and the reliance upon analysis of this information in making the choice."	N/A	DC (Decision Comprehensiveness) is positively associated with decision quality; No significant changes in this relationship due to the level of dynamic task environments.	N/A
Lee et al.	2017	"The extent to which organizations intend to be inclusive or exhaustive in making strategic decisions"	N/A	DC (Decision Comprehensiveness) enhances explorative orientation, which in turn increases new product development performance.	N/A
Lin et al.	2019	"The extent to which decision makers utilize an extensive decision process, including simultaneous consideration of multiple and alternative solutions, extensive search and analysis of the external environment, and extensive utilization of quantitative and qualitative information"	"The pace with which organizations implement all aspects of the decision-making process, spanning the initial consideration of alternative courses of action to the time at which a commitment to act is made"	TMT's long-term orientation is positively associated with DC (Decision Comprehensiveness), DS (Decision Speed), and strategy-making creativity, yet the relationship between long-term orientation and DC (Decision Comprehensiveness) is amplified when complexity becomes high and when the industry is characterized by a high level of innovation.	Opposite (yet Complementary by Sequencing): "The number of alternatives simultaneously considered was positively associated with decision speed. Given this logic, top managers with a long-term orientation (LTO) will speed up a single decision-making process when the consequence of a speedy decision is an integral part of a coherent overall program of decisions"
Meissner & Wulf	2014	"The extensiveness of the strategy process"	N/A	Decision quality mediates the comprehensiveness (DC)-performance link;	N/A

				Perceived uncertainty directly increases the degree of comprehensiveness (DC) in an organization rather than serving as a moderator.	
Miller	2008	"The extent to which an organization's upper-echelon executive group tends to utilize an extensive decision process when dealing with immediate opportunities and threats. The nature of the process is paramount. Extensive approaches include high levels of investigatory activity aimed at developing alternative courses of action, evaluating alternatives, and developing multiple criteria to screen alternatives"	N/A	<p>The author shows that the performance of DC (Decision Comprehensiveness) is different depending on the environment types;</p> <p>In non-turbulent environments, there is an inverted U-shaped relationship;</p> <p>However, in turbulent environments, the positive effects start to exist only from the moderate level of DC (i.e., no effect at the lower end of DC). That is, there is a minor curvilinear relationship.</p>	N/A
Miller et al.	1998	"The extent to which an upper-echelon executive group utilizes an extensive decision process when dealing with immediate opportunities and threats"	N/A	The influence of the diversity among executives on DC (Decision Comprehensiveness). This study finds that the diversity among executives inhibits DC (Decision Comprehensiveness).	N/A
Mohan et al.	2017	"Conducting an exhaustive consideration of multiple approaches" "Full exploration of new ideas"	N/A	DC (Decision Comprehensiveness) is positively associated with front-end innovation success.	N/A

Onken	1998	N/A	"The speed with which individuals in an organization accomplish tasks and the values attached to doing so"	Polychronicity is positively related with DS (Decision Speed); DS (Decision Speed) is positively associated with firm performance.	N/A
Papadakis	1998	N/A	N/A	DC (Decision Comprehensiveness) is positively related to performance.	N/A
Perlow et al.	2002	N/A	N/A	Decision speed (DS) can be detrimental to performance due to its inaccuracy and decision quality.	N/A
Powell	1992	N/A (but the measure of DC indicates external market search)	N/A	The fit between internal structure and the environment is a key strategic resource that explains firm performance. This strategic fit can be enhanced by DC (Decision Comprehensiveness).	N/A
Priem et al.	1995	"Extent to which an organization attempts to be exhaustive or inclusive in making and integrating strategic decisions"	N/A	There is a positive relationship between DC and performance for firms facing dynamic markets, but no such relationship for stable environments.	N/A
Rahimnia & Molavi	2020	N/A	"How quickly organizations execute all aspects of the strategic decision-making process" "The time spent on the process of strategic decision-making"	DS (Decision Speed) mediates between communication and innovation performance.	N/A
Ramos-Garza & Villalba-Moreno	2011	N/A	"How fast TMT members make strategic decisions"	DS (Decision Speed) is positively related to firm performance. Environmental complexity and team orientation are the antecedents to DS.	N/A

