

HETEROGENEOUS ENTREPRENEURIAL ACTION:
A KNOWLEDGE PROBLEM APPROACH

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ABSTRACT

This dissertation contributes new insights to the research on understanding heterogeneity in entrepreneurial action and outcomes. Prior research has undertaken numerous approaches to understanding the presence of variations in entrepreneurship by focusing on both the macro-environmental actor-independent factors, and the micro-level actor factors. I examine the presence of heterogeneity in entrepreneurial action and outcomes by offering a novel application of the contemporary work on Knowledge Problems (KPs). The dissertation undertakes this line of inquiry through the development of three inter-related essays.

In essay one, I develop a theory that identifies and explains KPs as a causal link between the macro-level environment and the micro-level entrepreneurial action. I argue that the external environmental changes generate KPs. I establish that these KPs are different forms of unknowingness that an entrepreneur encounters in undertaking action. Through a series of propositions, I explain how the identification and mitigation of these KPs explain the variance and similarity in entrepreneurial action and outcomes. Crucially, this essay suggests that opacity, as a configuration of KPs, varies in its composition. I assert that KPs can exist in a simultaneous fashion, therefore I offer a categorization of KPs into the agentic and generic elements of opacity, where the generic element constitutes the low mitigable KPs, and the agentic element constitutes the KPs that are higher in mitigability. This way, I offer a nuanced approach to understanding entrepreneurial action in

the light of exogenous changes. I test several dimensions of this theory in the following essays and offer implications for practice.

In essay two, I offer an empirical investigation of the heterogeneity in entrepreneurial action and outcomes following an exogenous change. To do so, I investigate the entrepreneurial pursuits of college athletes following the NCAA's rule change on the use of name, image, and likeness. Through the distribution of an IRB approved survey, this study taps into the population of over half a million potential entrepreneurs. This study argues for the simultaneous occurrence of different KPs, following an exogenous change. This study pioneers the operationalization of KPs using survey items. Through the study's findings, I bring home the idea that entrepreneurs face different types of KPs. Consequently, identifying and mitigating these KPs explain the heterogeneity in entrepreneurial action and outcomes.

In essay three, I delve into a deeper understanding of the temporal dimension of KPs by asserting that opacity related to the effect of an exogenous change varies in size and composition, over time. This study asserts and provides empirical evidence for the sequential occurrence of KPs as a consequence of exogenous change. Given the centrality of temporality in assessing the nature and impact of the opacity emanating from a given an exogenous change, the study's design has been developed in order to empirically test the argument in light of a gradually evolving exogenous change, Artificial Intelligence. I draw upon a rich and fine-grained archival dataset using CrunchBase. Methodologically, this study offers an

operationalization of opacity, and a novel approach towards understanding the chronology of action of different actors in an industry.

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GENERAL AUDIENCE ABSTRACT

This dissertation joins a vibrant conversation in entrepreneurship research about the variance and similarity of entrepreneurial action and related outcomes. Specifically, this dissertation explores the effects of external environmental changes, such as COVID-19, Artificial Technology, the NCAA's Rule Change on the use of Name, Image, and Likeness, on entrepreneurship. Given that these environmental changes vary—some are more sudden than others, they do not have the same impact on entrepreneurship, in essence, they lead to heterogeneous entrepreneurial action and outcomes. By developing three interconnected essays, the dissertation examines the heterogeneity in entrepreneurship. Collectively, these essays bring home the idea that changes in the external environment provide important raw materials for individuals and firms to undertake entrepreneurial action. The findings suggest that variance in the raw materials and the characteristics of the individuals and firms generate heterogeneous entrepreneurial action and outcomes. Consequently, the presence of inequities in entrepreneurship corresponds to the societal grand challenges faced by policymakers around the world. Subsequently, by providing a novel theory and empirical treatments of the causes of heterogeneity of entrepreneurial action, the dissertation signifies the continued relevance of the entrepreneurship discipline to the spheres of academia and practice.

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CHAPTER ONE

INTRODUCTION

INTRODUCTION

We are not all in the same boat.
We are in the same storm.
Some are on super-yachts.
Some have just the one oar.

-Damian Barr

The study of entrepreneurship is inundated with heterogeneity. In line with the epitaph that begins this chapter, Welter and colleagues (2016, p. 6) suggest that “rich heterogeneity” is hidden in studies of entrepreneurship. For years, scholarship has sought to unravel the heterogeneity of entrepreneurial action and outcomes (e.g., Micozzi & Lucarelli, 2016; Wang & Wan, 2013). Studies have examined a series of antecedents leading to this variance. For instance, Bruton et al. (2009), and Fredström et al. (2021) have shown that institutional arrangements at the macro-level lead to variances in entrepreneurial action and outcomes, while other scholars have suggested that individual differences, such as those related to decision-making drive the heterogeneity of entrepreneurial action and outcomes (e.g., Alshebami & Seraj, 2022; McMullen & Shepherd, 2006; Wiklund et al., 2018). Recent scholarship has suggested that the causes of the heterogeneity of entrepreneurial action and outcomes lie at the intersection of the macro- and the micro-levels (e.g., Aparicio et al., 2021; Motley et al., 2023; Schade & Schuhmacher, 2022). Subsequently, scholars to an increasing degree, have asserted the importance of a conceptual framework that intersects these different yet inter-related levels (e.g., Cowen et al., 2022; Jennings et al., 2013; Kim et al., 2016) to understand the heterogeneity of

entrepreneurial action and outcomes. Yet, a comprehensive theory that explains the causes of heterogeneity, and its subsequent empirical application remain an unchartered research niche in the study of entrepreneurship.

“Theory is the currency of our scholarly realm” noted Corley and Gioia (2011, p. 12). Consequently, the omission of a nuanced theorization of heterogeneity of entrepreneurial action and outcomes is of chief concern to entrepreneurship scholars. This percolates as the lack of unified body of empirical work that establishes a common thread of dependent variables which capture the degree and rate of heterogeneity in entrepreneurial action and outcomes. Subsequently, the introduction of a theory and related empirical toolkit can address research questions, including: How do exogenous changes lead to differential entrepreneurial action? Does the impact on entrepreneurial action vary based on the type of exogenous change? Do all cohorts of entrepreneurs reap similar rewards from undertaking action from exogenous changes? Are some entrepreneurs better suited to undertake action from exogenous changes than others? If so, why? Do they possess a better skillset and/or relevant experience in doing so?

The objective of this dissertation is to answer these challenging questions to explain the causes of the variations in entrepreneurial action and outcomes. To do so, I tap into the emergent Knowledge Problem (KP) framework. Building on the works of Zack (1999), Townsend and colleagues (2018) put forth a novel approach, the KP framework, that identifies, and conceptualities the multiplicity of unknowingness associated with entrepreneurial action. By developing on recent

scholarship that explains exogenous changes as generators of KPs (Rindova & Courtney, 2020), this dissertation contributes to the entrepreneurship literature by offering a novel theorization of KPs as a causal mechanism to understand heterogeneity in entrepreneurial action and outcomes, as an interplay between exogenous changes and individual characteristics. In developing a novel theoretical contribution, followed by two empirical treatments to test and enrich the theory, this dissertation offers a highly original framework with practical and scientific utility (Corley & Gioia, 2011).

The first essay develops a theory of entrepreneurial action in response to exogenous changes. Crucially, the theory asserts that external environmental changes lead to KPs. The mitigation of these KPs explains the heterogeneity of entrepreneurial action and outcomes. The second essay conducts an empirical investigation of an exogenous change across a spectrum of entrepreneurs to explain the multi-dimensional nature of KPs. By tapping into a readily identifiable institutional change—NCAA’s rule change on the use of name, image, and likeness by college athletes, the study illuminates the multi-dimensional nature of KPs. The results suggest that potential entrepreneurs face different KPs emanating from the same exogenous change that drives heterogeneity in action and outcomes. Finally, the third essay underscores the variance in entrepreneurial action and outcomes by uncovering the multi-temporal nature of KPs. Taken together, these essays open new vistas to reconceptualize the notion of heterogeneity in entrepreneurship by focusing on the nature of the exogenous changes, and related KPs.

Central to the research design in the empirical investigations is the operationalization of KPs. While the second essay uses survey data to operationalize KPs, in the third essay I operationalize KPs by tapping into a rich longitudinal data, at a granular level, from CrunchBase. The use of these distinctive data sources allows me to examine the multi-dimensional, multi-temporal, and multi-level nature of KPs (Townsend et al., 2018). Consequently, the empirical treatments underscore the simultaneous and sequential occurrence of different KPs.

Fundamentally, this dissertation focuses on explaining the role of macro-environmental change in entrepreneurial action. Contemporary entrepreneurship research has increasingly focused on the link between the macro-level and the micro-level (e.g., Cowen et al., 2022; Kim et al., 2016; Shepherd, 2011). The central argument that I make in this dissertation is the KPs serve as causal link that explain how macro-environmental changes impact entrepreneurial action. Through an extensive conceptualization of the different dimensions of KPs, this dissertation opens the door for subsequent research efforts towards unraveling the heterogeneity in entrepreneurial action and outcomes. A hallmark of this dissertation is the use of KPs as a causal link between the macro-level exogenous change and the micro-level entrepreneurial action. Table 1 provides a brief description of the three essays.

TABLE 1- Three Dissertation Essays. Capsule Descriptions

Essay #	Research Question(s)	Empirical/ Conceptual	Sample	Contributions
1.	<p>What are the causes and consequences of knowledge problems?</p> <p>What explains the multiplicity of knowledge problems and the influence they exert upon the heterogeneity of entrepreneurial action?</p>	Conceptual	-	<p>Establish a theory that identifies KPs as a causal link between external environmental changes and micro-level entrepreneurial action</p> <p>Offer a nuanced conceptualization of the five KP based on the level of mitigability</p> <p>Establish a theory that explains the presence of heterogeneity in entrepreneurial action and outcomes</p>
2.	<p>What explains heterogeneity in entrepreneurial action and outcomes arising from an institutional change?</p>	Empirical	Survey of D1, D2, and D3 college athletes, resulting in 308 usable responses	<p>The first comprehensive empirical study that operationalizes the KPs</p> <p>Detailed description of the heterogeneity in entrepreneurial action and outcomes as a consequence of the different KPs</p> <p>Underscores the multi-dimensional nature of KPs</p>
3.	<p>How does the opacity related to the effect of exogenous change on entrepreneurial action vary over time?</p> <p>How does it impact entrepreneurial action?</p>	Empirical	Archival data related to Artificial Industry, resulting in 26 event years and over 3,900 funding rounds	<p>The first comprehensive study of the temporality of exogenous changes, and resultant KPs</p> <p>Alternative explanation for the industry structure as KP identification and mitigation strategy</p> <p>Underscores the multi-temporal and multi-level nature of KPs</p>

Heterogeneity of Entrepreneurial Action

Entrepreneurship research has long been interested in examining the heterogeneity in entrepreneurship (e.g., Westhead & Wright, 1998). This variance relates to the decision to pursue entrepreneurship, and the variance in undertaking entrepreneurial action, and outcomes. In this vein, studies have shown that factors such as socialization experiences, peer groups can dictate the decision to pursue entrepreneurship (Falck et al., 2012). In addition, having entrepreneurial parents (Scherer et al., 1989), siblings, and neighbors can influence this decision (Patuelli et al., 2020; Vladasel et al., 2021). Further, Dew et al. (2009) suggests that variance among entrepreneurs stems from the experience and knowledge that enables some entrepreneurs to efficiently manage uncertainty. Similarly, Baron (2009) suggests that differences in decision-making processes are critical to understanding heterogeneous entrepreneurial outcomes. Further, studies have shown that factors such as risk propensities (Forlani & Mullins, 2000), can explain the persistent gender difference in entrepreneurship (Sexton & Bowman-Upton, 1990).

While the ongoing discussion points to differences at the individual-level, studies have sought to unravel differences accruing due to macro-level exogenous factors. In this line of work, studies have shown that macro-level actor-independent factors, such as gradually evolving demographic changes to more sudden institutional changes impact entrepreneurial action and outcomes (Davidsson et al., 2020). By tapping into the widely available macro-level datasets, that span across countries, including the Global Entrepreneurship Monitor (GEM), World

Development Indicators, studies have shown that factors such as institutional quality, cultural norms, availability of finance (Nabisaalu & Bylund, 2021; Ostapenko, 2015; Stenholm et al., 2013) drive heterogeneity of entrepreneurship—its type, intensity, and rate. Crucially, scholarship has suggested that the impact of these actor-independent macro-level changes is not uniform (Chen et al., 2020). In this vein, empirical treatments of exogenous changes, such as infrastructure, has shown the presence of variation owing to the spatial, sectoral, temporal, and demographic dimensions (e.g., Bennett, 2019; Chen et al., 2020; Manocha et al., 2021). In addition, research has undertaken nuanced approach to showcase how these macro-level factors influence entrepreneurial action, for instance, Huang et al (2021) suggests the presence of gendered institutions in impacting investors’ decisions and the related entrepreneurial outcomes. At the intersection of the macro- and the micro-level, recent work has shown that the persistence of the founding teams when faced with exogenous changes can generate higher venture performance and outcomes (Motley et al., 2023).

Knowledge Problem Framework

Initially conceptualized by Zack (1999), KP framework provides conceptual acknowledgement and clarity on the different types of unknowingness related to entrepreneurial action (Townsend et al., 2018). KP framework has recently resurfaced into entrepreneurship research following the comprehensive understanding of different KPs by Townsend et al. (2018). KP refers to “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). Further, “these dimensions may be structural (e.g., where and when) or agentic (e.g., how and why)” Townsend et al. (2018, p. 661). In their conceptualization, Townsend et al. (2018) suggest that there are four types of KPs—uncertainty, equivocality, ambiguity, and complexity.

Uncertainty refers to the Knight’s (1921) notion of indeterminism, i.e., a *priori* irreducible uncertainty (McGrath, 1999). Uncertainty is solved through the passage of time (Townsend et al., 2018). *Equivocality* refers to the co-existence of different and often times competing perspectives. Consequently, no amount of new information solves this KP. Through the passage of time equivocality resorts to public forums (Eriksson et al., 2016), thereby migrating to the KP of complexity. *Ambiguity* refers to the collapse of sensemaking (Weick, 1993). It arises in situations that are information deficient. As a result, collection of more information can solve this KP. *Complexity* refers to the situations where the decision-maker must take into account the total number of variables, and the permutations and combinations related to these variables (Zack, 1999). As a result, complexity can be solved through the application of appropriate tools.

Following work by Mitchell et al. (2022), and Manocha (2022) has sought to incorporate risk as the fifth type of KP faced while undertaking entrepreneurial action. *Risk* refers to situations that can be parametrized, i.e., it is possible to have a probability distribution with the outcomes and associated probabilities. The

comprehensive understanding of the KPs by taking into account the different dimensions of similarities and differences are critical towards understanding how these KPs impact entrepreneurial action. As a result, the KP framework offers a novel pathway for contemporary and subsequent entrepreneurship research. Crucially, it is imperative that while the KPs of ambiguity, complexity, and risk can be mitigated through ways, such as collection of information, application of appropriate tools, and parametrization, the KPs of uncertainty and equivocality are solved through time. As a consequence, the KPs vary in their level of mitigability. This in turn has important implications for entrepreneurial action. Following this there has been an increasing scholarly interest in examining the differences across the KPs, in terms of their impact on entrepreneurial action and outcomes. For instance, recent work by Hunt et al. (2023) suggests that correct matching between the perceived KP to the actual KP in higher outcomes from undertaking corporate entrepreneurship endeavors.

Given that KPs are “*multi-level, multi-dimensional, multi-temporal*” (Townsend et al., 2018, p. 678, italics and bold in original), understanding the consequences of the KPs is a challenging endeavor. The complex nature of KPs can lead to differences in a variety of ways. First, the multi-level nature of KPs suggests that KPs can emerge at a macro-level, and acting upon these by individual entrepreneurs can lead to heterogeneity of entrepreneurial action and outcomes. In this vein, Rindova & Courtney (2020) and Manocha (2022) suggest the role of exogenous changes as a generator of KPs that are acted upon by individual

entrepreneurs. Second, the multi-dimensional nature of KPs suggests that entrepreneurs may not face the same KP, influencing the nature of entrepreneurial action. Finally, the multi-temporal nature of KPs suggests that KPs unfold sequentially, that can explain variance in entrepreneurial action and outcomes—as a function of time, and other temporal aspects (Wood et al., 2021).

The emergence of the KP framework offers a fresh avenue to streamline the literature focused on understanding heterogeneous entrepreneurial action, owing to a series of macro- (Urbano et al., 2019), and micro-level factors (Patuelli et al., 2020). The comprehensiveness and the uniqueness of the KP framework is both an opportunity and a challenge for entrepreneurship research. Towards the end, this dissertation embarks upon the objective of understanding the heterogeneity of entrepreneurial action through the application, and enhancement of the KP framework. Through the novel theory and the empirical treatments of the KPs, this dissertation offers an important contribution to the field of entrepreneurship research. Specifically, this dissertation offers a contribution along the following two dimensions as suggested by Corley & Gioia (2011):

- (i) **Originality:** The theory developed in this dissertation is an original conceptualization that argues for KPs as a causal link between the macro-level actor-independent changes, and the micro-level changes. Given the increasing application of the KP framework, the lack of a theory constitutes a key obstacle for the advancement of literature on KPs. Through the conceptualization of KPs, this dissertation offers a

significant original and unique contribution to the field of entrepreneurship. While the theory developed is novel, it connects the broader and ongoing conversation in entrepreneurship research (Chen et al., 2020; Davidsson et al., 2020; Townsend et al., 2018).

- (ii) **Utility:** Given the multi-dimensional nature of KPs, they are of key importance not only to scholars but also to a variety of stakeholders in the entrepreneurship landscape. The theory developed in this dissertation argues for macro-environmental changes, including institutional changes as sources of KPs. As a result, stakeholders, including policymakers, customers, financial institutions, investors, entrepreneurs face different KPs. While, at a scientific level, it suggests the sequential and simultaneous occurrence of different KPs can explain heterogeneous entrepreneurial action and outcomes, at a practical level, the essential takeaway from this dissertation is that identifying and mitigating KP results in massive benefits, in terms of entrepreneurial action and higher outcomes. At the same time, institutional changes can exacerbate existing inequalities due to the KPs generated following such changes. Understanding exogenous changes, and their related effect has received heightened scholarly and practitioner attention following COVID-19 (e.g., Sharma et al., 2022). Thus, through empirical investigations in essays two and three, of the

different dimensions of the theory developed in essay one, the theory offers both practical and scientific utility.

Using a more objective lens, there is significant reason to believe that the dissertation addresses a relevant and timely gap in entrepreneurship. The topic of the recently published (year: 2023) *Strategic Entrepreneurship Journal's* Special Issue is 'Environmental Change, Strategic Entrepreneurial Action, And Success'. The Editors for the Issue noted in their call that "... (the) role of environmental change remains under-emphasized and under-theorized in contemporary entrepreneurship and strategy research" (Carter et al., 2021, p. 1), and invited work aimed at understanding the "*variance* and *similarity* by providing strong conceptualization pertaining to external changes and their effects" (Carter et al., 2021, p. 2, italics in original), thereby linking the macro-level factors to the micro-level entrepreneurial action . Further, the theme of this year's (2023) *Strategic Management Society's* Annual Conference resonates with understanding the environmental changes that generate uncertainty, complexity, and ambiguity. Through the novel conceptualization of different KPs—uncertainty, equivocality, ambiguity, complexity, and risk as a causal link between exogenous change and entrepreneurial action, this dissertation aligns with timely scholarly interest.

Summary of Three Essays

My dissertation consists of three essays each of which seeks to unravel the heterogeneity of entrepreneurial action and outcomes. Individually, each study undertakes a different approach towards understanding the variance of

entrepreneurial action and outcomes, by tapping into the causes of heterogeneity. Collectively, these essays provide an original theory and empirical treatments to understand the heterogeneity in entrepreneurial action and outcomes.

The first essay, *The Causes and Consequences of Knowledge Problems*, provides a theory that links the macro-level exogenous changes to the micro-level entrepreneurial action. Crucially, the theory asserts for the KPs emanating from exogenous changes as a causal mechanism for the entrepreneurial action, and the variance in it, at the micro-level. The central argument is that disequilibrating exogenous changes generate KPs (Rindova & Courtney, 2020), whose identification, and mitigation explains the variance in entrepreneurial action and outcomes. While extant literature has tilted towards either the macro-level factors such as institutions (e.g., Urbano et al., 2019) or the micro-level traits such as impulsivity (e.g., Wiklund et al., 2016, 2017) to explain the entrepreneurial action, this essay puts forth a theory of entrepreneurial action in response to exogenous changes. The theory accounts for the variation across the different types of exogenous changes, including gradually evolving technologies to immediate regulatory changes, in the form of KPs. The propositions elucidate that the differences among KPs in their level of mitigability are based on the role of individual agents in the mitigation. This allows for side-by-side comparison of the effect on the heterogeneity in entrepreneurial action based on the KPs generated by the exogenous changes. Scholarship has long acknowledged for undertaking a multi-level approach to the study of entrepreneurship, as “each level of analysis provides unique insight and

that the synthesis of these insights yields a richer understanding than that possible from the perspective of a single level of analysis” (Low & MacMillan, 1988, p.152). This way, the study links the macro- and the micro-level in the study of entrepreneurship. Additionally, this study offers opportunities for scholars, practitioners, and policymakers to understand and to a possible extent mitigate the KPs in undertaking action under exogenous changes.

The second essay, *Exogenous Changes, Multi-Dimensional Knowledge Problems, and Heterogeneous Entrepreneurial Action: Exposition of Name, Image, and Likeness*, undertakes an empirical investigation of a readily identifiable exogenous change—NCAA’s rule change on the use of Name, Image, and Likeness by college athletes. Through the discovery and exploitation of a sample of college athletes using an IRB approved online survey, this essay presents empirical evidence suggesting that actor-independent macro-environmental changes can lead to widely different entrepreneurial action and outcomes. While contemporary scholarship has suggested that entrepreneurship is influenced by the wide availability of digital technologies (Nambisan 2017), and the entrepreneurship industry (Hunt & Kiefer, 2017), that can stimulate entrepreneurial action, this study provides empirical evidence of the heterogeneous entrepreneurial action and outcomes by using these available resources. Crucially, I assert that the entrepreneurs face different KPs, underscoring the multi-dimensional nature of KPs. As a result, correct matching between the actual and perceived KP (Hunt et al., 2023), and the subsequent use of appropriate tools, impacts entrepreneurial

action and outcomes. Through the novel operationalization of KPs based on survey items, this study opens exciting vistas for future empirical work on KPs. Given that the study's population is over half a million college athletes attending degree granting institutions, the study's findings have huge policy implications.

Essentially, the study suggests that institutional changes can generate highly heterogeneous changes for college athletes. Consequently, these changes can exacerbate existing inequalities that can hinder the mission of higher education that seeks to promote equality.

The final essay, *Time, Knowledge Problems, and Opacity in Entrepreneurial Action: The Evolving Nature of Artificial Intelligence Investments*, examines how exogenous changes evolve over time, and their consequences on entrepreneurial action and outcomes. Issues of temporal dynamics have been of key concern to the study of entrepreneurship. "Temporal dynamics are at the heart of entrepreneurship" noted Bird & West III (1998, p. 5). Consequently, this essay conducts an empirical investigation of Artificial Intelligence (AI). AI has been considered as a key technological change (Chalmers et al., 2019), with implications for entrepreneurship scholarship and practice (Chalmers et al., 2021; Lévesque et al., 2022; Townsend & Hunt, 2019). This essay substantiates the assertion that KPs are multi-temporal (Townsend et al., 2018). Methodologically, this essay combines a longitudinal sample of portfolio companies, and investors in the AI industry from Crunchbase, resulting in granular data at the funding round level. By undertaking a multi-level analysis, this essay examines the importance of undertaking a

temporal view of exogenous change in understanding how different actors participate as an exogenous change evolves. By specifically tapping into the different investors and the time at which they participated in the funding round, the study establishes insights to understand the different tempos at which actors mitigate KPs.

Accordingly, this study pioneers the temporal understanding of KPs and its consequences on entrepreneurial action and outcomes, both conceptually and empirically. This way, the study joins recent work to undertake a temporal view on entrepreneurship (McMullen & Dimov, 2013; Wood et al., 2021). In addition to the KP framework, since the study particularly taps into the different types of investors—venture capitalists, corporate venture capitalists, private equity firms, and angels, it has important implications for understanding industry structure in entrepreneurial finance (Wadhwa et al., 2016). While scholars have heavily relied on Porter’s five forces model (1979) to understand industry structure (Agarwal & Gort, 1996), through the application of the KP framework, this study offers a fresh lens to understand the chronology of entry into an industry, based on the matching of toolkit and the nature of mitigation of KP.

Summary of Contributions

This dissertation makes several contributions to research on entrepreneurship. First, it offers a novel approach to understanding the heterogeneity of entrepreneurial action and outcomes by providing a common ground for the sources of these variations in the form of KPs. Fundamentally, the

theory allows for understanding the variance across different types of exogenous changes, including readily identifiable institutional changes, to gradually emerging socio-demographic changes (Davidsson et al., 2020) through the lens of KPs. In particular, by underscoring the exogenous changes as causes of KPs, and the heterogeneity in entrepreneurial action and outcomes as consequences of KPs, this dissertation develops a deeper understanding of the KPs. This theorization itself answers calls in this regard by Townsend et al. (2018) to understand the differences across the broad spectrum of KPs. While extant scholarship has extensively focused on understanding uncertainty and its consequences on entrepreneurial action (e.g., Packard & Clark, 2020), this dissertation offers conceptual clarity on the array of KPs that entrepreneurs face in undertaking action that has largely remained unaccounted for by the contemporary studies in entrepreneurship literature.

Second, the dissertation develops a typology to understand heterogeneity of entrepreneurial action by underscoring the type of KPs generated by exogenous change. This way, the dissertation bridges the macro- to micro-level link in the study of entrepreneurship (Kim et al., 2016). There is an increased interest in linking these levels of analysis, as is evidenced by spate of both empirical and conceptual work in this regard (e.g., Bolzani et al., 2020; Boudreaux et al., 2019; Gupta et al., 2019; Kerr & Coviello, 2020), as a result, the dissertation shapes a timely conversation by providing a theoretical framework to bridge these two levels. Understanding the macro-level and its consequences on entrepreneurial action has been of key focus to entrepreneurship scholars (e.g., Davidsson et al., 2020;

Gnyawali & Fogel, 1994; McMullen & Shepherd, 2006), however, scholarship has largely been descriptive in this regard. A theory that explains the role of different macro-environments has been long-overdue in entrepreneurship research. By providing a theory that argues for KPs as a causal link, the theory developed in this dissertation goes further by accounting for the heterogeneity in entrepreneurial action and outcomes, as a consequence of acting on the KPs emanating from exogenous changes.

Third, at a methodological level, through the two empirical treatments of the different dimensions of the theory developed in essay one, this dissertation contributes to the refinement, and the application of the KP framework in subsequent works. I operationalize KPs based on survey items in essay two and based on archival dataset in essay three. This way, the study offers novel operationalizations of KPs (Townsend et al., 2018), and offers scientific precision for the advancement of entrepreneurship research. Subsequently, through the integrated approach to understanding the KPs using a nuanced approach to temporality, this dissertation responds to timely conversations in entrepreneurship research (e.g., Juma et al., 2023). Ultimately, by delving into the heterogeneity of entrepreneurial action and outcomes at both practical and scientific levels, this dissertation holds the greatest promise for the continued growth of entrepreneurship discipline, and its relevance to the realms of academia and practice (Muñoz & Dimov, 2023).

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CHAPTER TWO

THE CAUSES AND CONSEQUENCES OF KNOWLEDGE PROBLEMS

THE CAUSES AND CONSEQUENCES OF KNOWLEDGE PROBLEMS

In society, people are the victims and even the immediate agents of change, but more often than not the causes are elsewhere—they are emergent, collective, inexorable forces.

—Matt Ridley

INTRODUCTION

In line with the epigraph that begins this chapter, entrepreneurship scholarship has established that entrepreneurial action does not take place in a vacuum (Chen et al., 2020); rather, it is influenced by environmental conditions, including historical, social, economic, cultural, market changes that are multifaceted, cutting across different, yet highly inter-dependent levels of analysis (Welter, 2011). As such, entrepreneurial action is subject to an incessant interplay between individuals and the macro environment (Davidsson, 2015), making it a meandering, provocative, peril-ridden endeavor involving context-dependent action (Lerner et al., 2018; McMullen & Shepherd, 2006; Welter, 2011) with incomplete knowledge (Alvarez & Barney, 2007) and *a priori* unknowable outcomes (Packard et al., 2017; Townsend et al., 2018). The cumulative impact of scholarly progress in the actor-centric conceptualizations of entrepreneurial action—including emerging emphases on design thinking (Berglund et al., 2020; Berglund et al., 2018; Dimov, 2016; Goldsby et al., 2014), judgment-based logics (Foss & Klein 2012, 2020) and impulsivity (Lerner et al., 2018; Wiklund, 2018)—constitutes an important and exciting advance in the scholarly understanding of entrepreneurial individuals, teams, and firms. Yet, concomitant with this steadily increasing sophistication and

acuity in micro-level studies of entrepreneurship, there is growing discomfort with the extent to which extant research continues to struggle with the role of exogenous, macro-environmental drivers of entrepreneurial actions and outcomes (Agarwal et al., 2017). While the tools to identify, describe, operationalize, and measure the influence exerted by macro-environmental changes are elusive, progress in doing so is indispensable to the conceptual maturity and empirical veridicality of entrepreneurship research.

Given the maxim “entrepreneurship requires action” (McMullen & Shepherd, 2006, p. 132), and the acknowledgment that “entrepreneurs do not operate in a vacuum” (Chen et al., 2020, p. 1), theories that incorporate the role of macro-level factors in explaining the micro-level entrepreneurial action constitute a key gap. Existing scholarship in entrepreneurship has attempted to achieve this top-down, bottom-up linkage through system-level theory development; however, gaps remain unaddressed.¹ Due to the lack of understanding of the underlying mechanisms and visible dependent variables, Davidsson (2020, p. 321) has pointed out, “as an engine for new strategic and entrepreneurial initiatives and driver of performance, environmental change is a rather marginal topic.” It’s not that these foci are wrong, but rather they are incomplete. Toward this end, the conceptualization offered here

¹ For instance, McMullen and Shepherd (2006) theorized the manner in which external changes impact entrepreneurship, for which I see two issues that are common to such theorization: (a) only technological change is considered as a stimulus, thereby excluding many other types of external changes, and (b) the focus on the role of uncertainty, while critical, constitutes only one category of the knowledge problems that are relevant to entrepreneurial actions and outcomes (Townsend et al., 2018).

connects the two levels (i.e., macro and micro) in a convincing and utilizable fashion—a meso-level connectome.

Crucially, the origin of the theory developed in this paper is that exogenous changes are sources of knowledge problems (KPs). Undertaking entrepreneurial action when faced by KPs—consisting of risk, ambiguity, complexity, uncertainty, and equivocality (Townsend et al., 2018; Zack, 1999)—requires accurate identification and application of solution sets to mitigate the KPs (Hunt et al., 2023; Manocha, 2022). Given the ubiquitous presence of the KPs to the study and practice of entrepreneurship, and the assorted nature of different KPs in undertaking entrepreneurial action, the application of solution sets, and their mitigability, it is imperative to offer a nuanced conceptualization of KPs in entrepreneurial action. Thus, the research question that this study addresses is: *What are the causes and consequences of knowledge problems? What explains the multiplicity of knowledge problems and the influence they exert upon the heterogeneity of entrepreneurial action?* The answers to these questions—as this chapter reveals—offer a compelling reconceptualization linking macro-environmental influences on heterogeneous entrepreneurial decision, action, and outcomes. My theorization builds on the KP framework developed by Townsend et al. (2018). In line with Rindova and Courtney (2020), I argue that actor-independent macro-environmental exogenous shocks, such as COVID-19, to slowly emerging more predictable changes such as technological growth and an aging population are the sources of different KPs in undertaking

entrepreneurial action. Through the conceptualization, I argue for the role of exogenous changes in generating KPs.

The contributions to scholarship are threefold. First, the study identifies the causal linkage between the macro environment and the micro-level entrepreneurial action. While there is an increasingly large body of work that seeks to explain the role of macro-level factors (e.g., Chen et al., 2020; Davidsson et al., 2020), there is a lack of rich conceptualization (cf. Kimjeon & Davidsson, 2021) attendant to this research, extending the long line of macro-level scholarship that is primarily observational and descriptive, evidenced by the relative paucity of dependent variables and reliable predictors that capture macro drivers of entrepreneurial action (Davidsson, 2020). The study identifies the role of KPs as a causal link between the macro-level exogenous changes and the micro-level entrepreneurial action, thereby proffering a meso-level theory of entrepreneurial action (cf. Dopfer, 2006). According to Talib and Fitzgerald (2016), “The meso level . . . lies between the micro and macro regions where even though its role is mainly an intermediary one, it is nonetheless fundamental as it makes explicit the transitional link between the micro and macro” (p. 536). As Vromen (2010, p. 374) noted, “causes (and their effects) can be at any level, including the macro-level,” in a similar way, the theory developed here asserts that KPs are generated by macro-level exogenous changes, and mitigated, to varying degrees, by micro-level entrepreneurial action. Therefore, the study responds to recent calls to offer a theory that connects the different levels of entrepreneurship (e.g., Cowen et al., 2022; Kim et al., 2016). By offering a

theorization of the dynamics to link macro- and micro-levels through the development of a mechanism, the study answer calls for developing mechanisms in entrepreneurship research (Berglund & Korsgaard, 2017).

Second, this paper contributes to the emerging stream of research on KPs (e.g., Hunt et al., 2023; Mitchell et al., 2022) by providing a typology that differentiates between the KPs based on (a) solution sets—actor-controllable and non-controllable, and (b) mitigability—high, moderate, and low. By offering a nuanced conceptualization of KPs based on the solution sets, the study responds to calls by Townsend et al. (2018) to move the needle on understanding KPs by investigating the role of actor-controllable factors in their mitigation. That said, by classifying the KPs based on mitigability, the study gives rise to new arenas for understanding the presence of heterogeneity of entrepreneurial action. While scholarship has acknowledged the presence of heterogeneity in entrepreneurial action arising out of external changes based on demographic (Manocha et al., 2021), sectoral (Bennett, 2019), and spatial and temporal dimensions (Chen et al., 2020), there exists a lack of nuanced common ground that can explain these differences (Kimjeon & Davidsson, 2021). Through this novel conceptualization, the study illuminates the role of exogenous changes in generating KPs that can be addressed societally and individually to activate the mechanisms of new venture creation. Ultimately, the theory developed here enhances the predictive capacity of the KP framework by offering testable propositions.

Contemporary scholarship in entrepreneurship has increasingly acknowledged and highlighted the existence and centrality of different KPs (Fisher & Neubert, 2022; Hunt et al., 2023). Crucially, the notion that entrepreneurs act under conditions of uncertainty has long been axiomatic to the nature and substance of business venturing. Entrepreneurship research has extensively grown by examining the relationship between uncertainty and entrepreneurial action (e.g., Bylund & McCaffrey, 2017) and the nature of uncertainty (Packard & Clark, 2020); however, the debate remains unsettled regarding the nature and impact of uncertainty on entrepreneurial action. Further, the acknowledgment and the relationship between other KPs and entrepreneurial action and outcomes is not robust. By thoroughly examining uncertainty, and other KPs, this study offers constructive mediation to this ongoing debate.

Finally, a critical finding of my theoretical model relates with the manner in which the KPs emerging from exogenous change impact the substance of entrepreneurial action in terms of heterogeneity. The theory developed here can be used to examine the impact of different types of exogenous changes, ranging from political, legal, and technological to slowly emerging demographic shifts. This is crucial in terms of policy implications in ascertaining why some policy changes favor some cohorts of entrepreneurs more than others, resulting in an inequitable distribution. This way, the study's assertions can guide future work that seeks to identify new strategies for increased understanding of the unequal effects in entrepreneurial action.

ENTREPRENEURIAL ACTION AND THE EXTERNAL ENVIRONMENT

Understanding the relationship between the external environment and entrepreneurial action has been one of the key themes within entrepreneurship literature. In this study, in line with extant work (e.g., Chen et al., 2020; Davidsson et al., 2020), the external environment refers to the macro-level aggregate factors that are not controllable by an individual entrepreneur that can impact entrepreneurial action and outcomes. These exogenous factors range across different categories, from natural environmental changes, such as COVID-19, to slowly emerging demographics and political, institutional, and economic trends. Exogenous, macro-environmental influences exert favorable and unfavorable material impacts when destabilization creates conditions relevant to entrepreneurial action (Chen et al., 2020). For decades, entrepreneurship research has acknowledged and established the role of an exogenous environment in entrepreneurial action (Gartner, 1985; Gnyawali & Fogel, 1994). Key studies in this regard include those by Gnyawali and Fogel (1994), McMullen and Shepherd (2006), and Davidsson et al. (2020). These three conceptual articles seek to examine the relationship between macro environment² and entrepreneurial action. While each of these follows its own path in examining the relationship between the macro

² It is important to note that there have been other seminal works that have sought to unravel the relationship between the macro environment and entrepreneurship. These include but are not limited to DiMaggio and Powell (1983), North (1990), Baumol (1996), and Scott (1995). However, the central focus of these scholarly pieces has been on the institutions. Given that the focus of this chapter is on the macro environment and entrepreneurship in general, and not on institutions in specific, these papers are not discussed in greater detail here. However, these are pivotal in the next Chapter, as it seeks to unravel the relationship between institutions and heterogeneity in entrepreneurial action and outcomes.

environment and entrepreneurial action, the articles are not mutually exclusive in the sense that the crux of the frameworks developed in each of these articles offers an observational description of the role of the external environment on entrepreneurial action. Next, I highlight how these key articles shaped the conversation of the relationship between the macro environment and entrepreneurial action before delving into theory building.

Gnyawali and Fogel (1994)

“Environments for entrepreneurship development: key dimensions and research implications” As one of the first truly important articles focusing on understanding the relationship between macro environment and entrepreneurial action, the study investigates the relationship between the different dimensions of entrepreneurial environments. The five dimensions identified are (a) government policies and procedures, (b) socioeconomic conditions, (c) entrepreneurial and business skills, (d) financial assistance, and (e) non-financial assistance. The article identifies a series of factors within each of these dimensions, ranging from government policy and restrictions on imports and exports to laws, business education, and availability of financing.³ While there were existing studies that explored the relationship between the external environment and entrepreneurial action (e.g., Reynolds et al., 1994; Romanelli, 1989), Gnyawali and Fogel (1994) developed a nuanced theoretical

³ In terms of understanding the impact on entrepreneurship, the article undertakes a process approach to examine the impact on various facets, including, opportunity, propensity to enterprise, likelihood to enterprise, and ability to enterprise. Since the focus is on understanding the drivers (i.e., the external environment), I do not delve deeper into the various elements in the venture creation process as described in Gnyawali and Fogel (1994). See Gnyawali and Fogel (1994) for details.

framework that articulates the impact of five different dimensions of the external environment on the different stages of the venture creation process. Following this, there has been a spate of work in entrepreneurship to investigate these relationships. For instance, Ucbasaran et al. (1999) suggested that the relationship between the external environment and entrepreneurial action constitutes a key theme in entrepreneurship research. The timing of the article, coupled with the availability of the Global Entrepreneurship Monitor (GEM), led to a spate of empirical work that sought to examine the relationship between the external environment and entrepreneurial action (e.g., Aparicio et al., 2016; Schillo et al., 2016). This, in turn, influenced work on other research streams, such as entrepreneurial ecosystems (e.g., Stam & van de Ven, 2021; Wurth et al., 2022). Studies (e.g., Coduras et al., 2008) have sought to examine the process that explains how the macro environment impacts entrepreneurial action by articulating a series of factors that act as mediators, including entrepreneurial potential, capacity, and motivation. Further, research has ascertained the differences in entrepreneurship rates across countries due to the external environments (Aidis et al., 2008; Aparicio et al., 2017).

McMullen and Shepherd (2006)

“Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur”. With over 3,600 citations at the point of this writing, McMullen and Shepherd (2006) offered a system-level theory of entrepreneurship. The article focuses on the external environment, specifically technological change, as a source

of uncertainty. It provides a two-step model that distinguishes between those undertaking entrepreneurial action and those not. Townsend et al. (2022) noted that the article delves “into account(ing) the epistemological and motivational drivers of entrepreneurial action, which the (authors) conceptualize as a sequential process, consisting of two stages: attention and action” (p. 158). The article focuses on the epistemic and motivational differences among individuals in undertaking entrepreneurial action. It has sought to advance the entrepreneurship literature by focusing on environmental and agentic factors (cf. Townsend et al., 2022), strongly emphasizing the extent to which individual-level differences toward uncertainty drive heterogeneity in the initialization of entrepreneurial action. The article sparked renewed interest in the literature on the role of uncertainty in entrepreneurial action, as is evidenced by subsequent work, including, Sarasvathy et al. (2008), which suggested that entrepreneurs deal with uncertainty differently from non-entrepreneurs. Further, Shepherd et al. (2015) argued that high levels of uncertainty could be associated with higher creativity by entrepreneurs as they work to generate novel solutions to existing problems. In sum, while the literature following McMullen and Shepherd’s (2006) seminal work has emphasized the nature and substance of the macro environment, the relationship with the micro-level entrepreneurial action is relatively weak, thereby, only tangentially achieving the objective of the theoretical framework to provide a “system-level” theory.

Davidsson et al. (2020)

“External enablement of new venture creation: A framework”. The most recent framework that seeks to unravel the macro-micro linkage is the external enabler (EE) framework by Davidsson et al. (2020). EEs are the macro-environmental factors, ranging from the recent rule change on the use of name, image, and likeness (NIL) by college athletes, bankruptcy laws to emerging trends such as the trend toward veganism and the aging population, which can impact the intensity, rate, and substance of entrepreneurial action (Davidsson et al., 2020). Following this, there has been an emergence of scholarly work that has examined the impact of a series of EEs: infrastructure (Bennett, 2019; Chen et al., 2020), internet (Manocha et al., 2021), technology (Chalmers et al., 2020) such as non-fungible tokens (NFTs) (Chandra, 2022). The key finding of this stream of research is that even though the EEs are macro-environmental actor-independent drivers of entrepreneurial action, their impact is far from uniform. Simply put, there is differential enablement of entrepreneurial action due to demographic (Manocha et al., 2021), temporal, spatial (Chen et al., 2020), and sectoral differences (Bennett, 2019), highlighting the heterogeneity of entrepreneurial action and outcomes.

While the above three conceptual articles have sparked scholarly interest to incorporate the role of the external environment in studies of entrepreneurship, there have been other frameworks as well that scholars have deployed to explain the link between the macro environment and entrepreneurial action. This includes classic work by North (1990) that suggested the role of the external environment as

the “rules of the game,” which “undergo(es) significant changes from one period to another” (Baumol, 1990, p. 894), influencing entrepreneurial action. For instance, research has shown that large-scale social movements can facilitate nascent-stage entrepreneurship, as Sine and Lee (2009) revealed in their investigation of the U.S. wind energy sector. Empirical work by Hunt (2015) documented the emergence of “contagion entrepreneurship” in response to the abrupt emergence of highly munificent environmental and institutional conditions. Hiatt et al. (2009) provided panoramic evidence that broad-scale social changes affect the quantity and substance of entrepreneurial action. In more recent developments, scholars have shown that macro-level shifts in digital technologies and platforms have led to the creation of novel organizational forms and business models (von Briel et al., 2018). Studies have shown that university programs (Eesley & Lee, 2021) and accelerators (Miles et al., 2017) play an important role in promoting entrepreneurship. Further, by applying a historical socioeconomic perspective, Ruef (2020) showed that the deinstitutionalization of slavery exerted a demonstrable influence on entrepreneurial activity.

Increasingly, scholars have examined macro-environmental forces and entrepreneurial ecosystems through the lens of process-based models (Davidsson, 2004), focusing on the resources available to would-be entrepreneurs in scaling their ventures (Spigel & Harrison, 2018). Entrepreneurial ecosystems have the capacity to be generative sources of entrepreneurial action (Spigel, 2017) by functioning as “systems of entrepreneurship” (Acs et al., 2014) at the regional and national levels.

As sources of knowledge, entrepreneurial ecosystems benefit from interactions between stakeholders (Autio & Levie, 2017) when spawning novel technologies, organizational forms, and business models (Autio et al., 2018). Economic (Patti et al., 2016) and institutional environments (Wu & Deng, 2020) are highly influential determinants of entrepreneurial activity (Urbano et al., 2020). Studies also suggest that institutional factors such as tax rates, and corruption shape entrepreneurship (Raza et al., 2019), as do business regulations, such as contract enforcement and entry procedures (Audretsch et al., 2019) and economic factors, such as the availability of financing (Somoye, 2013). Even informal institutions, including those related to culture, and related factors such as individualism, uncertainty avoidance, can influence entrepreneurship (Fuentelsaz et al., 2019; Wennekers et al., 2007). In fact, Baumol's (1996) exposition of productive, unproductive, and destructive entrepreneurship is predicated upon the notion that actor-independent forces occupy a central role in shaping entrepreneurship.

Subsequent works by Shane (2003), McMullen and Shepherd (2006), and others (e.g., Alvarez & Barney, 2007; Klein, 2008) have sought to problematize varying facets of entrepreneurial action as the nexus of actors and their respective environments but micro-level, agent-actor factors have tended to hold more fascination for scholars than the environmental contexts (Zahra et al., 2014). To sum up, entrepreneurship research has long acknowledged the role of the external environment, such as institutional, cultural, and socio-cognitive factors on entrepreneurial action (e.g., Autio et al., 2018; Gnyawali & Fogel, 1994; Guerrero et

al., 2021; Urbano et al., 2019). To some extent, prior work has sought to establish the importance of actor-independent sources of opportunity beliefs (Grégoire & Shepherd, 2012). The most recent framework in this regard is the external enablement framework offered by Davidsson et al. (2020). While these and other frameworks effectively describe the role of different external environments on entrepreneurial action, they are inadequate in providing a theory that predicts the impact of the external environment on entrepreneurial action (cf. Kimjeon & Davidsson, 2021).

The common thread running through this body of work is the concerted effort to identify and underscore the role of various types of external environments and their changes in determining entrepreneurial action. Extant work in entrepreneurship has offered anecdotal evidence on the role of the external environment. For instance, Baumol (1990) argued for the role of the institutional environment and the changes that can dictate entrepreneurial action, McMullen and Shepherd (2006) argued for technological changes as a stimulus for entrepreneurial action. Part of the problem is that macro-level impacts have received much less theoretical attention than agent-centric theorization of entrepreneurial action even though several studies have underscored their crucial role. Given that understanding the influence of macro-level factors on micro-level factors requires a mechanism approach (Falleti & Lynch, 2009), recent scholarship has argued for and even applied existing models, including Coleman's bathtub model (1986), to explain how macro-level artifacts affect individual-level actions

(e.g., Cowen et al., 2022; Kim et al., 2016). While scholars have developed frameworks to understand and link the macro-level external environment to micro-level entrepreneurial action, the substance of the theoretical frameworks aimed at linking macro-level exogenous shocks to micro-level entrepreneurial action has not accounted for explaining the presence of mechanisms in the articulation of the cause-and-effect relationship.

The absence of a robust theoretical framework that describes and predicts the impact of external environmental changes of different types, such as technological changes, socio-demographic changes, to natural environmental changes is a key impediment to the growth of the field of entrepreneurship research (Kimjeon & Davidsson, 2021). To address this scholarly need, the crux of this study lies in providing a theory that offers testable propositions in understanding the effects of different exogenous changes on entrepreneurial action. In the following sections, I articulate this cause-and-effect relationship through the articulation of macro-level changes as a source of unknowingness, or KPs.

Exogenous changes generate disequilibria, noted Edwards and Van Wijnbergen (1989). Recently, in the studies of entrepreneurship, scholars have investigated how entrepreneurs make decisions when faced with exogenous changes that result in disequilibrium (e.g., Morgan et al., 2020). External exogenous changes, as disequilibrating changes, result in unknowingness or KPs (cf. Manocha, 2022; Rindova & Courtney, 2020). Given that there are five types of KPs in undertaking entrepreneurial action (Townsend et al., 2018), the theory argues for

the accurate knowledge problem diagnosis and mitigation as antecedents for entrepreneurial action. Next, I provide a description of the different KPs based on the framework offered by Zack (1999), and later developed by Townsend et al. (2018).

Crucially, the crux of this paper lies in articulating the mechanism through which external environmental changes lead to entrepreneurial action. The starting point of the theory is that, as disequilibrating changes, external changes lead to KPs (cf. Rindova & Courtney, 2020). As previously noted, KPs can be of different types (Townsend et al., 2018; Zack, 1999), the next section offers a conceptualization of these different KPs that generate from exogenous changes.

UNCERTAINTY AND OTHER KNOWLEDGE PROBLEMS

As noted by Townsend et al. (2018):

A knowledge problem is any decision-making state in which the decision-maker has moved past ignorance—that is, he or she possesses at least some minimal awareness that a decision, judgment, prediction, observation, or assessment must be made—but the individual does not possess certitude regarding either the relevant factors or likely consequences of action. (p. 670)

Further, entrepreneurs face different types of KPs (Townsend et al., 2018). As Zack and McKenny (1988) suggested, there can be different types of KPs. KPs refer to the unknowingness about different possible outcomes related to entrepreneurial action. Unknowingness varies in nature, making it a pluralistic term for an array of KPs. As suggested earlier, given both the extensive scholarly and practitioner usage of the construct of uncertainty, uncertainty has been used in an omnibus fashion as

a way to refer to unknown conditions, even when that unknowingness is not actually uncertainty (e.g., Miller, 2012; Packard & Clark, 2020; Ramoglou, 2021). Myopic approaches to KPs that implicitly or explicitly categorize all unknowns as being uncertain vitiate important definitional distinctions between uncertainty and the other four KPs, thereby creating imprecision and fueling confusion in entrepreneurship literature vis a vis the other KPs. Uncertainty, though critical in entrepreneurial action, is merely one of the five KPs an entrepreneur can face (Townsend et al., 2018). Over a century since the publication of Knight's classical work *Risk, Uncertainty, and Profit* has led to conceptual clarity over the construct of uncertainty. However, extant research has used uncertainty as a proxy for different types of unknowingness, painting an inaccurate picture that uncertainty is a substitute for unknowingness, whereas, in reality, uncertainty is a type of unknowingness.

Unknowingness—which spans the entire landscape of human consciousness lying between ignorance and certainty—truly is ubiquitous, uncertainty is merely a subset of unknowingness. (Townsend et al., 2018, p. 660)

Townsend et al. (2018) noted the importance of understanding unknowingness as a pluralistic term, which constitutes five types of knowledge problems: uncertainty, equivocality, ambiguity, complexity, and risk. While Townsend et al. (2018) argued that entrepreneurs operate under unknowingness, I offer a refinement of this statement by arguing that entrepreneurs operate under different types of unknowingness. In my view, it is critical that entrepreneurship research situates and differentiates among the types of unknowingness.

Contemporary entrepreneurship studies' innate emphasis on uncertainty has blurred the lines between different types of unknowingness, leading to the interchangeable use of uncertainty, and unknowingness.

The emergent KP framework has advanced scholarship on the plurality of unknowingness by (a) situating the different types of KPs (e.g., Mitchell et al., 2022) and (b) articulating the consequences of inaccurate KP diagnosis (e.g., Hunt et al., 2023). Yet, a nuanced and comprehensive framework that situates these KPs, resulting in a typology remains unexplored. In the following section, I offer a nuanced understanding of the different types of KPs.

Different Types of KPs

KPs refer to the conditions of unknowingness that related to entrepreneurial action and outcomes (Townsend et al., 2018). Classic theories of entrepreneurial action, such as the foundational work offered by McMullen and Shepherd (2006), Alvarez and Barney (2007), and Foss and Klein (2012), each pointed to uncertainty as constituting the key link between the external environment and the entrepreneurial action—the substance of what Eckhardt and Shane (2003) referred to as entrepreneurial action amid “disequilibrium and incomplete information about opportunities” (p. 345). In an attempt to clarify the presence of the plurality of unknowingness in impacting the nature, substance, and quantity of entrepreneurial action, Townsend et al. (2018) offered a conceptualization of KPs. Building upon

Zack (1999), Townsend et al. (2018) described five ⁴ KPs: risk, ambiguity, complexity, uncertainty, and equivocality. I briefly describe each below.

As noted previously, uncertainty refers to Knight's (1921) notion of indeterminism, what McGrath (1999) referred to "a priori irreducible" uncertainty.⁵ It refers to the KP rising due to the absence of information leading to an indeterminable array of possible outcomes attendant to entrepreneurial decisions and actions (Townsend & Hunt, 2019). Uncertainty is the KP domain of "unknown unknowns" (Hampton et al., 2012, p. 31). The only true antidote to uncertainty is the passage of time, during which something either occurs or does not occur, allowing agent-actors to draw inferences of the future possibility states (Townsend et al., 2018). Otherwise, uncertainty is not mitigable from the standpoint of an entrepreneur. Extant scholarship has acknowledged and offered extensive understanding of uncertainty in entrepreneurship (e.g., McMullen & Shepherd, 2006; Packard & Clark, 2020).