Rovelli et al.	2022	N/A	"The extent to which an organization's executives systematically gather and process information from the external environment in making strategic decisions"	TMT DC (Decision Comprehensiveness) mediates between CEO narcissism and innovation opportunity exploitation.	N/A
Seyr & Vollmer	2014	"The degree to which different alternatives are weighted against each other and integrated into common decisions"	N/A	DC (Decision Comprehensiveness) mediates the link between socio-moral climate and innovation.	N/A
Simons et al.	1999	"The extent to which organizations attempt to be exhaustive or inclusive in making and integrating strategic decisions"	N/A	DC (Decision Comprehensiveness) mediates the interaction effects of debate and TMT diversity on financial performance.	N/A
Slotegraaf & Atuahene-Gima	2011	"The degree to which the team is exhaustive as it considers multiple approaches, courses of action, and decision criteria in its strategic decision making."	N/A	The level of stability in a new product development project team has an inverted U relationship with debate and DC (Decision Comprehensiveness). DC is positively associated with new product advantage, an increasing curvilinear relationship.	N/A
Souitaris & Maestro	2010	"Systematically gathering quantities of information and extensively analyzing this information"	"The velocity with which organizations execute all aspects of the strategic decision process, from the initial consideration of alternative courses of action to the time a commitment to act is made (Eisenhardt, 1989)."	TMT polychronicity has a positive influence on new venture performance when the environment is dynamic and unanalyzable; Such effect is partially mediated by DS (Decision Speed) and DC (Decision Comprehensiveness). (TMT polychronicity is positively related to DS; DS is positively related to new venture financial performance; On the other hand, TMT polychronicity is negatively related to DC; DC is	N/A

				negatively related to new venture financial performance.)	
Talaulicar et al.	2005	"Several alternatives are considered, comprehensively examined, and evaluated on multiple criteria before a decision is made"	N/A	Debate increases DC (Decision Comprehensiveness) yet decreases DS (Decision Speed). Characteristics of TMT organization also are antecedents to DC and DS	Complementary (Simultaneous Use of Both): "Both comprehensiveness and speed of decision making lead to high performance and thus are not mutually exclusive".
Thanos	2022	"The extent to which the decision process involves the collection of information relevant to the decision and the reliance upon analysis of this information in making this choice"	N/A	The combined joint effect of rationality (DC) and intuition enhances strategic decision quality; yet such effect becomes amplified under dynamic environments.	N/A
Thomas & Ambroism	2015	"It concerns an organization's executives' attempts to be exhaustive in their systematic gathering and processing of information from the external environment in making strategic decisions"	N/A	DC (Decision Comprehensiveness) and Organizational characteristics (i.e., management controls) are positively associated with Middle Manager (MM)'s implementation performance.	Opposite (yet Complementary by Sequencing): "The availability of real-time information is crucial due to the speed with which decisions need to be made to capitalize on opportunities. This is important for comprehensiveness since it provides MMs with the ability to assess several alternative courses of action simultaneously"
Ven Den Oever & Martin	2019	"The extent to which the decision process involves the collection of information relevant to the decision and the reliance upon analysis of this information in making the choice"	N/A	DC (Decision Comprehensiveness) increases total value creation (e.g., cost reduction etc. from the strategic alliance), but appropriate less value from the partnership.	N/A

Wally & Baum	1994	N/A	N/A	Personal (e.g., intuition, cognitive ability such as Decision Comprehensiveness [DC]) and organizational factors (e.g., centralization, formalization) are determinants of DS (Decision Speed).	Opposite (yet Complementary by Sequencing): "The ability to process numerous alternatives cognitively and simultaneously, a form of cognitive ability, appears to expedite the pace of strategic decision making"
Walter et al.	2012	"The extent to which decision makers engage in a comprehensive collection of the relevant information, analyze all that information, and attempt to select the best of all generated decision alternatives in the presence of incomplete information and bounded rationality"	N/A	DC (Decision Comprehensiveness) at the alliance level shapes alliance performance; and such effect will be stronger when there is a higher level of DC (Decision Comprehensiveness) at the firm level.	N/A
Zahra et al.	2002	"The thoroughness of the process and the breadth and depth of the variables considered and analyzed"	N/A	Comprehensiveness (DC), formality, and user orientation of competitive analysis activities increase new venture performance.	N/A
Zehir & Ozsahin	2008	N/A	"The time spent on the process of strategic decision making"	This study identifies the antecedents to decision speed (DS) as organizational (participation and autonomy) and environmental factors (technological sophistication and industrial competitiveness). DS (Decision speed) increases innovative performance.	N/A
Zehir et al.	2015	N/A	N/A	DS (Decision speed) increases firm performance;	N/A

4.8. REFERENCES (INCLUDED IN EMPIRICAL SAMPLE)

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