One of the most comprehensive distinctions among the types of uncertainty is offered by Frances Milliken (1987). Uncertainty in Milliken's work (1987) focuses on that which arises from external environment. Milliken (1987, p. 133) wherein actors "try to understand, make sense out of, and respond to conditions in the external environment." Milliken three types of this environmental uncertainty: state, effect,

⁴ Townsend et al. (2018) do not include risk as a KP, however, subsequent works, e.g., Manocha (2022), Mitchell et al. (2022) have included risk as a KP.

⁵ While uncertainty has been classified as aleatory and epistemic (Packard & Clark, 2020), this study's conceptualization is based on Knightian uncertainty. Epistemic uncertainty refers to the uncertainty for which a potential entrepreneur faces due to lack of knowledge, whereas aleatory uncertainty refers to the uncertainty due to ignorance that cannot be resolved (Packard & Clark, 2020). For parsimony, I refer to Knightian uncertainty as uncertainty.

and response. *State uncertainty* refers to uncertainty about the unpredictability of the future state of the world, *effect uncertainty* refers to uncertainty about how a given state of events will affect an actor's ability to act in the future, and *response uncertainty* refers to inability to predict the expected outcomes of a response choice and/or a lack of knowledge of available array of options. Essentially, Milliken (1987) offers an understanding of the nature of uncertainty arising from environmental changes in order to distinguish between the nature of the uncertainty as the descriptive state of (i) the environment and (ii) the actor. Milliken (1987, p. 133) differentiates between the three types of uncertainty to offer precision related to environmental uncertainty, and aid better understanding of how to address and manage uncertainty. However, uncertainty is in effect, one of the five KPs faced by the actors (Townsend et al., 2018; Zack, 1999). Thus, it is imperative to identify and explain the different KPs. To do so, next, I establish the theoretical importance of differentiating between the different types of KPs in terms of their effect on entrepreneurial action.

Ambiguity has similarities to uncertainty in that it is often characterized by actors facing a quandary. The difference is that ambiguity can often be resolved by gathering more and better information. As such, ambiguity involves unknowability related to whether a relationship between two or more variables remains constant in different scenarios. As Weick (1993) famously emphasized, it is closely attuned to the process of sensemaking, arising when the environment and circumstances in which the decision is to take place are vaguely defined. In such cases, entrepreneurs

attempt to mitigate by gathering more data pertaining to the situation. For ambiguity, the creation of critical action resolves the knowledge problem. Therefore, I argue that ambiguity is associated with moderate levels of mitigability.

Complexity is a function of the sheer number of variables a decision-maker must consider (detail complexity) and the degree of convolution (dynamic complexity) in how those variables are related to one another (Zack, 1999). In this sense, complexity is an issue of tools. To address complexity, one needs to apply the correct existing tool to a problem. In the absence of existing tools, mitigability requires the development of new tools, as was the case for Leibniz and Newton, inventing calculus to allow integration and differentiation. Thus, complexity is a form of unknowingness related to logics of consequence. The potential entrepreneur faces unknowingness as to whether they can reach the intended outcome by undertaking action. Townsend et al. (2018) suggested that in complex circumstances, the discovery of “more data . . . degrades decision-making accuracy” (p. 675). I take this argument a step further by asserting that complexity can be mitigated when the entrepreneur possesses the tools required to transform new and convoluted data into utilizable information.

Equivocality refers to the coexistence of multiple and sometimes even conflicting perspectives (Daft & Lengel, 1986; Eriksson et al., 2016). Equivocality has some similarities with ambiguity in that it is a KP that emerges in an ill-defined, sometimes contested, decision environment. The key difference is that no amount of new information mitigates the KP. Instead, equivocality must resort to

public forums and social norms to transform equivocality into complexity, which can then be addressed through tools. Equivocality is solved through the refinement of existing information (Eriksson et al., 2016). For example, the battle over the Copernican and Ptolemaic conceptions of the solar system was at an impasse—as Galileo famously fought the Catholic Church over whether the earth or sun lay at the center—until Kepler discovered elliptical orbits, which substantively settled the issue. Equivocality was irresolvable until it could be reconstituted as a KP of complexity. While history is filled with examples of equivocality, another example worth mentioning is the now-known “war of the currents,” a conflict between Thomas Edison and Nikola Tesla. Edison believed that direct current (DC), which delivered a constant flow of current, was the reliable form of electricity, whereas Tesla came up with alternating current (AC). The AC system was based on transformers, making it a more efficient power generation system. Over time, AC became the dominant design for the generation and distribution of power. However, it is critical to note that given DC’s stability, it is used in some devices, such as computers.

Risk, referred to as “measurable uncertainty” (Knight, 1921), is distinct among the KPs in that it can be “rationalized” through the analysis of patterns and probabilities. Like the other four KPs, risk involves unknowingness and indeterminism, but the degree of unknowingness is bounded and insurable, since risk can be quantified based on prior outcomes and the underlying distribution of all probabilistic outcomes; however, there is no certainty concerning which of the

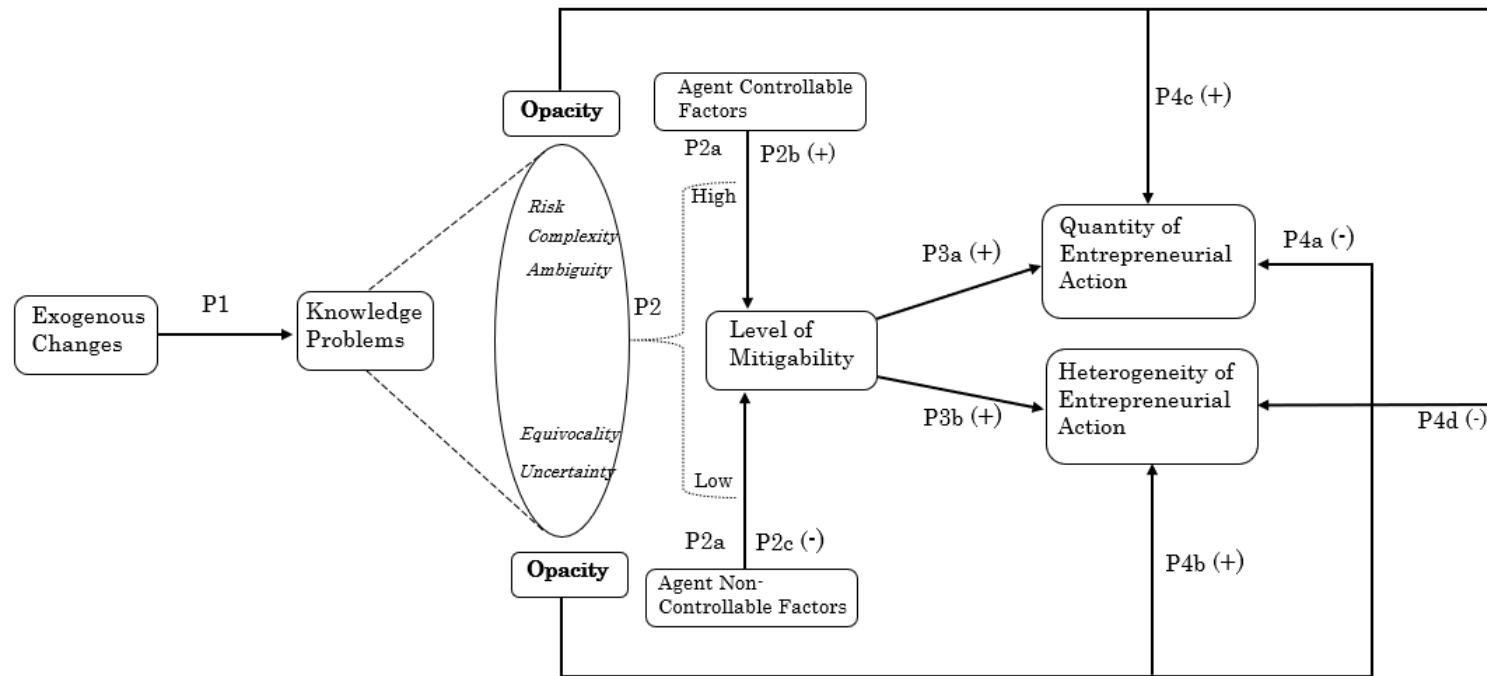
potential outcomes will actually occur. For example, there is no certainty regarding the roll of any two fair dice, but the distribution of possible outcomes can be easily calculated. Thus, risk can be thought of as involving decision-making wherein individual outcomes are unknowable, but the underlying set of probabilistic outcomes can be calculated and, as such, is insurable. In other words, risk can be parametrized, meaning it can be mitigated to a higher degree than the other KPs.

As the above description suggests, the wide spectrum of unknowingness can be split into five KPs.

KNOWLEDGE PROBLEM THEORY OF ENTREPRENEURIAL ACTION

To provide a theoretical framework of the KPs, including the causes and consequences of KPs, in this section, I focus on identifying the sources of KPs, situating and distinguishing among the different types of KPs by developing a typology, and understanding outcomes in terms of entrepreneurial action. In the following sections, I develop a theoretical model, as depicted in Figure 1. Figure 1 provides a more comprehensive understanding of the theory by including a series of propositions that explain the causes and consequences of KPs. These propositions are labeled P1 to P4d in Figure 1.

FIGURE 1- The Conceptual Model.



External Environment and KPs

Entrepreneurship research has suggested that environmental changes lead to uncertainties for entrepreneurs (Packard et al., 2017). Townsend et al. (2018) noted that external environments are a source of KPs. Contemporary entrepreneurship research notes the role of changes in the external environment as the origins of KPs (e.g., Manocha, 2022; Rindova & Courtney, 2020). Pontikes and Rindova (2020) noted, “Structure holds the seeds of change” (p. 157). D’Andrea (2022) asserted the role of the institutional market and technological conditions as sources of uncertainty. Management research, more broadly, has acknowledged the role of the external environment as sources of opportunities (e.g., Gavetti et al., 2017). In line with Manocha (2022) and Rindova and Courtney (2020), I argue that exogenous changes lead to KPs. Rooted in Austrian economics, the starting point of my theory argues for the role of exogenous changes in leading to entrepreneurial action.

As macro-environmental disequilibrating changes, I argue that exogenous changes generate KPs. This argument aligns with the extant scholarship that suggests that exogenous changes generate equivocality (Dutton et al., 1983) and other KPs. However, the exogenous changes can vary,⁶ not only across a spectrum (e.g., technological, regulatory) but also in their emergence. For instance, some are slowing emerging trends, such as changing demographics, whereas others are instantaneous (e.g., tsunamis, terrorist attacks) (Juma et al., 2023). Thus, it is

⁶ A detailed description of the different types of exogenous changes is offered by Davidsson et al. (2020).

imperative to understand that different exogenous shifts lead to different types of KPs. In fact, Williamson (2000) has argued for the difference in the frequencies of change of various institutions that are external to entrepreneurial action and lead to uncertainty. A refinement is offered by Packard et al. (2017), who suggested that the type of unknowingness is contingent on the nature of the change. Given that some changes are more predictable than others, the exogenous changes vary in the knowledge problem generation. Thus, in line with Townsend et al.'s (2018) notion of unknowingness, I argue that exogenous changes lead to a gamut of KPs for entrepreneurial action. This leads to the following proposition:

P1: *Exogenous macro-environmental changes generate one or more KPs.*

KPs and Mitigability

Given that KPs are central to this theory, it is imperative to enhance the conceptualization of KPs based on the level of mitigability. Thus, the next section entails the classification of the above-described KPs into categories based on their level of mitigability. The specification of the mitigability of the KPs lays the groundwork for theorizing the heterogenous entrepreneurial action and outcomes by identifying and mitigating knowledge problems emanating from exogenous changes. Extant scholarship suggests that KPs vary. For instance, the Mann Gulch disaster is a classic case of sensemaking, wherein “sensemaking is about contextual rationality” (Weick, 1993, p. 636). This posed the KP of ambiguity, which could be resolved through routes such as effective communication and team dynamics.

Whereas situations related to technological changes can pose uncertainty (McMullen & Shepherd, 2006), which are solved through the passage of time (Mitchell et al., 2022).

An entrepreneur who applies the logic of consequences when perceiving uncertainty would be at odds with the prevailing knowledge problem impediment if the actual environmental conditions were ambiguous, a condition that functions in accordance with the logic of appropriateness. (Townsend et al., 2018, p. 677)

In fact, these:

KPs can be distinguished by the nature of the knowledge being processed and whether the requirement is to acquire more knowledge or to place restrictions on what exists. (Zack, 2001, p. 23)

For ease of comparison, I offer a typology of the KPs based on the level of mitigability (i.e., low, moderate, and high). Crucially, I assert that uncertainty and equivocality are associated with low levels of mitigability (i.e., they do not lend themselves to being resolved), whereas ambiguity is associated with moderate mitigability, complexity with moderate-high mitigability, and risk is associated with high levels of mitigability. Being probabilistic in nature (Knight, 1921), risk requires parametrization in its mitigation. As a result, there is higher mitigability. Whereas complexity requires the use of appropriate tools in its mitigation, existing or new tools, lending it a stature of moderate to high mitigability, while ambiguity requires the collection of new information, making it a moderately mitigable KP.

As suggested before, gathering more information can resolve ambiguity. However, the same does not hold for equivocality. As explained in the example above concerning the debate related to AC or DC, the equivocality related to which

of the currents is the better option was solved over time and translated into one of ambiguity when the question to be asked became when to use AC power versus DC power. In terms of KPs, research has shown that uncertain situations evolve into equivocal ones as more information is generated (Barreto, 2011). However, as argued before, equivocality relates to situations wherein conflicting perspectives coexist (Daft & Lengel, 1986). As a result, no amount of new information solves equivocality. Rather it is solved when the conflicting and multiple perspectives are refined and parsed through mental structures (Barreto, 2012; Walsh, 1995) by resorting to public forums and norms using media (Daft & Lengel, 1986), over time (cf. Townsend et al., 2018). As a result, over time, equivocality can migrate to one of ambiguity, complexity, or risk.

As a result, it is crucial to view KPs as an array of unknowingness that vary in their mitigability. Therefore, in line with Zack (1998), I argue that KPs vary in their level of mitigability. This leads to the following proposition:

P2: *KPs vary in their levels of mitigability.*

While all KPs have conditions of unknowability, they vary in the degree to which solution sets are a priori indeterminable (Townsend & Hunt, 2019) by the potential entrepreneur.⁷ Thus, next, I provide for the role of different factors in mitigating the KPs.

⁷ The influence a potential actor has on the mitigability of the knowledge problem depends on the characteristics of the actor and the specific KP being encountered. Therefore, this is a key boundary condition in my theory.

KPs and Solution Sets

The ongoing discussion provides the taxonomy of KPs on the dimension of mitigability. Next, I argue that it is crucial to understand the solution sets that are required for the mitigability of KPs. Broadly, solution sets to mitigate KPs can either be actor-uncontrollable, or actor-controllable, i.e., tools specific to the individual agent can be used to mitigate the KP. For instance, as the above discussion indicates, uncertainty is resolved through the passage of time (i.e., actor-uncontrollable factors), whereas complexity is resolved by the application of correct tools (i.e., actor-specific toolkit). Building on the above explanation of the five types of KPs, I argue that solution sets for uncertainty and equivocality are actor-uncontrollable, while those for ambiguity, complexity, and risk are actor-controllable. Thus, the level of the mitigability of the KP is determined by the solution sets. This leads to the following proposition:

P2a: *Knowledge problem mitigability is influenced by the solution sets.*

Taking a step ahead, the following discussion seeks to understand how these solution sets influence the mitigability of KPs. Understanding the solution sets of the KPs provides a critical boundary condition among the array of KPs (Townsend et al., 2018). Since solution sets can be either actor-controllable or uncontrollable, the role of individual agents' characteristics in mitigating the KPs vary. As Townsend et al. (2018) noted that entrepreneurial action requires the ability and willingness to monetize unknowingness (cf. McGrath, 1999; McMullen & Shepherd,

2006), I argue that this is contingent on the type of KP posed. Mitchell et al. (2022) noted, “With ambiguity, increases in information lead to increases in consensus. Whereas with equivocality, no amount of additional information can create consensus” (p. 86). Given that unknowingness is pluralistic in nature, the individual agent’s ability and willingness to monetize the unknowingness will be determined, among other things, by the solution sets required to mitigate the KP (unknowingness). The application of agent-controllable solution sets suggests the individual agents can use their characteristics in mitigating the KP, other KPs’ mitigation is not agent-controllable. As such, the KPs that require agent-controllable solution sets provide more room for individual characteristics to be put to use than those KPs that are solved through agent-uncontrollable solution sets. KPs that can be resolved by actor-controllable sets dictate moderate to high levels of mitigability. Due to the role of agent-controllable solution sets in solving these KPs—ambiguity, complexity, and risk, I argue that they are moderately to highly mitigable. This leads to the following proposition:

P2b: *The greater the role of agent controllable factors in mitigating the knowledge problem, the greater the mitigability of the knowledge problem.*

As stated at the outset, identifying the correct knowledge problems is crucial to the application of correct tools in mitigating the KP. Thus, KPs can be arrayed along a continuum based on the solution sets that dictate the role of individual characteristics in their mitigability. The solution sets dictate whether individual agent characteristics can mitigate the KP faced. KPs of ambiguity, complexity, and

risk can be solved through actor-controllable solution sets—such as decision-making, application of tools, and gathering more information. Alternatively, some types of KPs (uncertainty and equivocality) are solved over time by resolving events and sociocultural acceptances (cf. Townsend et al., 2018). Therefore, the idea that these KPs are solved by solution sets that are actor-uncontrollable provides little room for individual agents to use their characteristics in mitigation. This leads to the following proposition:

P2c: *The greater the role of agent-uncontrollable factors in mitigating the knowledge problem, the lower the mitigability of the knowledge problem.*

To summarize the ongoing conversation, accurately diagnosing KPs (Hunt et al., 2023) is critical for applying the solution set to mitigate the knowledge problem. Solution sets, which can be either actor-controllable or uncontrollable, are contingent on the type of KPs. Building on the above explanation of the five types of KPs, I argue that solution sets for uncertainty and equivocality are actor-uncontrollable, while those for ambiguity, complexity and risk are actor-controllable. The applicability of actor-controllable solution sets requires individuals to use their own characteristics in mitigating the KP, whereas actor-uncontrollable solution sets do not provide for individuals to mitigate the KP. As a result, the role of individual agents' characteristics in mitigating the KPs varies. Table 1 differentiates the five types of KPs based on the solution sets, the role of individual characteristics, the level of mitigability, and nature of impact of the KP.

TABLE 1- Knowledge Problem Categorization

	Uncertainty	Equivocality	Ambiguity	Complexity	Risk
Determinants of Resolution	Passage of time	Can only be solved when it becomes complexity. For equivocality to become complexity, it must turn to public forums and social norms	Gathering more and better information	Application of correct tools; existing or new	Parametrization and decision-making
Solution sets	Agent-uncontrollable	Agent-uncontrollable	Agent-controllable	Agent-controllable	Agent-controllable
Role of Individual Characteristics in solving the KP	Low	Low	High	High	High
Mitigability	Low	Low	Moderate	Moderate-High	High
Nature of Impact	Generic	Generic	Agentic	Agentic	Agentic

KPs and Entrepreneurial Action

The ongoing discussion points to distinguishing the KPs based on their mitigability and the solution sets required to mitigate the KPs, thereby situating the KPs based on the role of individual-level characteristics in mitigating the unknowingness. Since the core of this theory is to determine how the KPs determine the substance of entrepreneurial action, I now shift towards explaining this wrinkle. I specifically situate my analysis of the substance of entrepreneurial action across two aspects: (a) quantity of entrepreneurial action, and (b) heterogeneity of entrepreneurial action. This is because, as a theory in response to exogenous changes, ranging from technological changes to socio-demographics, I seek to unravel to what degree these changes lead to heterogeneity in entrepreneurial action. Empirical evidence suggests that in understanding the impact of exogenous changes on entrepreneurial action, it is crucial to underscore any variation in entrepreneurial action arising from exogenous changes (e.g., Bennett, 2019; Chen et al., 2021; Manocha et al., 2022)

Of the five KPs, uncertainty and equivocality exhibit low levels of mitigability (Packard et al., 2017; Townsend & Hunt, 2019; Townsend et al., 2018).

Definitionally, both uncertainty and equivocality involve unknowingness that is largely generic and can only be addressed, respectively, through the passage of time or the emergence of new social norms, allowing the uncertainty of equivocality to be transformed—at least in part—into the KP of complexity, which can be addressed through existing or new analytical tools (Townsend et al., 2018; Zack 1999).

Mitigability through such means is arduous, and progress is elusive, meaning that individuals, firms, and even sectors may have little ability to influence actions and outcomes. For example, the existing laws of physics can only describe and predict approximately 5% of the matter in the known universe (Milgrom, 2002). Great uncertainty surrounds the other 95%, and drastically different, highly equivocal explanations dominate competing conceptions of how the universe was formed and has evolved.

Not all KPs face the same mitigability challenges as uncertainty and equivocality. Under the proper conditions, ambiguity, complexity, and risk are moderately to highly mitigable, meaning that they lend themselves to a wide variety of possible solution sets devised by individuals and organizations. This does not mean that these three KPs are easy to solve; rather, unlike uncertainty and equivocality, there are means by which the KP can be addressed (Townsend et al., 2018; Weick, 1993, 2015). As noted above, ambiguity refers to situations in which actors must determine whether the relationship between an action and outcome will hold in a vaguely defined environment. Skilled individuals can apply experience through analogizing and other sensemaking tools (Weick, 1993), resulting in a relatively high degree of mitigability. Similarly, a KP reflective of complexity involves a high degree of mitigability, though the proposed solution sets may be highly heterogeneous, and the level of mitigability varies from person to person.

The mitigability of the KPs determines the use of different tools (i.e., agentic and generic) in mitigating the KP. In terms of the substance of entrepreneurial action, I argue that *ceteris paribus*, the level of mitigability is deterministic of the substance⁸ of entrepreneurial action. This leads to the following proposition:

P3: *Knowledge problem mitigability determines the quantity and heterogeneity of entrepreneurial action.*

When faced with highly mitigable KPs, individuals will use their characteristics (e.g., specialized skills, knowledge, experiences) in undertaking entrepreneurial action leading to a greater quantity of entrepreneurial action, compared to when the KPs are less mitigable. Taking a step ahead, I argue that when faced with less mitigable KPs (i.e., under conditions of uncertainty and equivocality), no probabilistic outcomes exist, and there is coexistence of competing perspectives. As a result, entrepreneurial action emanates by acting upon these KPs. Alternatively, when faced with ambiguity, complexity, and risk, individuals can use the applied tools to mitigate these KPs. However, these KPs reflect an environment wherein consensus is reached, narrowing the possibilities of differentiated entrepreneurial action. As a result, there will be lower heterogeneity in entrepreneurial action.

⁸ In referring to the “substance” of entrepreneurial action, I take note of both the quantity and heterogeneity of entrepreneurial action. The quantity of entrepreneurial action includes the total number of new ventures created, business models employed, while the heterogeneity refers to the degree of diverseness across these ventures and business models.

Figure 2 explains the relationship between the mitigability of the KPs and the quantity of entrepreneurial action. The x-axis is knowledge problem mitigability, and the y-axis is the quantity of entrepreneurial action. The KPs are ordered from relatively low in mitigability (i.e., uncertainty and equivocality) to relatively high in mitigability (i.e., ambiguity, complexity, and risk) based on the solution sets and the role of individual agent characteristics in mitigating the knowledge problem. Whereas Figure 3 explains the relationship between the mitigability of the KPs and the heterogeneity of entrepreneurial action. In Figure 3, the x-axis is the mitigability of the knowledge problem, and the y-axis is the heterogeneity in entrepreneurial action.

FIGURE 2- Knowledge Problems—Mitigability and the Quantity of Entrepreneurial Action.

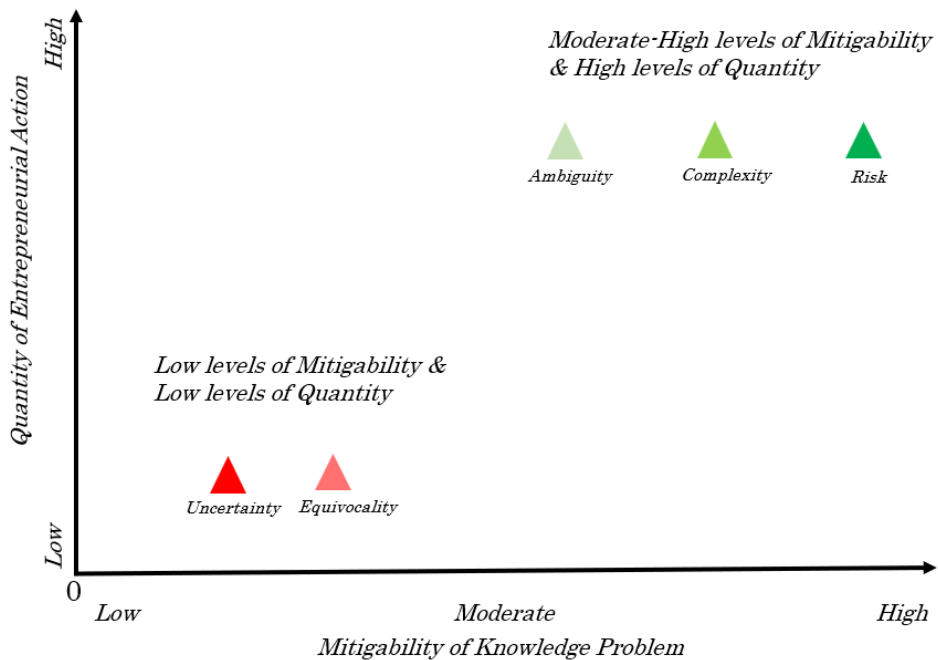
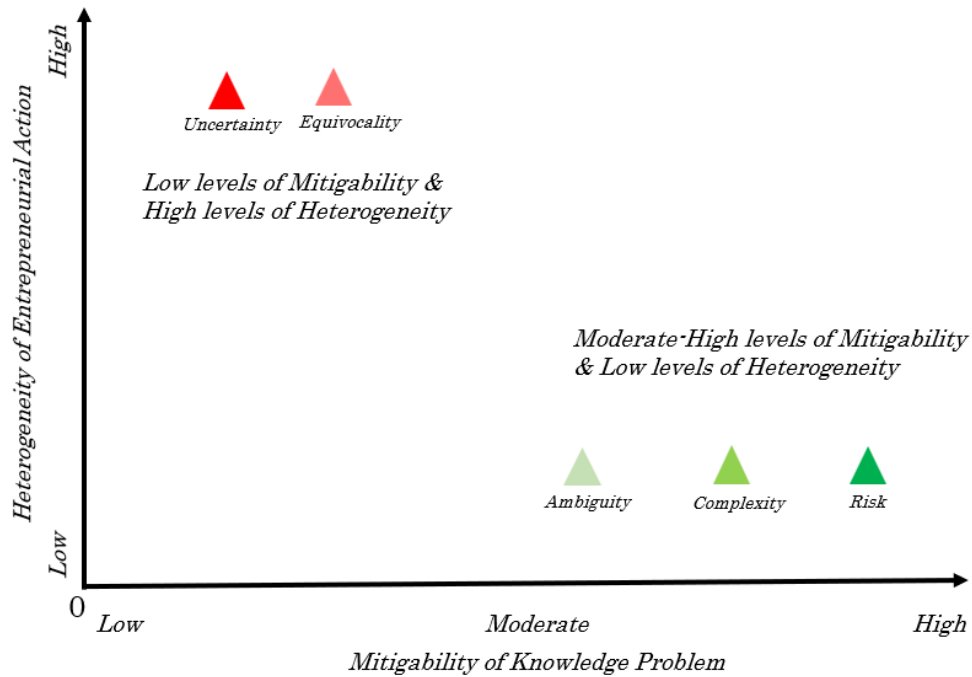


FIGURE 3- Knowledge Problems—Mitigability and the Heterogeneity of Entrepreneurial Action.



This leads to the following propositions:

P3a: *The higher level of mitigability of the knowledge problem, the higher the quantity of entrepreneurial action.*

P3b: *The higher the mitigability of the knowledge problem, the lower the heterogeneity in entrepreneurial action.*

External Environmental Change as a Generator of KPs

I started the theory by arguing for the role of external environmental changes as causes of KPs and then examined the relationship between KPs and entrepreneurial action. However, often, if not always, external environmental changes lead to a gamut of KPs rather than a single KP (Townsend et al., 2018).

While the ongoing discussion points to the relationship between KPs and entrepreneurial action, here I argue that it is imperative to understand the impact of different configurations of KPs on entrepreneurial action.

Thus, to study the impact of the configuration of KPs on entrepreneurial action, I introduce opacity. Simply put, opacity refers to “the fact of being difficult to see through” (OED, 2022). More broadly, across the study of management and organizations, opacity has been investigated through different lenses. Vicente-Lorente (2001) defined it as a property of strategic resources wherein “the absence of information to outsiders willing to exploit . . . [resource] to achieve . . . purposes” (p. 160). Cappellaro et al. (2021) referred to opacity as a type of ambiguity, defined as the “lack of a conceptual schema for interpreting what the organization is” (p. 10). Hannan et al. (2003) defined opacity as “limited foresight about interconnections among an organization’s units, and asperity, defined as normative restrictions on certain architectural features” (p. 400). While Wood et al. (2022) noted, “The effects of external change are shrouded in opacity” (p. 1). The common theme to each of these is that opacity is an obstruction to information—understanding, and interpretability.

In my theory, opacity refers to the degree of obstructiveness in understanding the impact of exogenous changes on entrepreneurial action. A high level of opacity would mean a higher level of difficulty in ascertaining the impact of exogenous changes on entrepreneurial action, whereas a low level of opacity would mean less difficulty in ascertaining the impact of exogenous changes on entrepreneurial

action. Thus, opacity can be thought of as a composition of KPs. As suggested before, exogenous changes lead to a series of KPs that constitute the opacity in discerning the impact of the exogenous change in entrepreneurial action and outcomes. Thus, in our model, opacity refers to the configuration of the KP generated by exogenous change. This leads to the following proposition:

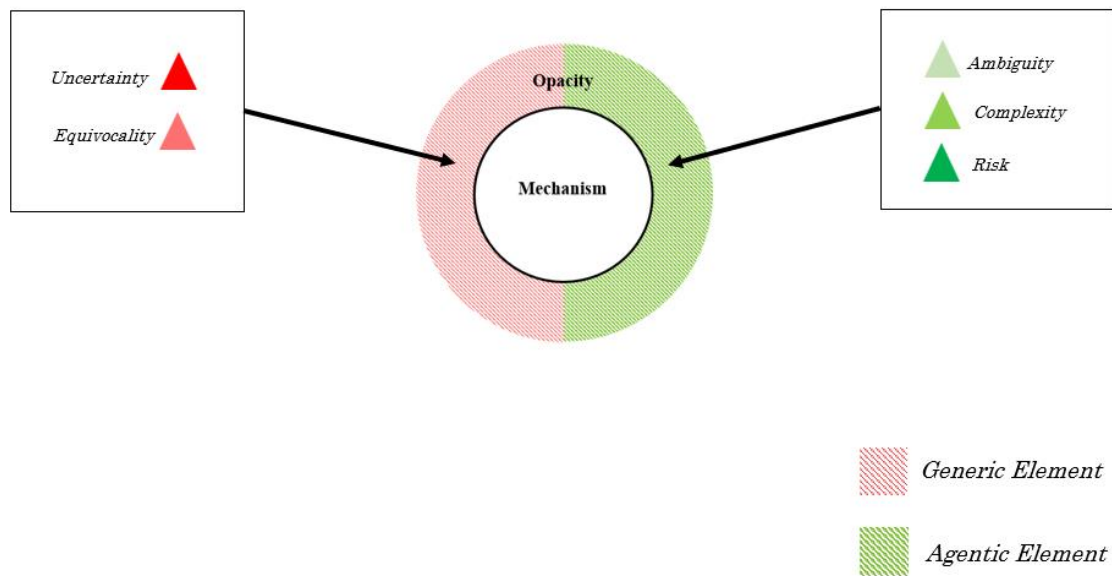
P4: *The extent to which KPs determine entrepreneurial action is determined by the opacity.*

While entrepreneurship research has acknowledged the presence of opacity in understanding the effect of exogenous changes on entrepreneurial action (e.g., Wood et al., 2022), understanding the composition of opacity is critical to understanding the processes through which opacity can be reduced or worked with. Thus, given that KPs vary in mitigability (proposition two), I argue that the composition of opacity is determined by the KP mix generated by the exogenous change. Simply put, understanding the nature of opacity entails understanding the configurational mix in terms of KPs. As suggested above, KPs vary in terms of mitigability. Thus, I argue that there can be three types of configurations: (a) a balanced split between highly mitigable and less mitigable KPs, (b) a high proportion of highly mitigable KPs, and (c) high composition of less mitigable KPs. Since the solution sets to mitigate the low mitigable KPs (i.e., uncertainty and equivocality) are actor-uncontrollable, therefore, these KPs are generic in their impact, and the KPs of ambiguity, complexity, and risk are actor-controllable, these KPs are agentic in impact (Table 1). I argue that opacity can be discerned as the relative composition of generic and agentic elements, where uncertainty and equivocality are the generic

element and ambiguity, complexity, and risk constitute the agentic element. The idea of a generic element of opacity is in congruency with the recent work by Chen et al. (2020), who argued that exogenous changes generate an impact that is not determined by the individual characteristics of the entrepreneur.

In a stylized fashion,⁹ Figure 4 represents opacity as a configuration of KPs. Opacity, in a stylized fashion, is shown as a relative composition of generic and agentic elements.

FIGURE 4- Opacity as a Configuration of Knowledge Problems

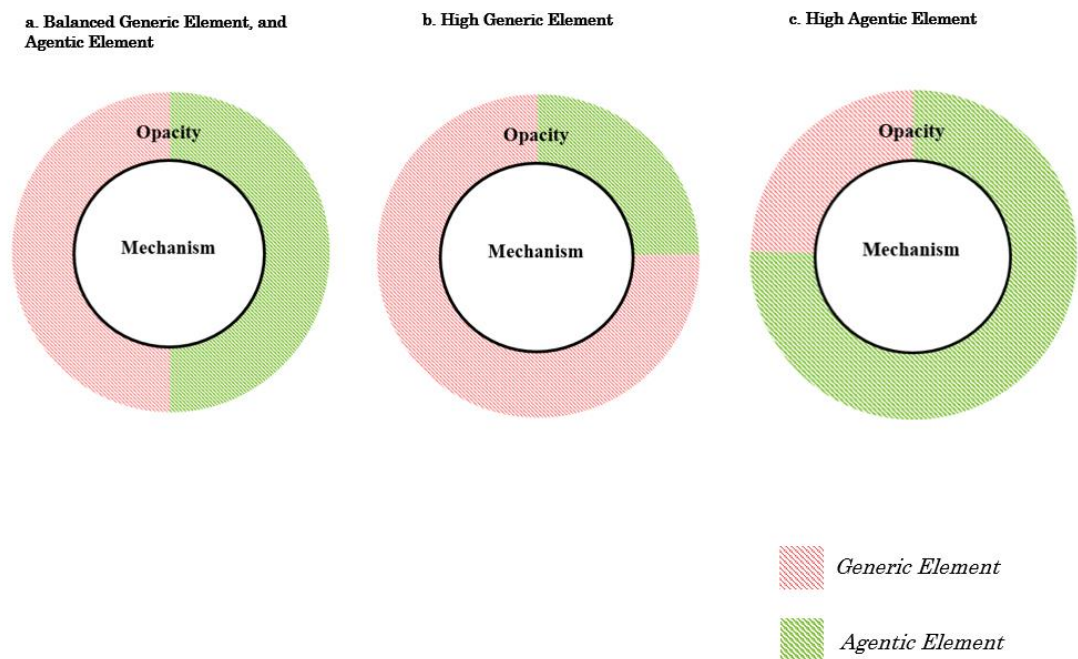


Further, it is important to note that the relative composition of generic and agentic elements can be of three types. The three conditions of the relative presence of generic and agency intensity are shown in Figures 5a, 5b, and 5c. In Figure 5a,

⁹ Here, the focus is to explain the composition and nature of opacity in terms of generic and agentic elements. However, opacity can and will vary in size as well. For brevity, I do not discuss this in this study.

opacity is composed of a balanced mixture of both high and low mitigable KPs, thus a balanced mix of generic and agentic elements. In Figure 5b, opacity is largely composed of low mitigable KPs, thus a high generic element condition, and finally, in Figure 5c, opacity is composed largely of highly mitigable KPs, thus representing a high agentic element condition.

FIGURE 5- Composition of Opacity



Next, I explain the relationship between opacity and the quantity and heterogeneity of entrepreneurial action. Extant research has shown that entrepreneurial action is low when individuals perceive higher levels of uncertainty (e.g., Foss & Klein, 2012). As a result, I argue that opacity composed of less

mitigable KPs (i.e., uncertainty and equivocality) will result in a lower quantity of entrepreneurial action. This leads to the following proposition:

P4a: *Opacity composed of less mitigable KPs will exhibit a lesser quantity of entrepreneurial action.*

Next, I explore the relationship between the less mitigable KPs and the level of heterogeneity of entrepreneurial action. Uncertainty pertains to conditions where it is difficult to predict outcomes from undertaking action (Knight, 1921) due to a lack of information (Mises, 1949). Further, research has shown that the conditions of equivocality marked with divergent perspectives increase divergence in interpretation, which leads to more diversity in action (Eriksson et al., 2016). Uncertain conditions lead to entrepreneurial action that is highly divergent until consensus is reached through intersubjectivity (cf. Autio et al., 2013). Thus, I argue that when opacity is composed of highly generic element, the heterogeneity¹⁰ of entrepreneurial action will be high. This leads to the following proposition:

P4b: *Opacity composed of less mitigable KPs will exhibit greater heterogeneity of entrepreneurial action.*

The preceding two propositions predict the relationship between opacity high in generic elements (i.e., opacity composed of less mitigable KPs). Next, I turn toward understanding the relationship between opacity that is high in agentic elements (i.e., opacity composed largely of moderately-highly mitigable KPs and the

¹⁰ In a similar fashion, Zhao et al. (2017) argued that in initial periods of an evolution of an industry, heterogeneity in entrepreneurial action by new entrants will be high.

quantity and heterogeneity of entrepreneurial action). Opacity that is high in agentic elements provides more room for individuals to use the tools in undertaking action. This leads to the following proposition:

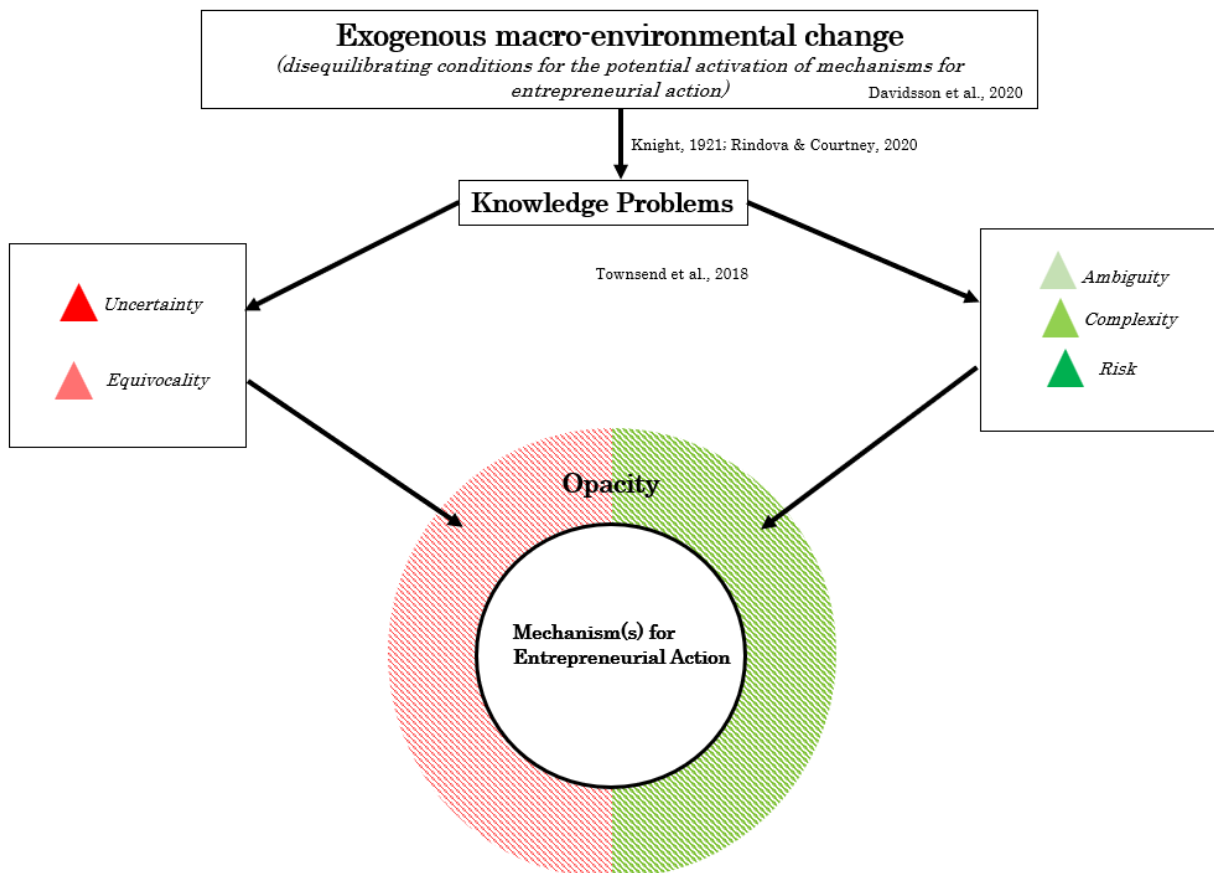
P4c: *Opacity composed of highly mitigable KPs will exhibit a greater quantity of entrepreneurial action.*

Next, I explain the relationship between opacity composed of agentic elements and the heterogeneity of entrepreneurial action. Simply put, when faced with the opacity high in agentic elements, the raw materials, in this case, are the KPs of ambiguity, complexity, and risk, which are vastly different from those available under KPs of uncertainty and equivocality. Extant work has shown that while action is highly differentiated under less mitigable KPs (e.g., Zhao et al., 2017), action becomes less differentiated as more information is generated and existing information is refined. Undertaking action under such conditions results in fewer possibilities of highly divergent entrepreneurial action. This is because opacity, composed of the KPs of ambiguity, complexity, and risk, relate to varying degrees the different possibilities that can arise from undertaking action. Even though individuals can apply their own characteristics in working through this opacity, the variation in entrepreneurial action is limited by the “raw materials” offered by the environmental changes. As individual entrepreneurs act to mitigate these KPs, dominant designs emerge, thereby leading to less differentiated action (Zhao et al., 2017). Consequently, I argue that entrepreneurial action under conditions of opacity marked with high agentic elements will generate homogeneous entrepreneurial action. This leads to the following proposition:

P4d: *Opacity composed of highly mitigable KPs will exhibit lower heterogeneity of entrepreneurial action.*

While the conceptual model developed in this study, along with the propositions, is provided in Figure 1, Figure 6 provides the conceptual model in a stylized fashion. The integrated model (Figure 6) suggests the role of exogenous change as a generator of KPs. These KPs vary in mitigability, which dictates the nature of opacity. The opacity determines the substance (i.e., the nature and heterogeneity of entrepreneurial action).

FIGURE 6- The Integrated Model



DISCUSSION

In line with the epitaph at the outset of this theoretical treatment, entrepreneurship scholarship has suggested that external environmental changes impact entrepreneurial action and outcomes (e.g., Hiatt et al., 2009; Ramoglou & Tsang, 2016). Entrepreneurship scholars have sought a deeper understanding of the manner in which macro-environmental factors impact the rate, substance, and fate of entrepreneurial action (Gnyawali & Fogel, 1994), yet little of this work permeated core theories of new venture formation. The lack of a strong theoretical toolbox necessitates the development of “meso-level studies—diamonds that should no longer be hidden in plain sight” (Kim et al., 2016, p. 286). The difficulty is that the effects of external changes are, to varying degrees, unknown (Wood et al., 2022). As disequilibrating changes, exogenous changes generate KPs. The explanation of the different KPs (cf. Townsend et al., 2018) presented in this study offers a typology of the KPs in terms of the nature of solution sets and the level of mitigability. Fundamentally, the model produces insights into the causes and consequences of the KPs in entrepreneurial action theory. By asserting the role of macro-level changes as the causes of KPs, and entrepreneurial action as a consequence, the developed model provides a meso-level theory. Crucially, the study theorizes on the wide spectrum of KPs (Townsend et al., 2018), moving the contemporary discussion in entrepreneurship beyond mere uncertainty. Next, I discuss the contributions the theory developed in this study joins.

Scholarly Contributions

This paper's theoretical model and propositions contribute to several interconnected literatures. First, through a series of testable propositions on the role of KPs as a causal link between the macro environment and entrepreneurial action, the theory developed in this study increases the predictive capability of the KP framework and elevates it to a theoretical standing. The extant work on the KP framework has offered insights into the different types of KPs (Mitchell et al., 2022; Rindova & Courtney, 2020) and the critical role of detecting actual KPs (Hunt et al., 2022). Yet, there is a lack of comprehensive work on KPs. By offering a nuanced conceptualization of different KPs, the study articulates the differences among the KPs and offers much-needed clarity on the difference between uncertainty and other KPs. Over a century after the publication of Knight's (1921) seminal work: *Risk, Uncertainty and Profit*, the scholarly attention in entrepreneurship concerning the meaning and impact of the uncertainty construct on entrepreneurial action is voluminous yet inconclusive. Existing research has established that entrepreneurial action takes place under conditions of uncertainty (McMullen & Shepherd, 2006). Following this, entrepreneurship research has documented a series of ways through which entrepreneurs act under uncertainty (e.g., Fisher et al., 2020; McMullen & Shepherd, 2006), leading to concerted efforts to clarify the role of uncertainty as it continues to unfold (Packard & Clark, 2020; Packard et al., 2017). Given the broad scholarly and popular usage of "uncertainty" in all its varied forms, the term uncertainty is used even when actual unknowingness is one of the

other KPs. For instance, Holm et al. (2013) noted,¹¹ “Entrepreneurs face multiple dimensions of uncertainty, both nonstrategic and strategic. We focus on risk and ambiguity to examine nonstrategic forms of uncertainty” (p. 1672). Through a comprehensive conceptualization of the five KPs, this study offers conceptual clarity for scholars to account for different types of unknowingness in theories of entrepreneurial action. This way, the study responds to calls for a nuanced understanding of uncertainty and other KPs (Ramoglou, 2021). Research has examined ways to mitigate KPs, including equivocality, by resorting to communication media (e.g., Daft & Lengel, 1986) as an antecedent for performance. Similarly, the theory developed here argues for KP identification and mitigation as an antecedent for entrepreneurial action and outcomes arising from exogenous change.

Second, the theory developed in this chapter contributes to understanding the relationship between exogenous changes and entrepreneurial action. Following Sarason et al. (2008), the study argues that while much entrepreneurship work focuses on either the entrepreneur or the environment, neither of these streams explicitly explains entrepreneurship, necessitating the development of a meso-level entrepreneurship theory. Meso-level theories sought to explain the “puzzling phenomena and create solid new knowledge” that can lead to good science (Boudon, 1991, p. 522). As Mark and Henry (2004) noted, “Current models of use are generally silent on the range of underlying mechanisms through which evaluation

¹¹ In a parallel fashion, Strzalecki (2013) used uncertainty as an umbrella term for risk and ambiguity.

may have its effects” (p. 37). Through the development of a theoretical model, the study closes the aforementioned gap in the sphere of entrepreneurship research. Early theories of entrepreneurship primarily focused on the role of the macro environment insofar as entrepreneurs were considered “arbitraguers.” Over the years, scholarship has suggested, “Agency is the starting point for entrepreneurship” (Stam & Welter, 2020). Nelson and Winter (1982) argued, “adequacy of a theory of firm and industry behavior should be assessed . . . As the response of firms and industry as a whole to exogenous change” (p. 24). Driven by the lack of systemic effort in this regard, the chapter provides a theory in response to exogenous changes, thereby providing a top-to-bottom approach to understanding individual-level entrepreneurial action. As Bacharach (1989) argued, the core of any theory lies in its ability to explain and predict: “The theory should provide a mechanism for predicting beyond chance” (p. 510). Further, theories should seek to answer what, how, and why questions (Whetten, 1989). Through a series of testable propositions, the theorizing demarcates the external environment as an “engine room” for KPs and entrepreneurial action providing a promising setting to extend the entrepreneurial action theory.

Third, the study offers a concrete way to understand the causal linkage between the macro and micro levels in entrepreneurship in the form of KPs. This way, the study offers a theoretical toolkit to integrate entrepreneurship scholarship that has largely been tilted toward either a macro- or micro-level analysis. The idea that understanding mechanisms is fruitful for entrepreneurship research is

intuitive (e.g., Berglund & Korsgaard, 2017), yet little theoretical work has been done in this regard. In fact, there have increasingly been calls to study “how” entrepreneurial action is affected. The theory put forth in this paper takes a step in this direction by untangling the role of mechanisms. Recent research has highlighted that understanding the influence of exogenous changes on entrepreneurial action may not be immediately clear and that some potential entrepreneurs might be unable to undertake action due to cognitive constraints (Wood et al., 2022). However, research does not provide a solid understanding of why cognitive abilities might be constraining. Toward this end, the theory developed in this paper takes a step further by identifying KPs as the constituents of the opacity and explains the situations (i.e., under conditions of ambiguity, complexity, and risk) where the lack of tools, including cognitive abilities are constraining in undertaking entrepreneurial action, I provide a complete picture of the unknowingness.

Next, to the growing empirical research in entrepreneurship that has sought to explain the relationship between exogenous changes and entrepreneurial action, this study provides a rich theoretical grounding. While studies (e.g., Bennett, 2019; Chen et al., 2020; Korsgaard et al., 2020; Manocha et al., 2021) have provided empirical evidence of the heterogeneity of entrepreneurial action based on dimensions, such as gender, sector, and time, a common theoretical grounding has largely been missing. Given that inequity in entrepreneurship from exogenous changes is persistent (Lippman et al., 2005), this study injects theory into this line

of work by identifying and explaining the causes of heterogeneity in entrepreneurial action and outcomes. This way, the theory developed here offers a novel conceptualization of open questions pertaining to heterogeneity in entrepreneurial action and outcomes (Bennett, 2019; Manocha et al., 2021). Accumulating insights by linking the macro-environmental changes to entrepreneurial action, much of the theory developed here deals with explaining heterogeneity as the interplay between the generation of KPs by exogenous change and the idiosyncratic mitigation of the knowledge problem by individual entrepreneurs and firms. Finally, understanding how and why the exogenous changes impact entrepreneurial action requires a robust explanation of the complex and dynamic nature of KPs generated by the exogenous changes. This theory asserts the role of actor-controllable and uncontrollable solution sets, thereby providing interplay between structure and agency in entrepreneurial action (Grillitsch, 2017; Lee & Jones, 2015). At a broader level, the theory developed in this paper offers to reconcile benefits to existing entrepreneurial action theories such as creation, discovery, and effectuation and bricolage. Extant entrepreneurship research has been heavily focused on understanding the role of agent characteristics in undertaking entrepreneurial action by shifting the needle toward the macro environment. This chapter provides a theory in response to exogenous changes. As a result, macro-environmental change is the starting point of this theory.

Practical Implications

Conditions favorable to new venture formation often come in the form of macro-environmental changes that lie beyond the direct control of individuals. In fact, recent history has delivered a virtual onslaught of such impacts, including Brexit, COVID-19, new and old wars, racial tensions, wildfires, and the emergence of platform technologies that support heretofore unimaginable forms of commerce—each of which has materially altered the landscape of entrepreneurial actions and outcomes. For prospective entrepreneurs, exogenous changes vary dramatically in the nature and extent of their respective KPs. The ability and willingness to address KPs determine an EE's impact on entrepreneurial actions and outcomes. Like all new tools and resources, some are readily put to use, while others have a more elusive set of purposes. The model developed in this chapter seeks to provide a theory to understand when and how these KPs can be mitigated. Fundamentally, it is imperative for the potential entrepreneur to align the toolset with the actual need, as suggested by the unknowingness generated by environmental change. Going a step further, it is crucial to understand that mitigating the KPs can lead to a variety of entrepreneurial decisions related to venture creation, venture performance, venture scaling, implementation of business models, and others.

The theory developed here offers a novel and precise toolkit to understand the heterogeneity of entrepreneurial action and outcomes from exogenous changes. Given that a key outgrowth of the model is the presence of heterogeneity in entrepreneurial action, the theory's predictions are crucial to policymakers. While,

to the policymakers, entrepreneurship is seen as an engine of economic growth (Acs & Szerb, 2007), inequities are a key outgrowth of entrepreneurship (Lippmann et al., 2005). Exogenous change can deepen the existing inequalities across cohorts of entrepreneurs at local, regional, national, and international levels. In fact, the COVID-19 pandemic has contributed to the first increase in global income disparity in a generation (Sustainable Development Goals Report, 2022). Policymakers around the globe are interested in closing inequities, including gender inequities, arising from exogenous changes, as is evidenced by the sustainable development goals (Sustainable Development Goals Report, 2022). It is critical to note that exogenous changes, including rule changes and policy measures to improve infrastructure aimed to promote entrepreneurship, can, in fact, lead to unequal distribution in terms of entrepreneurial action, thereby exacerbating the inequity in society (Manocha et al., 2021), if not supported by additional measures. Toward this end, I hope that the prediction of the model sensitizes policymakers to the need for additional mechanisms that can promote equality in entrepreneurship that aligns with the ultimate goal of equity.

Future Research Directions

The parsing of how external changes affect entrepreneurial action through the mitigability in the KP framework opens new vistas for future research. While this chapter provides a theory in response to exogenous changes within a framework of entrepreneurial action, it can be deployed to understand the impact of exogenous changes on a variety of outcomes that are of key interest to management

and entrepreneurship scholars. First, research can borrow ideas from this theory to understand entrepreneurial action in organizations in response to exogenous changes. Zack (2001) noted:

The taxonomy of knowledge problems presented here is an attempt to refine our thinking about knowledge, the problems it poses, the opportunities it creates, and the approaches required to create, manage and exploit it. The truly knowledge-based firm must maintain the capability to handle the entire scope of knowledge problems. (p. 31)

For instance, by investigating the impact of 9/11 attacks on globalization, Li and Tallman (2011) suggested the importance of understanding context in understanding firm performance by noting, “MNCs still can benefit from international diversification and from their ability to absorb information and knowledge to achieve superior performance” (p. 1126). Thus, the propositions developed in this study can be applied to understand how different organizations cope with the multitude of KPs posed by exogenous changes. The propositions developed in this study can be used as guides for future research questions in management and organizational research.

Research in strategic management on knowledge (e.g., Foss et al., 2010; Kogut & Zander, 1992) has provided for mechanisms such as the creation and sharing of knowledge as a source of competitive advantage (Dyer & Nobeoka, 2000; Tallman et al., 2004). To this body of work, future research could add the boundary condition of exogenous changes and ask: “Does knowledge sharing between firms mitigate knowledge problems emerging from exogenous changes?” Taking a step ahead, scholars could ask: “How does it impact firms’ performance?” “Is the effect uniform?” “Are there any situations where less knowledge sharing to mitigate KPs

is more conducive to a firm's performance?" Further, international business literature has suggested that knowledge acquisition by accessing and sourcing varies based on institutional contexts, resulting in different outcomes in terms of research and development (Awate et al., 2014). Toward this end, future work could ask: "How does the mode of knowledge acquisition impact entrepreneurial decisions such as entry into new market?" Further, scholars have been interested in exploring knowledge connectivity across firms and locations (Cano-Kollmann et al., 2016). In this vein, future studies could ask: "How can locally available resources foster knowledge connectivity in mitigating knowledge problems?"

As Townsend et al. (2018) noted, "Even within firms, differing tempos exist" (p. 679). Pointing to the pace at which KPs are addressed within firms, the insights from this study can inform future research in this regard. For instance, future researchers could ask: "How do organizations identify and mitigate knowledge problems?" Further, at a micro level, while researchers (e.g., Carter et al., 2003) have explored the behavioral and cognitive factors impacting the decision to start a business, based on the model developed in this paper, future work could address the role of individuals' cognitive factors in mitigating the KPs generated by exogenous changes.

Essentially, this study builds a theory that argues for KPs as a cause of exogenous changes, consequently leading to heterogeneity in entrepreneurial action. KPs are "*multi-level, multi-dimensional, multi-temporal*" in nature, noted Townsend et al. (2018, p. 678, italics and bold in original). Toward this end, future

scholarship can seek to explore KPs across the three aspects to unravel heterogeneity in entrepreneurial action. For instance, studies could ask: “Do different stakeholders in the entrepreneurial landscape (i.e., investors, entrepreneurs, and policymakers) face different knowledge problems?” Entrepreneurship industry scholars could investigate the impact of exogenous change by investigating stakeholders’ KPs within an entrepreneurial ecosystem. Further, studies could ask: “Do knowledge problems emanating from an exogenous change vary across the potential entrepreneurs?” For instance, the analysis of a readily identifiable rule change, such as the NCAA’s rule change¹² on the use of NIL, could be used to investigate if and how potential entrepreneurs (college athletes) face similar or different KPs and identify the impact on entrepreneurial outcomes. Further, given the multi-temporal nature¹³ of KPs, scholars could ask: “Do knowledge problems emanating from an exogenous change vary across periods?” To address this, scholars could undertake an in-depth analysis of ventures over time.

Weick (1993) suggested that no theory can simultaneously achieve all three dimensions: generalizability, simplicity, and accuracy. Given the challenge to strike a balance between these three dimensions and the specific need of the research question, a deliberate constraint of this study is that the identified cause of KPs is the external environment. However, KPs can exist endogenously to an

¹² The next chapter (Chapter 3) delves into an empirical investigation of NCAA’s rule change on the use of name, image, and likeness, suggesting that KPs are multi-dimensional.

¹³ Chapter 4 undertakes an examination of a gradually evolving exogenous change to underscore the multi-temporal nature of KPs.

entrepreneur. As a result, KPs can have a broader spectrum in terms of origin. In this vein, I urge future researchers to explore and identify other sources of KPs. Extant entrepreneurship research has established that heterogeneity in entrepreneurial action can be both individual and context dependent (Kuechle, 2011). Applying the key insights from this theory to future work on the endogenously formed KPs and their role in entrepreneurial action offers a credible pathway for refining, generalizing, and comprehending the developed theory.

Further, there are opportunities for research on other streams of literature within entrepreneurship. For instance, research on entrepreneurial ecosystems has suggested the role of macro-environmental factors (e.g., culture, legal systems) in impacting the ecosystem (e.g., Susan & Acs, 2017). Entrepreneurial ecosystems consist of a variety of interconnected actors (Acs et al., 2017; Cavallo et al., 2019), including suppliers, customers, government, professional services, and incubators that result in entrepreneurship (Acs et al., 2017; Miller & Acs 2017). Future empirical studies could ask: “Do knowledge problems vary across or within the stakeholders?” According to Cavallo et al. (2019), “Experimenting with business models is facilitated in an entrepreneurial ecosystem since entrepreneurs can create and capture value by interacting with the key entrepreneurial ecosystem actors” (p. 1306). Future studies can borrow insights from the theory developed in this study to extend work on ecosystems.

At a micro-level, scholars in entrepreneurship have focused on neurodiversity toward understanding entrepreneurship as a bridging context for mental health

inquiries (Gish et al., 2021). Research has suggested that individuals with ADHD possess attributes that can lead to creativity (Short et al., 2010), which can benefit entrepreneurs (Shirokova et al., 2022). However, in another line of work, ADHD has been shown to negatively impact entrepreneurial action (Vörös & Lukovszki, 2021). Gish et al. (2022) suggested that while understanding the relationship between ADHD and entrepreneurship is timely, it is complex. For instance, studies have shown that individuals with ADHD symptoms may have a higher passion for entrepreneurship (Hatak et al., 2021). Future studies could ask: “How does ADHD influence knowledge problem mitigability?” “Are entrepreneurs with ADHD better at knowledge problem mitigability?” “Does it lead to improved entrepreneurial outcomes?”

Conclusion

Recently, entrepreneurship scholars have embarked upon a broader and deeper consideration of exogenous shocks and their impact on entrepreneurial action (Bennett, 2019; Chen et al., 2020; Wood et al., 2022). As a result, this has sparked scholarly interest in linking the macro-level factors to the micro-level entrepreneurial action (Cowen et al., 2022). In this paper, the theory developed argues for entrepreneurial action, an incessant interplay between individuals and the macro environment (Davidsson, 2015), as a cause and consequence of the KP dynamics. The theory developed in this paper provides a typology of KPs, unraveling the causes and consequences of KPs regarding entrepreneurial action. Given the vibrancy, range, and significance of the KP framework in

entrepreneurship research, further advancement necessitated moving from mere description to elaboration and explanation (Bunge, 2004). The theory developed in this essay opens new vistas to understand KPs as emanating out of exogenous changes, resulting in entrepreneurial action, thereby providing a meso-level theory for entrepreneurial action. The theorization reaffirms the importance of change that Ridley alluded to in the epitaph but goes even further in demonstrating precisely why and how external changes elicit entrepreneurial action, offering a theoretical toolkit for entrepreneurship research. Given that mechanisms provide a pathway to understanding causality (Machamer et al., 2000), the central assertion is that KPs are a mechanism of entrepreneurial action, the resolution (or irresolution) of which becomes a determinant of entrepreneurial action and outcomes.

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CHAPTER THREE

**EXOGENOUS CHANGE, MULTI-DIMENSIONAL KNOWLEDGE PROBLEMS,
AND THE HETEROGENEOUS ENTREPRENEURIAL ACTION AND
OUTCOMES: EXPOSITION OF NAME, IMAGE, AND LIKENESS**

EXOGENOUS CHANGE, MULTI-DIMENSIONAL KNOWLEDGE PROBLEMS, AND THE HETEROGENEOUS ENTREPRENEURIAL ACTION AND OUTCOMES: EXPOSITION OF NAME, IMAGE, AND LIKENESS

INTRODUCTION

Long seen as an important predictor of entrepreneurship (e.g., Gnyawali & Fogel, 1994), the exogenous environment is increasingly considered a focal predictor of entrepreneurial actions and outcomes, as is evidenced by the renewed scholarly interest focused on conceptualizing the role of exogenous changes in entrepreneurship research (e.g., Chen et al., 2020; Davidsson et al., 2020; Wood et al., 2022). While exogenous changes can span a broad spectrum of technological, demographic, and natural-environmental changes (cf. Davidsson et al., 2020), institutions and the associated changes have been of key interest to scholars (Bjørnskov & Foss, 2016; Bradley & Klein, 2016; Urbano et al., 2019). Institutions, as “rules of the game,” exert influence on economic activities, including entrepreneurship (North, 1990, p. 3). Entrepreneurship research has extensively investigated the relationship among institutions, entrepreneurial action, and outcomes (Acemoglu et al., 2010; Acs et al., 2008; Baumol, 1996; Scott, 1994). Institutions include formal ones, such as property rights (Fuentelsaz et al., 2015), and informal ones, such as cultural values (Krueger et al., 2013) that can impact the rate, intensity, and nature of entrepreneurial action. The relationship between institutions and entrepreneurship is complex, as changes in institutions can lead to heterogeneity in entrepreneurship (Baumol, 1996). Fueled by the growth of the rich theoretical frameworks (e.g., Baumol, 1996; North, 1990; Scott, 1994) and the

widespread availability of datasets such as the Global Entrepreneurship Monitor and World Development Indicators, empirical work in entrepreneurship has sought to examine the complex relationship between institutions and entrepreneurship (e.g., Estrin et al., 2012; Fredström et al., 2021; Hechavarria et al., 2019), suggesting that institutions can facilitate and inhibit entrepreneurial action (Bourdeaux et al., 2019; Boudreaux & Nikolaev, 2019; Fredström et al., 2021).

Yet, a complication arises because exogenous changes do not uniformly impact all entrepreneurs, resulting in a differential effect on entrepreneurial action (Bennett, 2019; Chen et al., 2020; Manocha et al., 2021). Seminal work by Baumol (1996) offered a taxonomy of entrepreneurship arising from institutional change, underscoring the heterogeneity in entrepreneurship at a macro level (cf. Sorgner & Wyrich, 2022). However, taxonomy omits the possibility that heterogeneity can exist simultaneously—between and across different cohorts of entrepreneurs. Consequently, studies have not accounted for the simultaneous differential effects on entrepreneurial action and outcomes arising from institutional changes. This complication is of chief concern because institutional change, as an exogenous change, leads to uncertainty (Bylund & McCaffrey, 2017; McMullen & Shepherd, 2006) and other knowledge problems (KPs) (Rindova & Courtney, 2020; Townsend et al., 2018). KPs refer to the different types of unknowingness in decision-making and assessment when undertaking action (cf. Townsend et al., 2018). KPs are “*multi-dimensional*” (Townsend et al., 2018, p. 678, italics and bold in original). Identifying and mitigating these KPs can lead to heterogeneity in entrepreneurial

action (Manocha, 2022) and outcomes (Hunt et al., 2023). As a result, emergent research on the KP framework provides a potent avenue to explore heterogeneity in entrepreneurial action and outcomes in the light of institutional change.

One of the most recent institutional changes that has spurred a gamut of entrepreneurial action and outcomes is the NCAA's rule change on the use of name, image, and likeness (NIL) by college athletes. Practically overnight, college athletes all around the country began deploying an array of business models in various product and service industries—clothing lines, company endorsements, enhanced online promotional events, music gigs, art showings, brand ambassadorships, jewelry portfolios, make-up lines, and a cavalcade of other new business ideas—monetized through every conceivable conventional channel and digital platform, including TikTok, Twitter, and YouTube. Some of the early deals were extraordinarily lucrative; for instance, it has been reported that first-year quarterback Bryce Young of the University of Alabama immediately signed a million-dollar endorsement deal before he even stepped on the field for his first game.

Driven by the theoretical consideration and the timely need to address the aforementioned gap, the research question that this study asks is: *What explains heterogeneity in entrepreneurial action and outcomes arising from an institutional change?* To answer this research question, I integrate insights from the KP

framework offered by Townsend et al. (2018). Scholarship has identified five¹⁴ types of KPs that entrepreneurs can encounter. The KP framework offers an ideal vehicle to address the research question, primarily on the following grounds: (a) the KP framework describes the problems associated with identifying correct tools in mitigating unknowingness in the light of exogenous changes, and (b) accounts for heterogeneity in entrepreneurial action and outcomes, due to different pairings between the actual and perceived KP. Thus, in line with Rindova and Courtney (2020) and Manocha (2022), I argue that as an exogenous change, the institutional change governing NIL creates an identifiable set of multi-dimensional KPs. As a result, the solution sets required to mitigate these KPs vary (Townsend et al., 2018). To empirically test the hypotheses, the data were drawn through an electronically distributed IRB-approved survey to college athletes at over two dozen colleges and universities across each of the three NCAA divisions. Crucially, the study's findings suggest that the multi-dimensional nature of KPs faced by college athletes leads to heterogeneity in entrepreneurial action and outcomes.

This study contributes to literature in the following ways. First, the study argues that the resolution of a given KP is determined by matching the correct tool to the nature of the KP faced by the potential entrepreneur. This way, the study joins recent work (e.g., Hunt et al., 2023) in the KP research area (Townsend et al., 2018). Crucially, by showing the consequences related to the multi-dimensional nature of KPs, in terms of the heterogeneity in entrepreneurial action and

¹⁴ While Townsend et al. (2018) identified four KPs—uncertainty, equivocality, ambiguity, and complexity—subsequent works have considered risk the fifth KP (e.g., Manocha, 2022; Mitchell et al., 2022).

outcomes, this study responds to the call by Townsend et al. (2018). Following the work by Townsend et al. (2018), scholars have increasingly noted the presence of different types of KPs (e.g., Fisher & Neubert, 2022; Scazziota et al., 2023), while a nuanced approach that provides an empirical investigation remains an uncharted research niche. Toward this end, the study undertakes an empirical investigation of the different KPs and suggests the simultaneous existence of different KPs. As a result, the study's findings contribute to the advancement of understanding the multiplicity of KPs and provides important implications for the persistent variance in entrepreneurship following an exposition (e.g., Bruton et al., 2021; Lippmann et al., 2005; Thébaud, 2015). Second, the study adds insights to the extant literature that seeks to explain the relationship between institutions and entrepreneurship (e.g., Urbano et al., 2019). Scholarship has suggested that the relationship between institutions and entrepreneurship is complex (e.g., Fredström et al., 2021). To this, the study offers a fresh perspective by arguing for institutional change as a gamut of KPs faced by potential entrepreneurs whose resolution (and irresolution) leads to variance in entrepreneurial action. By arguing for institutional change as a source of KPs, this study joins recent work in this regard (Bylund & McCaffrey, 2017). Third, since the study specifically investigates the modern-day institutional change—NIL—the tools are the modern-day resources—the entrepreneurship industry and digital technologies. This way, the study enhances the role of these resources in entrepreneurship, thereby joining recent conversations in entrepreneurship (e.g., Hunt & Kiefer, 2017; Nambisan, 2017). Relatedly,

examining heterogeneity following a timely institutional change, the findings highlight a societal challenge related to inequality. Thereby, the study responds to the call for relevancy in entrepreneurship research (Wiklund et al., 2019).

Fourth, this study seeks to explain the role of NIL—an exogenous change on individual-level entrepreneurial action. By linking the macro-level factors to micro-level entrepreneurial action, the study enriches scholarship in this regard (e.g., Cowen et al., 2022; Kim et al., 2016). Next, entrepreneurship researchers face challenges related to a lack of data on firm failures and exits. Using a survey design, the study is able to reach out to college athletes who are undertaking action, those who have exited, and potential entrepreneurs who have not undertaken action. This way, the study injects critical insights into entrepreneurial non-occurrence and exit, thereby responding to calls for empirical work in this regard (e.g., Jayawarna et al., 2021). Finally, from a practical viewpoint, the findings report the heterogeneity of outcomes arising from the NIL rule change. Given that the population is half a million college athletes enrolled in degree-granting institutions that intend to provide an equitable platform, the presence of heterogeneity can be of key interest to present and prospective college athletes, coaches, universities, businesses, and policymakers.

THEORY AND HYPOTHESIS DEVELOPMENT

The essence of this study involves establishing a nuanced relationship between institutional change and entrepreneurship to uncover the presence of heterogeneity of entrepreneurial action and outcomes. As stated at the outset, one of the seminal papers in entrepreneurship that sparked the notion of heterogeneity in entrepreneurship arising from institutional change was by William Baumol (1996). Institutional change, as an exogenous source of influence, leads to uncertainty (Bylund & McCaffrey, 2017), and other KPs (Manocha, 2022; Rindova & Courtney, 2020). KPs are multi-dimensional in nature (Townsend et al., 2018). As a result, different types of KPs can result in heterogeneous venture-related actions and outcomes (Kuratko et al., 2017). Therefore, understanding the relationship between KPs, and their impact on entrepreneurial action and outcomes is key for entrepreneurship research. To do so, I first offer a brief review of extant research on institutions and entrepreneurship, including the explanation of Baumol (1996). Next, I delve into the consequential heterogeneous entrepreneurial action by anchoring into contemporary research in entrepreneurship.

Institutions and Entrepreneurship

Institutions exert enormous impact in generating and/or inhibiting entrepreneurship (cf. Acs et al., 2008). Defined by North (1990) as the “rules of the game,” institutions create payoffs for economic activities, including entrepreneurship (Boettke & Coyne, 2009). Scholarship has investigated the impact of formal and informal institutions on entrepreneurship. Formal institutions

include the political and economic factors affecting entrepreneurship, such as the rule of law (e.g., Agostino et al., 2020). In this regard, research has shown that formal institutions, such as property rights, business freedom, and financial capital can influence entrepreneurship (Fuentelsaz et al., 2015; Sahasranamam & Nandakumar, 2020). Drawing on the Global Entrepreneurship Monitor¹⁵ (GEM) data show that the different types of institutions result in different entrepreneurship rates between countries (Urbano & Alvarez, 2014). While informal institutions refer to the norms and cultural values that can influence entrepreneurship. In this line, studies have underscored the impact of informal institutions (e.g., uncertainty avoidance), perceptions toward entrepreneurship, on entrepreneurial action (Fuentelsaz et al., 2019). Williams and Vorley (2015) by undertaking a joint examination of formal and informal institutions suggested that informal and formal institutions are important for facilitating entrepreneurship. Recent work by Hechavarria et al. (2023) taps into the uncertainties created by institutional changes and suggests that institutional changes impact entrepreneurship. Further, scholarship has suggested that factors such as media coverage, fear of failure, and entrepreneurial alertness can explain the differences in entrepreneurship across countries (Apracio et al., 2021). Scholarship has shown the effects of institutions on the types of entrepreneurship. For example, Alwakid et

¹⁵ GEM is a data repository to study cross-country entrepreneurship. It is based on a survey of a representative population across different countries. The wide availability of GEM data has been pivotal in the empirical investigation of the cross-country entrepreneurship differences due to factors, including institutions.

al. (2020) show that factors such as environmental consciousness increase green entrepreneurial activity.

Scholars have increasingly noted the heterogeneity of entrepreneurs based on factors such as gender, race, ethnicity, nationality (e.g., Ardagna & Lusardi, 2009; Lee & Easley, 2018). Following this, research has established the presence of variation in entrepreneurial activity emanating from institutional changes. For instance, Petriduo et al. (2009) show that existing gender norms can influence entrepreneurship education, thereby leading to a gender gap in entrepreneurial activity. Further, research has shown that the availability of institutional arrangements such as paid leave can increase the opportunity cost of entrepreneurship as a career choice, thereby exacerbating the gender gap in entrepreneurship (Thébaud, 2015). In addition, scholarship has sought to understand the impact that institutional arrangements can have on different types of entrepreneurs (e.g., formal and informal) (Thai & Turkina, 2014), the value creation goals (Hechavarria et al., 2017). Further, studies have shown that institutional predictors such as culture impact the necessity- and opportunity-based¹⁶ entrepreneurship (Hechavarria & Reynolds, 2009; Van der Zwan et al., 2016). In essence, institutions and the associated changes have been used to a large extent to explain the heterogeneity in entrepreneurial action.

¹⁶ “*Necessity-based* entrepreneurship involves people who start a business because other employment options are either absent or unsatisfactory. In contrast, *opportunity-based* entrepreneurship involves those who choose to start their own business by taking advantage of a perceived entrepreneurial opportunity” (Hechavarria & Reynolds, 2009, 418, *italics* in original).

Thus, entrepreneurship research has undertaken an integrated view of the broad spectrum of institutional factors that can impact the intensity and type of entrepreneurship (Stenholm et al., 2013). Accordingly, institutional change is regarded as one of the most potent, external, actor-independent, exogenous, macro-environmental drivers of entrepreneurial action, and concomitantly, a source of massive heterogeneity across entrepreneurial actions and outcomes (Urbano et al., 2019). One of the key works in understanding the role of institutions—formal and informal—on the different types of entrepreneurships is by William Baumol (1996). Given that the crux of this study lies in understanding the heterogeneous entrepreneurial action due to institutional changes, next, I briefly review the different types of entrepreneurships as explained in Baumol (1996).

Baumol’s Typology of Entrepreneurship

Drawing upon a wide array of formal and informal factors, Baumol (1996) asserted that entrepreneurship can be productive, unproductive, or destructive. Crucially, Baumol’s (1996)¹⁷ seminal work argued that entrepreneurship could either enhance or hinder economic growth by offering a typology of entrepreneurship: productive, unproductive, and destructive entrepreneurship, which can emerge in response to changes in formal institutions. Productive entrepreneurship refers to the “startup” activity; unproductive entrepreneurship entails activities that are merely rent-seeking, or related to distributing existing

¹⁷ Baumol’s (1996) article does not refer to the classic Douglass North (1990) “Institutions, Institutional Change and Economic Performance” that argues for institutions as the “rules of the game.” Baumol (1996), however, does refer to North and Thomas’ (1973) book to discuss the role of institutions in promoting economic growth.

rents, whereas destructive entrepreneurship refers to activities wherein entrepreneurs extract wealth from the system by discouraging innovation and creating inefficiencies. Following this, there has been a spate of studies examining the relationship between institutions and entrepreneurship. Crucially, studies have sought to examine institutional-level differences across the countries in ascertaining the differences between entrepreneurship rates (e.g., Apracio et al., 2021; Estrin et al., 2013; Ghosh, 2017; Raza et al., 2019; Wong et al., 2005).

While Baumol (1996) focuses on institutions, both formal and informal, ranging from the cultural values in Jewish communities to formal institutions such as government programs, in explaining that the resultant entrepreneurship for the economy at large can be heterogenous, I argue that the framework has two main limitations: (a) the predictions in terms of the type of entrepreneurship are made at the macro level, thereby, overlooking any between or within group variation, and (b) relatedly, while the taxonomy accounts for different types of entrepreneurship, there can be situations where these three types of entrepreneurship can occur simultaneously, if the level of analysis is distilled to the micro level.

Toward this end, I anchor into extant entrepreneurship scholarship, and provide hypotheses by considering a specific institutional change. One of the most recent, and readily identifiable, institutional changes pertains to the NCAA's rule change on the use of NIL. As a modern-day institutional change with the target population of over half a million college athletes, aged between 18-22 years, this rule change provides a contemporary exposition of heterogeneity in entrepreneurial

action and outcomes from institutions' changes. As a "rule of the game" this rule change has metaphorically and literally changed the game for college athletes.

Next, I explain NIL, following which I put forth the hypotheses by synthesizing key arguments from extant research.

NCAA Rule Change on the Use of Name, Image, and Likeness

Intercollegiate sports began in the United States in the mid-1800s with the sport of rowing. The competition was intense but genteel, and little was at stake aside from bragging rights. However, by the early 1900s, college athletics had become a chaotic morass. Spurred by President Theodore Roosevelt, the NCAA was founded in 1906 as the governing body of collegiate athletics. Since 1973, the NCAA has been fractioned into three divisions to reflect the growing divergence in the size and role of sports at the collegiate level. Only Divisions 1 and 2 can offer scholarships, but all athletes are subject to NCAA policies. Today, the NCAA oversees 1,268 institutions, comprised of 358 Division I schools, 306 Division II, and 438 Division III. Nearly half a million athletes compete in 90 sports—46 women's, 41 men's, and 3 coed—for up to 4 years of athletic eligibility. By a sizable margin, football and men's basketball dominate the financial landscape, though baseball and men's hockey are also important sources of revenue at some schools. Since the 1980s, televised sports have become a major source of revenue for Division I institutions. The big money has brought rampant cheating in the recruitment and retention of outstanding athletes.

In an attempt to control this abuse, the NCAA adopted what was called the “Sanity Code” to set reasonable, identifiable, educationally relevant limits on the amount of compensation that could be paid to athletes. Violators were subject to stiff penalties, though in reality cheating simply became cleverer, and the hypocrisy of “unpaid” college athletes deepened (Mahony et al. 1999). The result of this action functionally barred college athletes from engaging in entrepreneurial action related to anything that could be vaguely construed as NIL. These conditions persisted until, under intense pressure and multiple pending lawsuits, the NCAA related in 2021, enacting rule changes that allowed college athletes to profit from NIL. While all athletes in all sports are technically eligible to monetize NIL, those participating in major sports at Division I schools were likely to have a decided advantage, as do white athletes who have access to supporting resources and technologies (Mossberger et al., 2006).

Institutional Change, KPs, Entrepreneurial Action, and Outcomes

The foregoing discussion points to the crucial link between institutions and entrepreneurship. While there have been a series of studies that have intended to underscore the relationship, the objective of this work is to offer a nuanced approach to untangle the mechanism through which institutional change leads to heterogeneity in entrepreneurial action and outcomes. First and foremost, I assert that as an exogenous change, the NIL rule change generates a series of KPs—uncertainty, equivocality, ambiguity, complexity, and risk (Bylund & McCaffrey, 2017; Rindova & Courtney, 2020; Townsend et al., 2018). While uncertainty refers

to *a priori* irreducible uncertainty (McGrath, 1999), equivocality relates to the simultaneous presence of competing perspectives. Ambiguity refers to sensemaking (Weick, 1988); complexity is a matter of permutations and combinations related to the different variables, where risk is a parametrization problem. These KPs vary in the level of mitigability due to the applicability of tools (Manocha, 2022).

Understanding the level of mitigability becomes even more important when its impact on entrepreneurial action is to be considered. Given that these KPs vary in their mitigability and use of tools, next, I briefly explain the KPs.

KP Mitigability and Heterogeneity of Entrepreneurial Action

First, I explain the relationship between the KPs¹⁸ and the type of entrepreneurial action undertaken by college athletes. As asserted before, the NIL rule change creates a gamut of KPs for college athletes. KPs can vary in their mitigability, while risk is highly mitigable, complexity is moderately to highly mitigable, ambiguity is moderately mitigable, whereas uncertainty and equivocality are low in their mitigability. In the light of NIL, college athletes face different KPs that can lead to variance in the entrepreneurial action to monetize from NIL.

To understand the relationship between KPs and entrepreneurial action, I specifically consider the business model deployed by the college athlete in monetizing from NIL. In line with extant research (Saebi et al., 2016), *business model* is defined as how the college athlete captures or creates value. Further, given that this study entails uncovering the presence of heterogeneity in entrepreneurial

¹⁸ As argued in the previous chapter, ambiguity is solved by collecting more information, complexity is solved by applying correct tools (existing or new), whereas risk is a matter of parametrization and calculation (cf. Townsend et al., 2018).

action and outcomes, extant work has shown that business models are linked to performance and heterogeneity (e.g., Zott & Amit, 2007). Scholarship suggests that entrepreneurial action is less distinctive under ambiguity, complexity, and risk (Zhao et al., 2017), resulting in the similarity of business models employed. Thus, in the light of NIL, such tools generate entrepreneurial action for these college athletes in the form of existing business models of endorsements, modeling, etc., as professional athletes use. As a result, the following hypothesis is put forward:

H1: *Higher knowledge problem mitigability is associated with greater reliance upon the application of existing business models in undertaking entrepreneurial action.*

Next, I navigate the relationship between less mitigable KPs (i.e., uncertainty and equivocality) and entrepreneurial action. It has been argued that entrepreneurial outcomes are skewed (Crawford et al., 2015). KPs of ambiguity, complexity, and risk can be resolved to varying degrees by the individual's characteristics, including the use of resources. KPs of uncertainty and equivocality are resolved through the passage of time and provide little room for available resources to be put to use in their resolution. As a result, I argue that these KPs arise in a context that is resource deficient. Resources available in institutions play a crucial role in entrepreneurship (Dess & Basu, 2013). While scholarship has suggested that resource deficit environments can limit entrepreneurial action (Ardichvili et al., 2003), studies have shown that when entrepreneurs are in a context of resource constraint, they undertake entrepreneurial action through the creative use of available social, financial, and material resources (e.g., Baker & Nelson, 2005). Senyard et al. (2014) suggest that when entrepreneurs are faced with

resource constraints, entrepreneurs use those available resources innovatively. Similar findings are reported in a meta-analysis study suggesting that entrepreneurs use resources in novel ways in resource-constrained environments (Scazziota et al., 2023), experimenting with business models (Tryba & Fletcher, 2020). As a result, when faced with the KPs of uncertainty, and equivocality, college athletes undertake highly heterogeneous action, departing from the conventional application of existing business models.

One such resource in the modern era that provides plenty of ways to experiment with business models is the widespread availability of digital technologies and platforms (Nambisan, 2017). Digital technologies have opened new avenues for new business models (Kraus et al., 2018). The growth of digital technologies has opened avenues for entrepreneurship, especially in terms of NIL (Kunkel et al., 2021). The growth of digital technologies has stimulated the rise of online content creation¹⁹ (Törhönen et al., 2021). Scholars have argued for online content creation as a novel form of entrepreneurship (Jerslev, 2016). Thus, based on the ongoing discussion, I assert that when the lower knowledge problem mitigability is low, the potential entrepreneurs (i.e., college athletes in my case) undertake a “do-it-yourself” approach by experimenting with business models using digital technologies. This leads to the following hypothesis:

H2: *Lower knowledge problem mitigability is associated with greater reliance upon experimentation of business models in undertaking entrepreneurial action.*

¹⁹ There has been a series of terms used for content creators including influencers, entrepreneurial broadcasters, and entrepreneurial content creators. See Törhönen et al. (2021) for further details.

KP Mitigability and Heterogeneity of Entrepreneurial Outcomes

Next, I turn toward understanding the relationship between the mitigability of KPs and the heterogeneity of entrepreneurial outcomes. While the above set of hypotheses put forth the relationship between the level of the KP mitigability and heterogeneity of entrepreneurial action in the form of business model application versus experimentation, next I explain the relationship between the mitigability of KP and entrepreneurial outcomes. In terms of the business model pursued, when faced with high mitigable KPs, college athletes apply existing business models, including endorsements and modeling. Alternatively, when faced with low mitigable, KPs tend to experiment with business models (e.g., by creating content for online audiences). However, undertaking varied actions by experimenting with the business models does not fully solve the KPs of uncertainty and equivocality. The low mitigable KPs of uncertainty are not solved through the application of tools or resources. However, they are solved through the passage of time (Townsend et al., 2018), whereas equivocality is solved when it migrates to high mitigable KPs. Townsend et al. (2018) noted, “the misdiagnosis of a knowledge problem and the resulting actions taken by entrepreneurs to resolve these problems hold major significance concerning the relative effectiveness of organizing mechanisms used by entrepreneurs” (p. 677). Therefore, using resources to mitigate the KPs of uncertainty and equivocality is less useful in generating returns (entrepreneurial outcomes) than using resources when faced with the KPs of ambiguity, complexity,

and risk. Further, research has acknowledged that less mitigable KPs (e.g., uncertainty) are associated with entrepreneurial exit (Ucbasaran et al., 2013).

As a result, in terms of entrepreneurial outcomes, college athletes facing more mitigable KPs have stronger results in terms of monetary value from undertaking entrepreneurial action and are less likely to exit. This leads to the following hypothesis:

H3 a & b: *College athletes encountering relatively more mitigable KPs, on average, exhibit: (a) stronger monetary results, and (b) lower exit rates, than college athletes encountering relatively less mitigable KPs.*

KP Mitigability and the Use of Appropriate Tools

I undertook this study to explain the multi-dimensional nature of KPs and their consequences on entrepreneurial actions and outcomes (Townsend et al., 2018). According to Townsend et al. (2018), “Some forms of unknowingness may impact all humans, everywhere, whereas other forms’ unknowingness may cause perceived uncertainty among some individuals but not others” (p. 678). In this study’s context, potential entrepreneurs face different KPs because college athletes operate in different contextual and individual circumstances, as evidenced by the wide array of sports played and the variation in the resources based on the division of the school. This section explains the relationship between the KP mitigability and the level to which appropriate tools are useful. As asserted previously, conditions marked with highly mitigable KPs of ambiguity, complexity, and risk provide room for tools to create circumstances for entrepreneurial action. While these tools to solve KPs can be of different types, such as individuals’ skillset and presence of resources (e.g., financial, social), contemporary entrepreneurship research has

sought to understand the role of tools available to an entrepreneur in terms of a wide array of services from brokers and agents. Dubbed the “entrepreneurship industry” (EI) by Hunt and Kiefer (2017), this industry includes the goods and services available for existing and potential entrepreneurs and has spurred research on the role of the EI in entrepreneurial action and outcomes (Brattström & Wennberg, 2022).

In terms of sports, historically, the use of EI, including agents, has been crucial in helping professional athletes monetize in forms such as endorsements. Following the NIL rule change, a series of brokers and matching platforms have come up to facilitate entrepreneurial action by the college athlete. Thus, the importance of EI has become even more stark (Dellenger, 2021). While EI acts as a tool to mitigate the KPs that college athletes encounter, these tools do not necessarily solve all kinds of KPs. KPs vary in terms of the application of solution sets in their mitigation. While ambiguity, complexity, and risk can be solved through actor-controllable solution sets, uncertainty and equivocality are solved through actor-uncontrollable solution sets. Hunt and colleagues (2023) assert that correct matching between the actual and perceived KPs generates markedly better entrepreneurial outcomes. Similarly, I argue that applying tools to mitigate KPs will generate better returns when the tools are well suited for mitigation. In terms of NIL, those college athletes who face highly mitigable KPs will gain higher returns from using intermediaries, as these KPs allow room for these tools to be used in their mitigation.

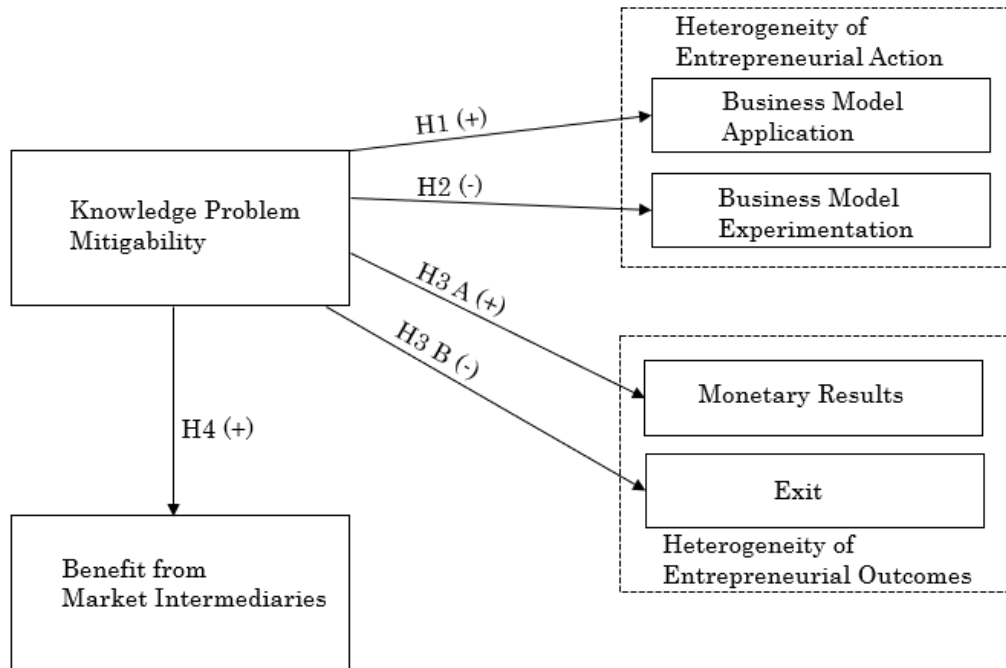
Extant literature on the use of intermediaries in economic transactions has shown that intermediaries can serve as information providers (Bessy & Chauvin, 2013), consequently, reducing the asymmetry in information related to the monetization from NIL by taking a specific entrepreneurial action. Similarly, Rossi (2018) suggests that intermediaries as third-party organizations can facilitate transaction between the two or more parties, reducing transaction and search costs. In sports, the roles of the agent and other²⁰ intermediaries have been widely discussed, both historically, and currently (Rypma, 1989; Shelley et al., 2023). For example, Bull and Faure (2022) suggest that these intermediaries play a critical role in not only representation of the (professional) athletes but also in facilitating the terms of appointment of the contract and deals between the endorsement companies and the athletes. Intermediaries such as Postgame have been critical in securing endorsement deals by college athletes. As a result, I argue that these intermediaries constitute key representatives from the EI that facilitate mechanisms for entrepreneurial action by college athletes in terms of monetizing off NIL. Thus, these market intermediaries serve as representatives of the EI. As a result, use of market intermediaries generates greater benefit for college athletes who face the KPs that can be solved through application of tools. Thus, I argue that those college athletes who face high mitigable KPs benefit greatly from the EI. This leads to the final hypothesis:

H4: *College athletes encountering relatively more mitigable KPs will, on average, will have greater benefit from market intermediaries than those encountering relatively less mitigable KPs.*

²⁰ Intermediaries can involve agents and non-agents. See Rossi (2018) for details.

Figure 1 shows the hypothesized relationships in this study.

Figure 1 - The Conceptual Framework



DATA AND METHODS

The objective of this study is to underscore the multi-dimensional nature of KPs emanating from exogenous changes and the consequential heterogeneity in entrepreneurial action and outcomes. To empirically achieve this, the research design undertakes an empirical investigation of the NCAA’s rule change on the use of NIL. It is well suited to address the research question on the following grounds. First, the research setting explores the impact of a single rule change—NIL on entrepreneurial action and outcomes. As suggested before, NIL is a readily identifiable exogenous change, institutional in nature, that has, as of July 1, 2021, turned a population of close to half a million college athletes into potential

entrepreneurs. Second, given that the research question seeks to understand the heterogeneity of entrepreneurial action and outcomes (i.e., the between-person differences across the college athletes), the respondents are reached out to through a cross-sectional survey (Stephan, 2018; Wach et al., 2021). In sum, the research design undertaken in this study finetunes the research question that this study posed (Baer & Shaw, 2017).

While NIL can impact varied stakeholders, including schools, intermediaries in addition to college athletes, this study specifically analyzes the impact of the NCAA rule change on college athletes. As a result, the sample of the study is the college athletes. I electronically distributed an IRB-approved survey²¹ (IRB # 21-936) to college athletes at over two dozen D1, D2, and D3 schools. After removing survey responses that failed to pass the “attention check,” there were 308 usable responses.

Dependent Variables

To measure the variable *business model application*, I created a dummy variable coded as 1 if the respondent reported monetization by appearing in commercials and modeling, and 0 otherwise. Given the popularity of modeling and product endorsements (Bergkvist & Zhou, 2016; Choi & Rifon, 2012), these activities represent business model application (Ge et al., 2016).

To measure the variable *business model experimentation*, I created a dummy variable coded as 1 if the respondent reported monetization by online content creation on YouTube and other social media channels, and 0 otherwise. Given the

²¹ The IRB approval letter is available in Appendix A.

recent emergence of use of content-based digital platforms as effective sources of promotion (Jiménez-Castillo & Sánchez-Fernández, 2019), it has been suggested that online content creation offers a novel form of business model (Belanche et al., 2021; Wirtz et al., 2010). Thus, the operationalization is in line with the ongoing research suggesting that digital platforms offer innovative business models to pursue entrepreneurship (Johnson et al., 2022).

Monetary results is an ordinal value²² ranging between 1 and 7 (1 = less than \$100; 2 = between \$100 and \$1k, 3 = between \$1k and \$5k, 4 = between \$5k and \$10k, 5 = between \$10k and \$50k, 6 = between \$50k and \$100k, and 7 = over \$100k), capturing the dollar value of the money made through NIL activities. Thus, a higher value corresponds to a higher degree of monetization. Similar measurement approaches have been undertaken in entrepreneurship research (e.g., Dahlgvist & Wiklund, 2012; Dimov, 2010; Ucbasaran et al., 2009).

Exit is a dummy variable coded as 1 if the respondent answered that they tried to make money through NIL and have been unsuccessful, and 0 if the respondent said that they are actively engaging in entrepreneurial action by monetizing NIL. This way, the operationalization is in line with extant research in entrepreneurship (e.g., Justo et al., 2015²³; Sarkar et al., 2006).

Market intermediary is an ordinal variable ranging between 0 and 3 and captures the extent to which the respondent benefited from the use of market intermediaries

²² In case of a missing value, it is replaced with 0.

²³ Specifically, it aligns with the variable “*exit for failure*” in Justo et al. (2015). Exit can be for a variety of reasons, including personal (see Jayawarna et al. 2021, for details). Further, see Ucbasaran et al. (2013) for details on the difference between exit and failure.

representing the EI, including third-party agents, such as postgame. A higher value means a higher perceived benefit from the market intermediaries. Similar approaches have been used in prior entrepreneurship studies (e.g., Brinckmann & Kim, 2015; Zhou et al., 2020).

Independent Variable

The variable *knowledge problem mitigability* is calculated in two steps. First, I measure the relatively high mitigable knowledge problems—ambiguity,²⁴ complexity, and risk and low mitigable knowledge problems—uncertainty and equivocality. The *KPs with high mitigability* are measured based on five survey items²⁵ on a Likert scale ranging between 1-5. The Cronbach's alpha for this measure is 0.75. Following works by Nunnally (1978), it has been widely acknowledged that Cronbach's alpha is a measure of reliability and internal consistency of a measure, and a value exceeding 0.7 is acceptable.²⁶ The *KPs with low mitigability* are measured based on 4 survey items on a Likert scale ranging between 1-5. The reliability (Cronbach's alpha) for this measure is 0.88, which is above the acceptable value of 0.7. Finally, the *knowledge problem mitigability* is calculated as the difference between *KPs with high mitigability* and *KPs with low mitigability*. It is a dummy variable coded as 1 if the difference is greater than or equal to 0, and 0 otherwise. Thus, a value of 1 corresponds to high KP mitigability,

²⁴ While ambiguity has a moderate level of mitigability, and complexity has moderate to high levels of mitigability, these along with risk are coded as relatively high mitigable KPs.

²⁵ Appendix B provides the survey items used for the measures in this study.

²⁶ Nunnally (1978) is one of the highest cited works in terms of measures and their reliability. Nunnally (1978) suggested that, for exploratory work, a reliability level of 0.7 is acceptable, however, for advanced practice research where important decisions are to be made, 0.9 should be the criterion.

whereas a value of 0 corresponds to low KP mitigability. Similar approaches for measurement have been undertaken in entrepreneurship studies (e.g., Hamidi et al., 2008).

Controls

Since the variable *school action* is not directly observable, I measure it with survey items (McNeish, 2017). This measure is based on 4 items that capture, on a Likert scale of 1-5, the various actions undertaken by the school in creating opportunities for the athletes to monetize off NIL. These include whether the school uses Opendorse, INFLCR and other applications in creating NIL opportunities. The reliability (Cronbach's alpha) for this measure is 0.94, which exceeds the criterion of 0.7 for internal consistency of a measure, as suggested by Nunnally (1978). Recent scholarship (e.g., Kunkel et al., 2021) has suggested that platforms such as INFLCR are helpful in monetizing NIL. Therefore, I control this effect.

The next variable is *school policy*. Schools have increasingly focused on educating college athletes about the rule change. Schools, including Texas Christian University, have started a three-credit course that explains how monetizing NIL can lead to a successful career. I control for the effect that such educational opportunities have might on the NIL activity by college athletes. This is in line with extant research suggesting that entrepreneurship education and the related ecosystem influence entrepreneurial action and outcomes (e.g., Binks et al., 2005; Brush, 2014). This measure is based on four items that capture the different policy measures, such as use of school logo by college athletes in endorsements, to help the

athletes monetize from NIL. The reliability (Cronbach's alpha) for this measure is 0.74, which is above the recommended value of 0.7 for the reliability of a measure, suggesting that this measure of school policy has adequate internal consistency.

Football/basketball is a dummy variable = 1 if the respondent plays football or men's basketball and 0 otherwise. Given that research has shown that football and men's basketball are highly televised sports driving the financial returns in college sports (e.g., Baade et al., 2011), I control for any effect the sport played might have on undertaking action by the college athlete, following the NIL rule change.

Division is an ordinal value (1, 2, or 3) denoting the division of the college athlete's school. A value of 1 corresponds to a Division 1 school, whereas a value of 3 corresponds to a Division 3 school. Given that the division of the school relates to differences in terms of scholarship available and other resources available to the college athlete, in line with extant research (e.g., Hall & Sobel, 2008; Rasmussen & Borch, 2010), I control for this effect.

Male is a dichotomous variable coded as 1 if the college athlete identified as male, and 0 otherwise.²⁷ Given the body of work suggesting gender differences in entrepreneurship (Jennings et al., 2022; Manocha et al., 2021; Murnieks et al., 2020), I control for the potential confounding gender effects.

Parent(s) entrepreneurs is a dummy variable coded as 1 if the college athlete responded that either or both the parents are entrepreneurs, and 0 otherwise. Given

²⁷ Those who identify as females are coded as 0. In addition, there were 6 respondents who identify as non-binary, and are coded as 0.

that extant scholarship has examined the effect of having parents who are entrepreneurs on the likelihood of becoming an entrepreneur (e.g., Lindquist et al., 2015; Mungai & Velamuri, 2011), I control for this effect in the regression analysis.

Experience is an ordinal value²⁸ ranging between 1-8 and captures the school year of the college athlete. Undergraduate first-year student is coded as 1, sophomore as 2, junior as 3, senior as 4, graduate first-year as 5, and so on. Similar approaches have been used to capture experience in prior work (e.g., Sapienza, 1992). Given that research has suggested that experience can influence the determination of entrepreneurial outcomes (e.g., Rueber & Fischer, 1994), I add the *experience* variable in the regression to control for this effect.

Descriptive Statistics

Table 1 provides the descriptive statistics, and Table 2 provides the correlation matrix for the variables included in the study. Surprisingly not, as shown in Table 2, the pairwise correlation between money made and males (0.3423, $p < 0.05$) is positive and significant, suggesting that males are likely to make more money compared to females. The pairwise correlation between exit and males (-0.1658, $p < 0.05$) is negative and significant, suggesting that males are less likely to exit compared to females. Further, the pairwise correlation between exit and knowledge problem mitigability (-0.2426, $p < 0.05$) is negative and significant, which is in line with the hypothesized relationship. Further, the correlation between division and exit is positive (0.1181, $p < 0.05$) and significant, which suggests those attending Division 3 schools are more likely to exit than attending

²⁸ In case of a missing value, it is replaced with 0.

Division 1 schools. Further, the correlations between school action and exit ($-0.3445, p < 0.05$), and school policy and exit ($-0.2244, p < 0.05$) are negative and significant. This suggests that athletes are less likely to exit if the school has adequate resources that help them monetize NIL. Further, the coefficient between the benefits of market intermediary and male ($0.4028, p < 0.05$) is positive and significant, between market intermediary and sports dummy is ($0.2969, p < 0.05$) positive and significant, between market intermediary and division ($-0.3625, p < 0.05$) is negative and significant, suggesting that college athletes at Division 1 are more likely to gain benefit from the use of a market intermediary than Division 3 college athletes. Further, the correlation coefficient between market intermediaries and business model application is positive and statistically significant ($0.516, p < 0.05$), which is in line with research suggesting the use of market intermediaries results in emulative models for undertaking entrepreneurial action (Hartmann et al., 2022).

Table 1- Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Market Intermediaries	308	0.26	0.439	0	1
BM Application	308	0.409	0.492	0	1
BM Experimentation	308	0.101	0.301	0	1
Money Made	308	1.903	2.074	0	7
Exit	308	0.14	0.347	0	1
Knowledge Problem Mitigability (=1 if high, 0 if low)	308	0.487	0.501	0	1
School Action	308	11.042	4.815	4	20
School Policy	308	1.49	1.843	-4	4
Sports Dummy	308	0.276	0.448	0	1
Experience	308	3.081	1.241	0	8
Division	308	1.646	0.812	1	3
Parent(s) Entrepreneurs	308	0.302	0.46	0	1
Male	308	0.461	0.499	0	1

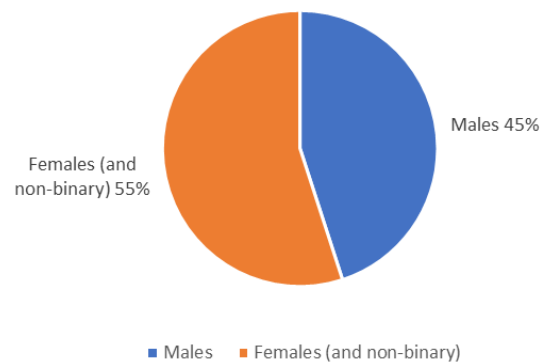
Table 2 - Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Market Intermediaries												
(2) BM Application	0.516*											
(3) BM Experimentation	-0.05	0.139*										
(4) Money Made	0.664*	0.849*	0.229*									
(5) Exit	-0.239*	-0.335*	-0.135*	-0.370*								
(6) Knowledge Problem Mitigability (=1 if high, 0 if low)	0.223*	0.418*	0.235*	0.447*	-0.243*							
(7) School Action	0.654*	0.586*	0.069	0.710*	-0.345*	0.324*						
(8) School Policy	0.506*	0.582*	0.145*	0.713*	-0.224*	0.295*	0.614*					
(9) Sports Dummy	0.297*	0.062	-0.158*	0.148*	0.066	-0.093	0.236*	0.218*				
(10) Experience	0.051	0.143*	0.004	0.142*	0.049	0.083	-0.041	0.068	0.047			
(11) Division	-0.362*	-0.443*	-0.160*	-0.543*	0.118*	-0.208*	-0.513*	-0.595*	-0.098	-0.017		
(12) Parent(s) Entrepreneurs	-0.051	0.1	0.156*	0.075	-0.081	0.166*	0.022	0.082	-0.042	0.071	-0.018	
(13) Male	0.403*	0.303*	-0.115*	0.342*	-0.166*	0.102	0.387*	0.249*	0.201*	0.071	-0.086	0.044

* p<0.05

Next, as shown in Figure 2, while the sample includes 308 responses, of which 45% are males and 55% females,²⁹ and those who identify as non-binary. Further, there are some intriguing gender wrinkles in the survey responses that are worth mentioning here. For instance, when asked what makes it difficult to monetize from NIL, males mention the lack of resources at the school, while females see it as due to inability to gain social media attention.

Figure 2 - Gender Split of Survey Respondents

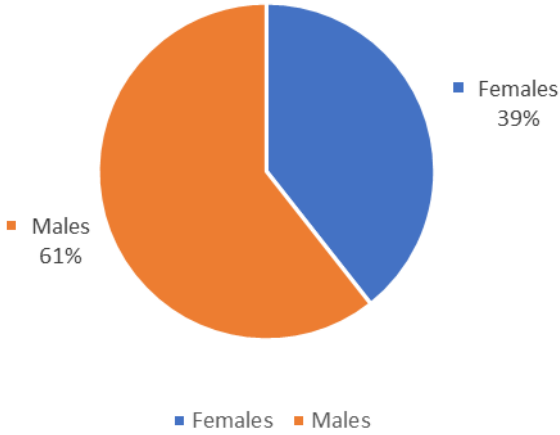


Note. N = 308.

Further, only 160 respondents are monetizing from NIL. Figure 3 provides the gender split of college athletes who are monetizing from NIL, 61% are males, and 39% are female college athletes. Simply put, while females are over-represented in the survey, they remain a minority when it comes to monetizing NIL.

²⁹ While the population of college athletes consists of 56%, and 44% females (NCAA demographics database), the over-representation of females in the study's sample aligns with recent scholarship suggesting that "Because male entrepreneurs outnumber female entrepreneurs, it is necessary to oversample female entrepreneurs or seek a matched sample, so that any gender-related differential effects can be demonstrated fully" (Zhao et al., 2021, 1).

Figure 3 - Gender Split of Those Monetizing From NIL



Further, as shown in Figure 4, of those who are not monetizing off NIL, 70% are females, and 30% are males.

Figure 4 - Gender Split of Those not Making Money From NIL

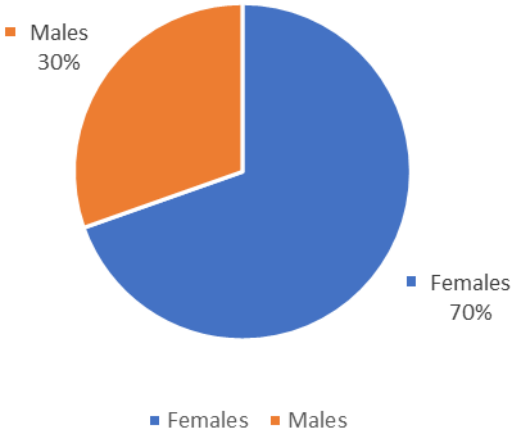
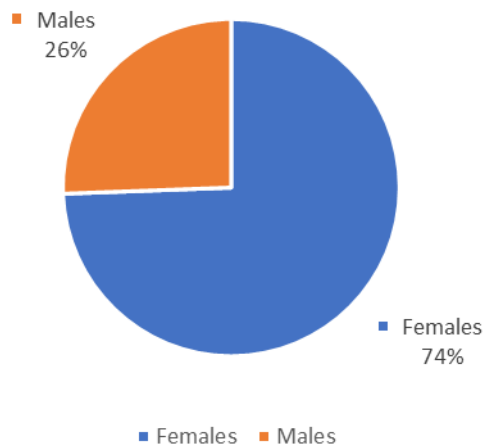


Figure 5 suggests that of those who have “exited” (i.e., tried to monetize NIL, and have been unsuccessful), 74% are females, and 26% are males. Extant work in entrepreneurship suggests that females are more likely to exit due to being unsuccessful (failure) (e.g., Justo et al., 2015), the findings reported in the pie chart

below are in line with the extant research on gender differences in entrepreneurial exit.

Figure 5 - Gender Split of those who “Exited”



Given that research has suggested that sources of variation in entrepreneurship can be institutional in nature (e.g., Chowdhury & Audretsch, 2019; Dilli & Westerhuis, 2019), in the light of NIL, it is worthwhile to examine factors such as the division of the school of the college athlete. Figures 6 and 7, provide the respective division split for males and females (and non-binary).

Figure 6 - Division Split of Females and Non-Binary in the Sample

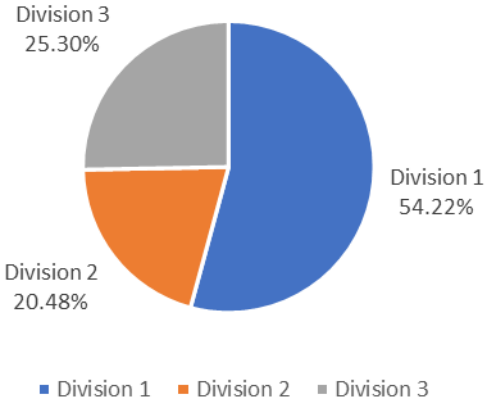


Figure 7 - Division Split of Males in the Sample

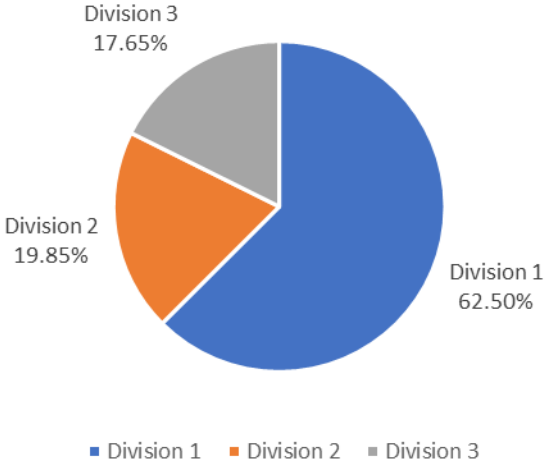
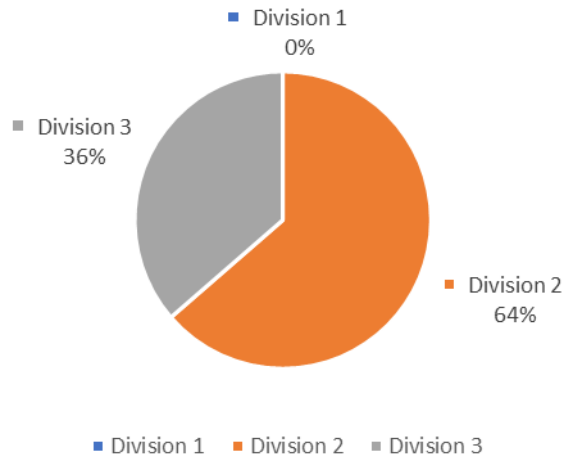
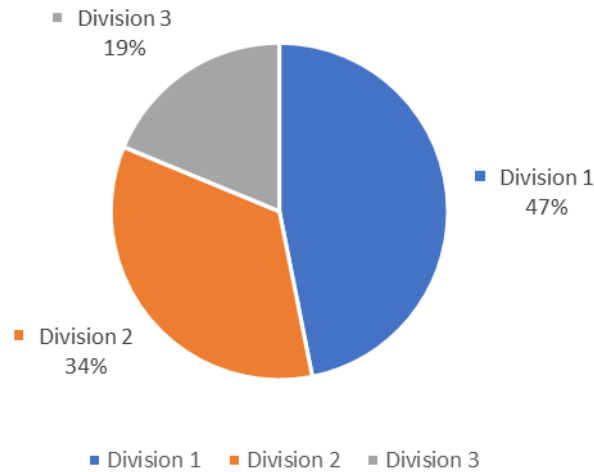


Figure 8 - Division Split of Males Who Have “Exited”



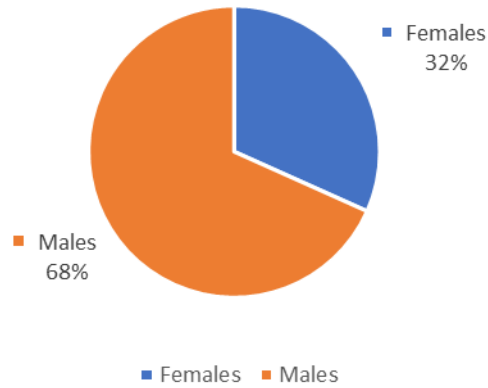
As suggested before, there are differences in the level of resources based on the school’s division. Next, I explain some of the critical findings in terms of heterogeneity at the intersection of gender and the division. As Figure 8 shows males who have exited belong to Division 2 or 3, while Females who have exited belong to all three different divisions, as shown in Figure 9. This finding is of importance toward understanding the context within which the college athlete is embedded, in addition to the gender of the college athlete. Extant scholarship suggests the role of understanding context in addition to gender differences (Welter, 2011), for instance, Jayawarna et al. (2021) noted, “the choices men and women make regarding how they structure their entrepreneurial activities cannot be divorced from the gendered social context in which they occur” (p. 1422). The findings in Figures 8 and 9 suggest that context, in this case, the division of the school, plays a critical role in entrepreneurial outcomes of the college athletes.

Figure 9 - Division Split of Females who have “Exited”



Given that understanding the persistent gender inequality is a prominent theme in research on entrepreneurial exit (e.g., Boden & Nucci, 2000), the survey results suggest gender as a driver of heterogeneity in entrepreneurial success and failure, from undertaking action under exogenous changes, such as NIL. As a result, these findings offer novel insights on understanding differential effects in terms of entrepreneurial outcomes from exogenous changes (Manocha et al., 2021). Given that the research setting is college athletes enrolled in higher-educational institutions, the gender differences can exacerbate the issue pertaining to Title IX. Next, as shown in Figure 10, of those who believe that there are significant opportunities for them to monetize NIL, 68% are males, and 32% are females.

Figure 10 - Gender Split of Those That Agree/Strongly Agree That There are Significant Opportunities for Me to Monetize NIL



Further, the survey results provide insights into understanding why some college athletes are not able to monetize NIL financially. Toward this, some athletes have tried and been unsuccessful (i.e., exits) (as shown in Figure 5), while others suggested that they have not tried, primarily for two reasons: (a) they cannot find a way to monetize, or (b) are not interested in financially benefiting from NIL.

Figures 11 and 12 suggest the gender gap for these reasons, a greater proportion of females than males have tried and been unsuccessful. These findings align with the extant work suggesting the gender gap in entrepreneurial action due to gender differences in factors, such as entrepreneurial self-efficacy and career intentions (Shinnar et al., 2012; Wilson et al., 2007).

Figure 11 - Gender Split of not Monetizing Because Cannot Find a Way to Do so

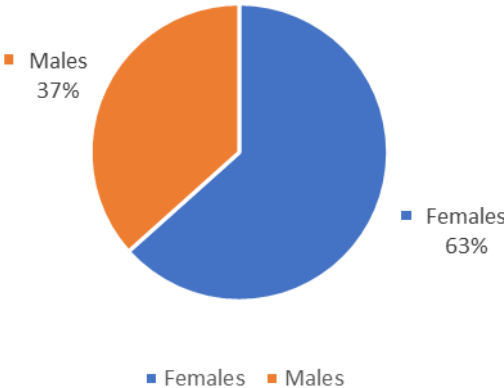
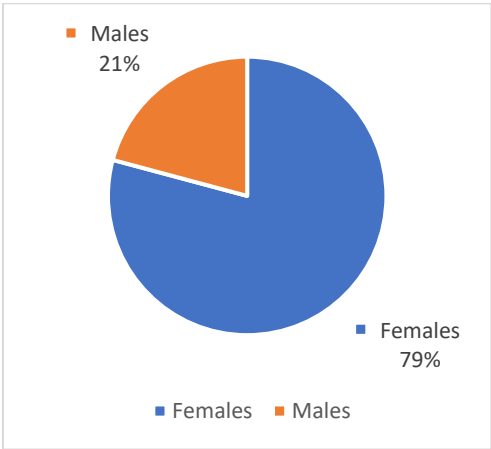


Figure 12 - Gender Split of not Monetizing Because not Interested



RESULTS

I conducted a series of regression models to test the hypothesized relationships, as reported in Tables 3-7. Since the dependent variables in hypotheses 1, 2, and 3b are dummy variables, I ran logit regression,³⁰ whereas the dependent variables in hypotheses 3a and 4 are ordinal values, therefore, I used Poisson regression.

To test hypothesis 1, which predicted a positive relationship between KP mitigability and business model application, I ran logit regression in model 3, Table 4. The coefficient of KP mitigability is positive and statistically significant ($\beta = 1.446, p < 0.01$). Thus, it provides support for hypothesis 1. Further, the coefficient of school action is positive and statistically significant ($\beta = 0.899, p < 0.01$), suggesting that through the school's partnership with online platforms such as Opendorse college athletes are more likely to undertake action through modeling and endorsing products.

³⁰ The odds ratio for these regressions is reported in Appendix C.

Table 3 - Regression Analysis. Business Model Application and KP Mitigability

Dependent Variable	Business Model Application	Business Model Application	Business Model Application
Regression	Logit	Logit	Logit
Hypothesis tested			H1
Model #	Model 1	Model 2	Model 3
<i>Independent Variable</i>			
Knowledge Problem Mitigability (=1 if high, 0 otherwise)	1.619*** (0.350)		1.446*** (0.451)
<i>Controls</i>			
School Action		0.911*** (0.230)	0.899*** (0.247)
School Policy		1.494** (0.594)	1.322** (0.613)
Sport Dummy		0.143 (0.397)	0.524 (0.422)
Experience		0.196 (0.164)	0.0974 (0.171)
Division of the School		-0.0152 (0.369)	0.00615 (0.388)
Parent(s) Entrepreneurs		0.538 (0.373)	0.405 (0.387)
Male		-0.125 (0.392)	0.0787 (0.403)
Constant	-2.499*** (0.300)	-6.038*** (1.179)	-6.786*** (1.310)
Pseudo R-squared	0.0877	0.2798	0.3189
Observations	160	160	160

Standard errors in parentheses

***p<0.01, **p<0.05,*p<0.1

Model 6 in the following Table (Table 4) tests hypothesis 2, which suggests that those facing lower knowledge problem mitigability rely on business model experimentation. However, since the coefficient of KP mitigability is positive and not statistically significant ($\beta = 0.402$, $p = 0.314$), hypothesis 2 is not supported. It is worth mentioning that the coefficient of sports dummy is negative and significant ($\beta = -1.14$, $p < 0.05$), suggesting that college athletes playing sports other than the highly televised sports of men's basketball and football are more likely to experiment with the business model in undertaking action.

Table 4 - Regression Analysis. Business Model Experimentation and KP Mitigability

Dependent Variable	Business Model Experimentation	Business Model Experimentation	Business Model Experimentation
Regression	Logit	Logit	Logit
Hypothesis tested			H2
Model #	Model 4	Model 5	Model 6
<i>Independent Variable</i>			
Knowledge Problem Mitigability (=1 if high, 0 otherwise)	0.705		0.402
	(0.397)		(0.444)
<i>Controls</i>			
School Action		0.103	0.113
		(0.244)	(0.246)
School Policy		0.149	0.116
		(0.553)	(0.557)
Sport Dummy		-1.231***	-1.140**
		(0.452)	(0.461)
Experience		-0.125	-0.145
		(0.166)	(0.168)
Division of the School		-0.244	-0.293
		(0.398)	(0.401)
Parent(s) Entrepreneurs		0.491	0.493
		(0.366)	(0.366)
Male		-0.270	-0.208
		(0.385)	(0.391)
Constant	-1.068***	0.0386	-0.220
	(0.350)	(1.122)	(1.159)
Pseudo R-squared	0.026	0.063	0.067
Observations	160	160	160

Standard errors in parentheses

***p<0.01, **p<0.05, * p<0.1

Model 9 [Table 5] tests hypothesis 3a, which suggests a positive relationship between knowledge problem mitigability and results. Since the coefficient of KP mitigability is positive and statistically significant ($\beta = 0.577$, $p < 0.01$), hypothesis 3a is supported. Further, the coefficient of the male dummy is positive and

significant ($\beta = 0.297, p < 0.01$), suggesting that males are gaining markedly higher monetary results from undertaking action. Next, the coefficient of school action is positive and significant ($\beta = 0.362, p < 0.01$), suggesting that the school's partnerships with platforms such as INFLCR generate higher returns for college athletes. Similarly, the coefficient of school policy is positive and significant ($\beta = 0.783, p < 0.01$), suggesting that the school's active role in education related to NIL generates higher monetary returns for college athletes.

Table 5 - Regression Analysis. Monetary Results and KP Mitigability

Dependent Variable	Monetary Results	Monetary Results	Monetary Results
Regression	Poisson	Poisson	Poisson
Hypothesis tested			H3a
Model #	Model 7	Model 8	Model 9
<i>Independent Variable</i>			
Knowledge Problem Mitigability (=1 if high, 0 otherwise)	1.048***		0.577***
	(0.0931)		(0.102)
<i>Controls</i>			
School Action		0.411***	0.362***
		(0.0557)	(0.0573)
School Policy		0.880***	0.783***
		(0.149)	(0.149)
Sport Dummy		-0.328***	-0.150
		(0.0983)	(0.101)
Experience		0.0816**	0.0354
		(0.0385)	(0.0392)
Division of the School		-0.508***	-0.520***
		(0.107)	(0.107)
Parent(s) Entrepreneurs		0.177**	0.119
		(0.0885)	(0.0891)
Male		0.214**	0.297***
		(0.0953)	(0.0948)
Constant	5.08E-13	-0.844***	-0.916***
	(0.0796)	(0.277)	(0.282)
R-Squared	0.1063	0.3726	0.3975
Observations	308	308	308

Standard errors in parentheses

***p<0.01, **p<0.05, * p<0.1

Model 12 [Table 6] tests hypothesis 3b suggesting a negative relationship between knowledge problem mitigability and exit. Since the coefficient of KP mitigability is negative and statistically significant ($\beta = -3.026$, $p < 0.01$), hypothesis 3b is supported. Further, the coefficient of school action is negative and significant ($\beta = -2.078$, $p < 0.01$), and that of school policy is negative and

significant $\beta = (-3.218, p < 0.05)$, each of which suggests that the school's active role by partnering with platforms such as Opendorse to facilitate college athletes' online presence and imparting education related to NIL lowers the chances of exit by the college athletes.

Table 6- Regression Analysis. Exit and KP Mitigability

Dependent Variable	Exit	Exit	Exit
Regression	Logit	Logit	Logit
Hypothesis tested			H3b
Model #	Model 10	Model 11	Model 12
<i>Independent Variable</i>			
Knowledge Problem Mitigability (=1 if high, 0 otherwise)	-2.477***		-3.026***
	(0.431)		(0.770)
<i>Controls</i>			
School Action		-2.052***	-2.078***
		(0.456)	(0.520)
School Policy		-2.658**	-3.218**
		(1.058)	(1.401)
Sport Dummy		1.231*	1.304
		(0.717)	(0.934)
Experience		-0.305	-0.147
		(0.254)	(0.321)
Division of the School		0.469	0.506
		(0.478)	(0.573)
Parent(s) Entrepreneurs		-0.551	-0.238
		(0.665)	(0.758)
Male		-0.409	-0.382
		(0.727)	(0.863)
Constant	-0.206	5.067***	6.170***
	(0.228)	(1.758)	(2.197)
Pseudo R-squared	0.2045	0.6074	0.7094
Observations	203	203	203

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Model 15 [Table 7] tests hypothesis 4, suggesting that higher KP mitigability benefits more from a market intermediary. Since the coefficient of KP mitigability is positive and significant ($\beta = 0.576, p < 0.05$), hypothesis 4 is supported. Further, the regression analysis in model 15 suggests that male college athletes are driving statistically significantly greater benefits from the market intermediaries, as the coefficient of the male dummy is positive and significant ($\beta = 0.774, p < 0.05$).

Table 7 - Regression Analysis. Market Intermediary and KP Mitigability

Dependent Variable	Market Intermediary	Market Intermediary	Market Intermediary
Regression	Poisson	Poisson	Poisson
Hypothesis tested			H4
Model #	Model 13	Model 14	Model 15
<i>Independent Variable</i>			
Knowledge Problem Mitigability (=1 if high, 0 otherwise)	0.783*** (0.239)		0.576** (0.267)
<i>Controls</i>			
School Action		0.789*** (0.173)	0.767*** (0.178)
School Policy		0.600 (0.424)	0.522 (0.426)
Sport Dummy		-0.112 (0.263)	0.0776 (0.271)
Experience		0.0389 (0.104)	-0.0134 (0.107)
Division of the School		-0.314 (0.309)	-0.332 (0.310)
Parent(s) Entrepreneurs		-0.0137 (0.262)	-0.0822 (0.264)
Male		0.684** (0.303)	0.774** (0.302)
Constant	-1.804*** (0.196)	-4.561*** (0.879)	-4.734*** (0.896)
Pseudo R-squared	0.0307	0.3073	0.3201
Observations	308	308	308

Standard errors in parentheses

*** p<0.01, **p<0.05, *p<0.1

Consequently, the above results map to the typology offered by Baumol (1996). The presence of a gender gap suggests the presence of “destructive” entrepreneurship, whereas the presence of stronger results in money made by those facing lower mitigable KPs points to “productive” entrepreneurship, and the exits relate to Baumol’s “unproductive” entrepreneurship. Crucially, since this study

accounts for differences across cohorts of entrepreneurs, the three³¹ types of entrepreneurship occur simultaneously. Model 9 suggests that those encountering low mitigable KPs receive higher monetary results, whereas model 12 suggests that those encountering high mitigable KPs are more likely to exit (i.e., undertake action and are unsuccessful). This maps to the productive and unproductive types of entrepreneurship, respectively. Further, the presence of a gender gap in the monetization of NIL and exit (Models 9 and 12), as suggested before conflicts with the overall objective of Title IX. Subsequently, at a broader level, I assert that this finding depicts the notion of destructive entrepreneurship by Baumol (1996).

DISCUSSION

This study was undertaken with the bold intention of unraveling the heterogeneity in entrepreneurial action and outcomes arising from exogenous changes, such as institutional changes. While research has acknowledged that institutional changes lead to a variety of entrepreneurship for the overall economy (Baumol, 1996), as noted previously, a nuanced theoretical and empirical investigation of heterogeneity of entrepreneurial action and outcomes between and within cohorts of entrepreneurs is lacking. By empirically investigating the NCAA rule change on NIL, the study brings to light the multi-dimensional existence of KPs. These KPs vary in nature, the mitigability of which is, to a greater extent, determined by the degree to which available tools are applicable in mitigation. The mitigability of these KPs by college athletes results in the different forms of

³¹ It is important to note that the “destructive” entrepreneurship as evidenced by the gender gap is at the macro level, whereas evidence of “productive” and “unproductive” entrepreneurship is at a micro level (i.e., across the entrepreneurs).

business models undertaken by college athletes in undertaking entrepreneurial action. As a result, in line with most entrepreneurship arising from exposition (Lippman, 2005), the study's findings report the heterogeneity of entrepreneurial outcomes among college athletes. Overall, the study aligns with recent conversations in entrepreneurship research (Hunt et al., 2023; Bennett, 2019; Chen et al., 2020; Davidsson et al., 2020; Fredström et al., 2021; Hechavarria et al., 2019; Justo et al., 2015; Manocha, 2022; Manocha et al., 2021; Wood et al., 2022) and contributes to these in the following ways.

Scholarly Contributions

This study uncovers the multi-dimensionality of KPs emanating from exogenous changes and the consequential heterogeneous entrepreneurial action and outcomes. This way, the study joins recent work in this regard (e.g., Hunt et al., 2023; Mitchell et al., 2022). Subsequently, this study contributes to the KP framework in two ways. First, this study responds to Townsend et al.'s (2018) calls for investigating the multi-dimensional nature of KPs. Crucially, this study brings home the idea that KPs can vary across the cohorts of potential entrepreneurs, which leads to heterogeneity of entrepreneurial action and outcomes. Second, at a methodological level, this study operationalizes KPs using survey items. While the measures for KPs in this study are specific to one stakeholder group (i.e., college athletes), this study offers insights for future studies to enrich research in this regard by capturing the KPs faced by different cohorts of potential entrepreneurs.

Next, this study enriches the extant scholarship on understanding the relationship between institutions and entrepreneurship (e.g., Urbano et al., 2019). Entrepreneurship scholars have examined the complex relationship between institutions and entrepreneurship (Acs et al., 2006; Bourdeaux et al., 2019; Bourdeaux & Nikolaev, 2019; Fredström et al., 2021; Urbano et al., 2019). By investigating a single readily identifiable, modern-day institutional change—NIL, the study’s findings showcase the simultaneous presence of heterogeneous entrepreneurial action and outcomes. As suggested before, necessitated by Baumol’s seminal work on different types of entrepreneurship, scholarship has focused on understanding the variance based on two dimensions: direction and intensity at which different institutional arrangements impact entrepreneurship (e.g., Aparicio et al., 2021), by accounting for the variation within and across cohorts of entrepreneurship, this study enriches the scholarship on institutions and entrepreneurship. While Baumol’s (1996) predictions related to the type of entrepreneurship lie at the macro level, the emergence of the “flat” world necessitates research that predicts at a micro level by considering the somewhat unconventional variations the flat world offers. It is not that Baumol’s (1996) seminal contribution is wrong. However, given the emergence of the “flat” world, more points of differentiation are available than when Baumol’s seminal work was published. Thus, the insights developed in this study suggest that the existing frameworks to explain exogenous changes, such as institutional changes, are independently insufficient, and the integration with the contemporary frameworks,

such as the KP framework, is necessary to understand the simultaneous heterogeneity in entrepreneurial action and outcomes from exogenous changes. As a result, through the findings, the study provides evidence of all three types of entrepreneurship (Baumol, 1996) simultaneously. Given that the starting point in the study's framework is the institutional change—NIL—which is exogenous change, the study responds to calls to link the macro-level drivers to micro-level entrepreneurial action (e.g., Cowen et al., 2022).

Third, this study offers key insights for research on entrepreneurial failure and non-occurrence (e.g., Cefis et al., 2022; Lee et al., 2022). “In entrepreneurship . . . many are called, but few are chosen,” noted Aldrich and Martinez (2001, p. 41). Scholars have shown that entrepreneurship is largely skewed (e.g., Crawford et al., 2014). Therefore, the non-availability of data related to non-occurrence and entrepreneurial failure has been challenging in entrepreneurship research. Entrepreneurship research has long called for accounting for entrepreneurial non-occurrence to correct for the left-side truncation, as failure to account for entrepreneurial non-occurrence creates: (a) inaccurate estimates of firms' failure rates, (b) obstructing research on the underlying causes of failure (e.g., Yang & Aldrich, 2012). To the existing work in entrepreneurship that seeks to understand the non-occurrence in entrepreneurship, this study adds valuable insights. The survey captures the college athletes who have not tried monetizing their NIL for various reasons. When asked for reasons, respondents described “my school cannot offer me financial aid for my athletic participation,” pointing to the lack of resources

at the institutional level, and other reasons that explain heterogeneous outcomes, such as “I’ve reached out to a few companies, but I don’t have a big enough following on social media,” “I’ve tried to generate money from YouTube and TikTok content.” Through the survey, I reached out to not only college athletes undertaking action but also to those who have tried and failed and those potential entrepreneurs who have not undertaken action. The results from the survey suggest that not all respondents are undertaking action, and some who undertook action could not derive financial outcomes and therefore decided to exit. Through the novel integration of contemporary research in entrepreneurship with the emergent KP framework, the study illuminates how exogenous changes can lead to the non-occurrence of entrepreneurial action and capture exits by those who tried to create valuable outcomes from the NIL rule change.

Fourth, the study has implications for ongoing work on understanding the heterogeneity in entrepreneurial action and outcomes (e.g., Chen et al., 2020). The primary objective of this study is to assess how changes in institutions lead to heterogeneity of entrepreneurial action and outcomes by synthesizing arguments from extant work on the KP framework. Entrepreneurship research has long acknowledged the persistent inequality related to action and outcomes (e.g., Bruton et al., 2021; Thébaud, 2015). By specifically focusing on the institution change, this study adds insights to the scholarship that has focused on heterogeneity in entrepreneurship arising from other exogenous changes, such as the growth of infrastructure (e.g., Bennett, 2019; Chen et al., 2020; Manocha et al., 2021). Recent

scholarship (e.g., Lucas et al., 2023) has suggested that exogenous changes, such as governmental interventions—tax incentives, research and development, and subsidies generate heterogeneous outcomes for firms engaging in entrepreneurial initiatives due to the factors such as a firm’s resources. Crucially, this study injects fresh theorization into this body of work by arguing for KPs as a new theoretical lens to examine the heterogeneity in entrepreneurial action and outcomes.

Fifth, the study captures the *gender differences* in the entrepreneurial exit, and non-occurrence, thereby joining scholarly conversation in this regard (e.g., Jayawarna et al., 2021; Yang & Triana, 2019). The findings suggest that the majority of college athletes who are monetizing from NIL are males. Research has acknowledged gender as a key factor of exit in the early stages of entrepreneurial action (Kalleberg & Leicht, 1991). Further, females reported a higher exit rate than males, and a significantly lower proportion of females than males think there are opportunities to monetize NIL. As a result, the study’s findings align with work intended to understand gender differences in exit (e.g., Boden & Nucci, 2000; Justo et al., 2015) and enhances the conversation by tapping into a population of college athletes. This way, the study responds to the call for research that investigates exit across different research settings, including higher education (e.g., Justo et al., 2015). Further, the survey findings suggest that females are less interested in monetizing NIL than men, and a higher majority of females cannot think of ways to monetize. These findings align with the extant stream of work in entrepreneurship that suggests factors such as gendered socialization process, risk-taking and self-

efficacy (Kinias & Sim, 2016; Shinnar et al., 2012) that explain the gender gap in entrepreneurship. While extant scholarship has examined the presence of differential effects from exogenous changes in terms of entrepreneurial action (Manocha et al., 2021), the findings of this study provide evidence of differential effects in terms of gender differences in entrepreneurial exit, thereby shaping the ongoing conversation in gender dynamics in entrepreneurship (e.g., Simmons et al., 2019). At a higher level, these findings add urgency to the recent conversation in female entrepreneurship literature that argues that females do not have the same likelihood of entrepreneurial resources and success, thereby arguing to undertake a gendered approach to entrepreneurship (Brush et al., 2019; Welter et al., 2014), including entrepreneurial exit (Marlow & Swail, 2015).

Finally, by investigating a modern-day exposition—NIL—and arguing for the role of digital technologies, this study adds to timely conversations in entrepreneurship literature, including the role of digital technologies (e.g., Nambisan, 2017). Crucially, I argue that in situations marked with lower KP mitigability, entrepreneurs can use digital affordances to create value. This way, I attend to calls for research on technology-based entrepreneurial strategies (Elia et al., 2020). Entrepreneurship research has sought to understand the relationship between technology and the heterogeneity in entrepreneurial action and outcomes (e.g., Manocha et al., 2021). Given that some college athletes are using digital technologies in undertaking entrepreneurial action, the study points to flattening the effects of technology.

Policy Implications

Entrepreneurship research faces a challenge of relevancy to stakeholders, Wiklund et al. (2019, p. 433) noted “much of (entrepreneurship) research goes unused perhaps because it focuses more on what researchers want to study, rather than what our different stakeholders care about.” Given that NCAA’s rule change on NIL is of key interest to a wide gamut of stakeholders (e.g., present and prospective college athletes, universities, policymakers), this study investigates a relevant societal and political issue, thereby addressing the grand challenge of relevancy. Below, I provide implications for this study to each stakeholder group.

This study’s findings are crucial for current and prospective college athletes. To the college athletes, who are presently not monetizing from NIL and looking for ways to, the findings suggest that social media channels can be a way to get started. Further, these athletes might want to contact local businesses and form partnerships to promote the brands. When looking for schools, prospective college athletes might want to consider the support and platforms the school has in place for NIL, additional policies (at the state and the school level), and other ideas. While the findings indicate heterogeneous outcomes for college athletes, the findings also point to the positive and significant role of a school’s action and policy by imparting education and collaborating with online platforms, such as Opendorse, in stimulating action by college athletes. This has implications for the coaches. For instance, prospective college athletes, in their recruitment, may be interested in knowing what kind of support (if any), in terms of educational resources and access

to platforms such as Opendorse and INFLCR, is available to college athletes in pursuing NIL initiatives. As a result, coaches might be interested in the importance of these platforms and other policies at the school level to help potential college athletes make informed decisions.

Online marketplaces such as Opendorse can be a good start for businesses interested in reaching out to college athletes. Further, given the compliance requirements with specific school and state laws, businesses should pay attention to the compliance dimensions. Further, businesses can step up to support social causes such as equality (e.g., Adidas signed a deal with female college athletes to celebrate the 50th anniversary of Title IX). Next, NIL offers lucrative opportunities for the EI (Hunt & Kiefer, 2017). Potential entrepreneurs can come up with exciting business models, such as providing matching platforms for college athletes and companies.

The study's findings have important implications for the schools. Schools can play a facilitative role in NIL monetization by college athletes. For instance, they can partner with Opendorse and INFLCR in facilitating NIL by the athletes. In addition, they can partner with other organizations (e.g., jersey customization) and pay royalties to the athletes. Schools can also offer educational resources to make sure that the students understand the implications of NIL. It is imperative that the schools are aware that the NIL initiatives are equitable for all college athletes so that their initiatives do not contradict Title IX. Title IX requires all universities and colleges receiving federal financial assistance to "provide equal athletic opportunity for members of both sexes," While the schools are actively exploring the NIL

landscape with and for the college athletes, in case a school creates opportunities for men compared to the female athletes, it can conflict with the Title IX. Next, understanding the impact of the NCAA rule change on the use of NIL is crucial to the policymakers, as this shift has resulted in almost half a million potential entrepreneurs. NIL was launched with the intent of playing as a “leveling field,” creating circumstances so that college athletes, including those not on scholarships, can benefit. These potential entrepreneurs are enrolled in degree-granting universities, and understanding the implications is a key concern for policymakers.

“NCAA president Mark Emmert testified before Congress that there are “many challenges and concerning trends. These concerns, if not addressed soon, may be very difficult to reverse” . . . [t]he “patchwork” of state laws fails to provide uniform protections for college athletes nationwide and creates an uneven playing field” (Nsouli & King, 2022).

The findings from the NIL exposition are critical because they conflict with the objective of Title IX.³² While the objective of Title IX was to close the gender gap in college sports, the findings suggest that NIL rule change has, in fact, exacerbated this gap. Fifty years of Title IX has created opportunities that have sought to close the gender gap. The explosion of NIL can lead to gender disparities, conflicting with the overall mission of Title IX. Thus, the finding related to the persistent gender gap is of chief concern to the policymakers.

While inequity is a common outgrowth of explosive entrepreneurship (Lippmann et al., 2005), this situation is particularly important given that college

³² “Title IX of the Education Amendments of 1972 (“Title IX”), 20 U.S.C. §1681 *et seq.*, is a federal civil rights law that prohibits discrimination on the basis of sex in education programs and activities” (US Department of Education). The guidelines of Title IX obligate universities to create equal athletic opportunities for males and females. However, third parties are not required to provide males and females with equal opportunities.

athletes are enrolled in degree-granting institutions, and these higher-educational institutions seek to create circumstances for equality in society. Athletes participating in highly televised sports such as football and men's basketball are reaping significantly greater benefits, whereas women and athletes participating in low revenue-generating sports are far more likely to use technology to pursue innovative business models. The results suggest the presence of highly heterogeneous entrepreneurial outcomes as a result of the rule change. The findings provide evidence of differential enablement of entrepreneurship. Similar findings have been reported in prior works (e.g., Manocha et al. [2021]). Thus, these point to the need for additional policy measures that can be put in place to ensure that the benefit from policy changes is equitable. Toward this end, providing additional resources, in terms of imparting education of the NIL to college athletes, could lead to closing the inequities.

Limitations and Future Research Directions

While most features of the research design and empirical analysis are ideal for a rigorous test of the hypothesized relationships, I acknowledge some limitations that can be addressed in future research. First, the study focuses on the consequences of the multi-dimensionality of KPs. As a result, the causes of the multi-dimensionality remain a potent future research avenue. Next, given the cross-sectional nature of the survey, there might be concern related to endogeneity. To address this concern, future studies could undertake a longitudinal analysis of college athletes that can offer a process-based understanding of entrepreneurship,

entrepreneurial ideation, decision-making, action, and outcomes. Relatedly, since the variables—independent, dependent, and controls came from a single cross-sectional survey, there are concerns related to common method variance (Podsakoff et al., 2003; Siemsen et al., 2010; Tehseen et al., 2017). In line with Liu et al. (2019), I took the following steps to address the concern, (a) ensuring anonymity of the response in the introduction to the survey and (b) arranging the questions in a way that those pertaining to the dependent variables and the independent variables are not in close proximity. However, to address other concerns related to the common method bias, I suggest that future work uses triangulation (Simmering et al., 2015) to eliminate the common source bias.

Third, as stated previously, while the study undertakes a gender analysis, future work could build on the findings of this study. Existing work has shown that females are less likely to reenter entrepreneurship than males due to the public stigmas of entrepreneurial failures (Simmons et al., 2019). Given that exit is a nuanced construct and can be understood at various staging across the spectrum of an entrepreneurial venture's stage of development (Josefy et al., 2017), scholarship could seek to conduct a finer examination of gender differences in exit by asking at what point/stage did the college athlete “exit.” Future work could unravel the differences in exit, such as “distress and voluntary exit” (Jayawarna et al., 2021, p. 1421). By deploying a longitudinal setting (Gustafsson, 2010), in line with Baù et al., (2017), future work could seek to unravel whether the gender gap in reentry exists for college athletes and whether factors such as resources, including support

from the university, could change the calculus. Fourth, given the population of college athletes, the sample size is relatively small.

Fifth, this study undertakes a modern exposition of institutional change, and the results find support for the role of technology (i.e., online platforms and social media) in entrepreneurial action. Future work could use the framework to understand the role of more recent technological changes, such as ChatGPT (AlAfnan et al., 2023), as educational tool for college athletes in monetizing from NIL. Next, the study sought to unravel heterogeneity related to entrepreneurial action and outcomes by specifically relying on college athletes. Future work could use the ideas generated in this study to explain the other types of exogenous changes that impact different cohorts of entrepreneurs. For instance, studies could examine how institutional changes such as bankruptcy laws lead to heterogeneity of entrepreneurial action and outcomes. Next, given recent scholarship has noted for the balance between business model experimentation (exploration) and application (exploitation) (Rojas-Córdova et al., 2022), future research could tap into understanding this balance in terms of the business models undertaken by college athletes.

Further, while the study pioneers in the measure development for the KPs, these measures are far from perfect. The study's approach for operationalizing the KPs provides directions for future research to tap into this niche, which could lead to improved measures of KPs. Crucially, I develop measures that group KPs of ambiguity, complexity, and risk into "high" mitigable KP, whereas uncertainty and

equivocality are categorized into “low” mitigable KP. While this operationalization, to a large extent, answers the posed research question, future work could create measures for each of the five KPs, and investigate the presence of heterogeneity in entrepreneurial action and outcomes emanating from all five types of KPs. Finally, the exogenous change in this study is a one-time change. However, exogenous changes can vary in their onset, as some can be slowly evolving, such as demographics, changes in the value-system, and growth of technologies that can happen over time. Given that KPs are “*multi-temporal*” in nature (Townsend et al., 2018, p. 678, italics and bold in original), future work could borrow the ideas generated in this study to explain the temporal dynamics of KPs by tapping into an exogenous change that evolves over time.

Conclusion

Institutional changes shape the “rule of the game” (North, 1990) for entrepreneurs. Yet, the impact on entrepreneurial action and outcomes is heterogeneous (Baumol, 1996) due to the complex nature of the KPs exerted by such exogenous changes (Townsend et al., 2018). At its core, the framework developed in this chapter considers the consequences of asymmetries faced by potential entrepreneurs, in terms of KPs generated by exogenous changes. On July 1, 2021, NCAA’s rule change on the use of NIL by college athletes changed the rules of the game, both literally and metaphorically. The study’s findings, based on an IRB-approved survey of college athletes, suggest that the multi-dimensional nature of KPs arising from this institutional change explains the heterogeneity of action and

allows for superior returns in terms of entrepreneurial action when the tools to mitigate the KPs match with the nature of the KP faced. The way the college athletes are embedded in the landscape based on factors such as gender, sport played, the division, are critical to the outcomes related to monetization from NIL. At a broader level, the findings point to the unintended consequences in terms of inequity of entrepreneurial action and outcomes. Given the sheer size of the study's population, the findings are of crucial importance to policymakers.

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CHAPTER FOUR

TIME, KNOWLEDGE PROBLEMS, AND OPACITY IN ENTREPRENEURIAL ACTION: THE EVOLVING NATURE OF ARTIFICIAL INTELLIGENCE INVESTMENTS

TIME, KNOWLEDGE PROBLEMS, AND OPACITY IN ENTREPRENEURIAL ACTION: THE EVOLVING NATURE OF ARTIFICIAL INTELLIGENCE INVESTMENTS

INTRODUCTION

To an increasing degree, entrepreneurship scholars have sought to incorporate temporal considerations when developing process-oriented frameworks for the description and prediction of entrepreneurial action (e.g., Lévesque & Stephan, 2020; McMullen & Dimov, 2013; van Lent et al., 2021; Wood et al., 2021). Temporality is crucial to understanding the role of uncertainty in entrepreneurial action (McMullen & Dimov, 2013; Wadhvani et al., 2021; Wood et al., 2021), particularly which arises from exogenous environmental changes (Rindova & Courtney, 2020). These macro-environmental factors are of different types, including technological, environmental, and sociocultural changes (Bennett, 2019, 2021; Chalmers et al., 2021; Chen et al., 2020; Davidsson et al., 2020; Hunt et al., 2022; Manocha et al., 2021) that vary on their outset, ranging from gradually changing socio-demographics to sudden events such as regulatory changes on the use of name, image, and likeliness by college athletes that can change the dynamics for entrepreneurial action (Hunt et al., 2022). Contemporary work has sought to unravel the impact of a series of exogenous changes, such as technology (Chalmers et al., 2021), non-fungible tokens (Chandra, 2022), infrastructure (Bennett, 2019), Internet access (Manocha et al., 2021), and government programs (Hechavarria & Ingram, 2019) on entrepreneurial action. However, the difficulty is that the impact on entrepreneurship is not uniform, and to a large degree, is contingent on the

temporality of the onset of these exogenous changes (Chen et al., 2020). Yet, research has not offered a nuanced examination of the temporality at which exogenous change impacts entrepreneurial action.

This is of primary concern for entrepreneurship scholars as contemporary scholarship has shown that exogenous changes, such as disequilibrating changes, are temporal (Juma et al., 2023) and generate knowledge problems (KPs) (Rindova & Courtney, 2020). KPs are the different types of unknowingness in entrepreneurial action. KPs can be of five types: uncertainty, equivocality, ambiguity, complexity, and risk (Townsend et al., 2018). KPs are “***multi-temporal***”, noted Townsend and colleagues (2018, p. 678, italics and bold in original). Consequently, the absence of work that underscores the temporality in the effect of exogenous changes on entrepreneurial action and outcomes and the subsequent oversight of the multi-temporal nature of KPs obscures the advancement of entrepreneurship research. To close this gap, this study draws upon the emergent research on the KP framework to underscore the temporality of KPs emanating from exogenous changes.

Fundamentally, this study investigates the temporality of opacity, which is a configuration of five KPs—uncertainty, equivocality, ambiguity, complexity, and risk generated by an exogenous change. Therefore, the study seeks to introduce the dimension of temporality in understanding the effect of external changes on entrepreneurial action by asking the following research questions: *How does the opacity related to the effect of exogenous change on entrepreneurial action vary over time?* Taking a step further, *how does it impact entrepreneurial action?*

To answer these research questions, I integrate key insights from the KP framework. Building on the work of Zack (1999), Townsend et al. (2018) suggest that the temporality of KPs can be understood in two ways: (a) by examining a phenomenon across multiple periods and (b) by investigating the different tempos at which different entrepreneurs identify and mitigate the KPs. Toward this end, I assert that, over time, the overall opacity level declines as the KPs are rightly identified and mitigated. Further, over time, the nature of opacity changes as the generic KPs of uncertainty and equivocality are solved through the refinement of information, and opacity changes from high in generic element to high in agentic element comprised of KPs of ambiguity, complexity, and risk. I empirically test my arguments in the research context of Artificial Intelligence (AI) technology, primarily on the following grounds: (a) AI is increasingly regarded as an important niche to both entrepreneurship research and practice (e.g., Autio et al., 2018; Nambisan, 2017; Townsend & Hunt, 2019), (b) AI is widely regarded as an exogenous technological change (Obschonka & Audrestch, 2020), one that has evolved gradually over time. Specifically, I investigate the investments made in the AI industry over time. The data from the study are drawn from CrunchBase. CrunchBase serves as an excellent repository to study investments, as it has granular data at the level of funding rounds, spanning across years. As a result, it has been used in a series of recent studies to uncover the investment dynamics in entrepreneurship (e.g., Ko & McKelvie, 2018; Wise et al., 2022).

This study makes a number of important contributions, several of which invite fundamental reconceptualization of foundational categories for entrepreneurial action, entrepreneurial finance, innovative capacity, innovation policy, and explanatory variables governing the heterogeneity of ideation, decision-making, actions, and outcomes. First, to the extant work that seeks to link the exogenous changes to entrepreneurial action (e.g., Davidsson et al., 2020), this study adds insights by asserting the importance of accounting for the temporality in the entrepreneurial action and outcomes. Despite the proliferation of the research that links the exogenous changes in entrepreneurial action and underlying variance in entrepreneurial action (e.g., Bennett, 2019, 2021; Chalmers et al., 2021; Chen et al., 2020; Manocha et al., 2021), relatively few studies have examined the presence of heterogeneity by considering the temporal evolution of exogenous change. By focusing on the level and nature of the opacity related to the impact of exogenous change, this study offers a rare view of temporality from the macro side. This study joins a timely conversation by examining the temporality in entrepreneurial action (e.g., Davidsson et al., 2021; Lévesque & Stephan, 2020; Wood et al., 2021).

While research has acknowledged the importance of understanding the role of time (Lévesque & Stephan, 2020), to date, time has been included in the studies of entrepreneurship largely as a dependent or control variable (Lippman & Aldrich, 2016). Scholars have argued for undertaking a process approach to entrepreneurship (Wood et al., 2021), yet the temporality of exogenous changes remains an uncharted research niche. As such, tapping into the temporal

dimension of exogenous changes in entrepreneurial action and outcomes opens vistas for future research to undertake a top-bottom understanding of the role of time in entrepreneurship. In doing so, the study responds to calls for understanding the changing nature of exogenous changes (Kimjeon & Davidsson, 2021).

Consequently, the study shapes the ongoing conversation on the role of macro-environmental factors on entrepreneurial action (e.g., Davidsson et al., 2020) from a “snapshot” to a panoramic view.

Second, this study explores the temporal dimension of opacity—its relative level and nature. By investigating the temporality of opacity, which is a configuration of KPs, this study responds to the call by Townsend et al. (2018) to uncover the multi-temporal nature of KPs. It has been widely acknowledged that uncertainty is extremely high in the early stages of market category evolution (Aldrich & Fiol, 1994). Similarly, this study’s findings argue that opacity in the early periods of initiation of an exogenous change is composed of generic elements (i.e., uncertainty and equivocality), whereas as the exogenous change continues to evolve over time, the opacity is characterized by high agentic element (i.e., the KPs of ambiguity, complexity, and risk). This way, by integrating insights from the KP framework (Townsend et al., 2018), the study undertakes a panoramic view of KPs, from the early periods of the exogenous change to the later ones, explaining its consequences for entrepreneurial action and outcomes.

In addition, the study has important methodological contributions. By operationalizing the construct of opacity related to exogenous changes, this study

offers one of the first empirical investigations of the role of opacity in entrepreneurship. Scholarly interest in understanding the opacity related to exogenous changes is increasing, as evidenced by recent work by Wood et al. (2022) and Davidsson et al. (2020). By operationalizing the level and composition of opacity over time, the study responds to calls by Davidsson et al. (2022) to understand the long-term effect of exogenous change on entrepreneurial action and outcomes. Next, this study's research context is the AI industry. AI is regarded as a timely and important research topic in entrepreneurship and management, as demonstrated by the growth of articles published in this research niche (e.g., Nambisan, 2017; Raisch & Krakowski, 2021; Townsend & Hunt, 2019). While scholars have argued for the relationship between AI and uncertainty in entrepreneurial action (Townsend & Hunt, 2019), this study injects fresh perspectives into the ongoing conversation on the role of AI by undertaking an evolutionary perspective of AI as an exogenous change. At a practical level, given the emergence of the latest AI technologies, such as NFTs and ChatGPT, this study's framework offers the basis for future research to borrow ideas developed in this study and offers an enhanced and refined understanding of how these technologies impact entrepreneurial action, in due course.

Next, the study offers fresh perspectives to understand the actors in entrepreneurial finance literature (Dutta & Folta, 2016). Research in this domain has suggested that different types of investors invest at varying investment stages. While venture capitalists (VCs) and angels invest in early rounds, private equity

(PE) firms and corporate venture capitalists (CVCs) invest in later rounds (Block et al., 2018). Toward this end, this study injects fresh insights into the role of investors in the entrepreneurship landscape. While extant work in this field has sought to explain the differences in the performance of portfolio companies due to investor differences (e.g., Galloway et al., 2017; Wadhwa et al., 2016), this study enhances the conversation by underscoring differences across the spectrum of investors—VCs, angels, PEs, and CVCs, in the AI industry. The central argument is that Angels and VCs have a different set of tools; therefore, they are well suited to solve the KPs of uncertainty and equivocality, whereas CVCs and PEs are well suited to solve the KPs of ambiguity, complexity, and risk. This way, the study joins recent work by Hunt et al. (2023) on accurately identifying and mitigating KPs as a precursor to higher performance. Essentially, the study provides for the presence of heterogeneity in the entrepreneurial finance landscape. While investors constitute an important part of the entrepreneurial landscape, the study provides a strong foundation for work to borrow these ideas and apply them to further refine the heterogeneity argument by tapping into other stakeholders (e.g., customers, suppliers). While recent work by Hunt et al. (2023) suggests the importance of matching the perceived KP to the actual KP to generate higher entrepreneurial outcomes, taking a step ahead, this study advances the application of the KP framework by showcasing the KP mitigation over time.

Next, through the empirical investigation of the players in entrepreneurial finance, this study provides new insights into the industry structure. Agarwal et al.

(2017, p. 300) suggested the importance of KP mitigation by noting, “Industry emergence and concomitant firm investment in new industries may also hinge on successful resolution of various uncertainties during incubation.” The findings of this study suggest that as the industry evolves, different types of players enter the market. In this empirical treatment, VCs and angels enter the industry prior to CVC and PE firms. This is because, in line with extant work, the study’s findings suggest that VCs and angels are better equipped to mitigate the generic elements of opacity, whereas CVCs and PEs are better equipped to mitigate the agentic element of opacity. Thus, acting upon the type of KP based on the actors’ expertise can explain an enrichment of the extant work that has sought to explain the chronology of the industry’s emergence. Scholarship has drawn heavily upon Porter’s five forces model (Porter, 1979, 2008) to understand the industry structure over time. Contemporary studies in strategy scholars have argued for the multiplicity of outcomes related to using tools in undertaking processes (e.g., Jarzabkowski & Kaplan, 2015). This study’s findings provide a novel finding that matching the toolkit to the actual KP faced is of key strategic importance in an industry’s emergence.

This essay is structured as follows. First, I build my theoretical arguments and hypothesis on the nature of opacity over time and its consequences on entrepreneurial action. Next, I describe the AI industry as the research context for the study. Further, I explain the data and methods and provide the results. Finally,

I offer implications for research, practice, and policy and provide an agenda for future research.

THEORY AND HYPOTHESIS DEVELOPMENT

The objective of this study is to investigate the multi-temporal nature of opacity related to exogenous changes and its effect on entrepreneurial action. To do so, I first review extant literature that explains the relationship between exogenous changes and entrepreneurship. Next, I draw key insights from the extant literature to unravel the relationship between time and opacity. Further, given that opacity can be understood as a configuration of KPs, I distill key insights from the KP framework to unravel the nature of opacity over time. Townsend et al. (2018, p. 679) suggest that the temporality of KPs can be studied along two broad dimensions: (a) studying the phenomenon across multiple timeframes and (b) capturing the variation between the different actors due to their different tempos in the mitigation of KPs. Using Townsend et al.'s (2018) guardrails for the temporality of KPs, I hypothesize relationships related to the level and nature of opacity, as a configuration of KPs, over time and its consequences on entrepreneurial action. While the first hypothesis deals with the overall level of KPs, the second delves deeper into the composition of opacity by underscoring the different tempos at which different actors (investors, in this case) mitigate the KPs. Subsequent hypotheses explain the consequences of changing opacity over time on entrepreneurial action.

External Environment and Entrepreneurial Action

Entrepreneurship research has long been interested in understanding the role of exogenous changes on entrepreneurial action (e.g., Gnyawali & Fogel, 1994). Exogenous changes refer to actor-independent macro-level factors that can impact the nature and substance of entrepreneurial action (Davidsson et al., 2020). Research has shown that factors such as political institutions (Thai & Turkina, 2014; Wennekers et al., 2002), and institutional uncertainty, including the rule of law (Hechavarria et al., 2023), impact entrepreneurial action. For instance, by drawing upon the Global Entrepreneurship Monitor (GEM) data, Kim et al. (2012) show that policies related to the provision of insurance and training can influence entrepreneurship. Studies have shown that macro-level factors such as political stability and the level of corruption influence decisions related to entrepreneurship (e.g., Alvarez & Urbano, 2011). Further, studies have shown that the availability of resources concerning finance and education can impact entrepreneurship (Bowen & De Clercq, 2008). Cannavale and Nadali (202) show that cultural values related to creativity and risk-taking can influence entrepreneurship. Further, research has accounted for the variation in the entrepreneurship rates across countries to macro-level factors, such as culture and formal institutions (Busenitz et al., 2000; Hechavarria & Reynolds, 2009; Kauffman et al., 2005; Wennekers et al., 2005). In sum, scholarship has investigated the impact of exogenous factors on entrepreneurial action, such as COVID-19 (Ratten, 2020; Sharma et al., 2022) that are more sudden in their rollout than others—the cultural factors, such as the

nation's level of uncertainty avoidance (Khan et al., 2021; Wennekers et al., 2007), yet impact the nature and quantity of entrepreneurial action.

Further, studies have shown that the impact of these actor-independent factors varies based on gender (Hechavarria & Ingram, 2019; Manocha et al., 2021) and sectoral and temporal dimensions (Chen et al., 2020). One of the most recent and comprehensive frameworks in this regard is the external enabler (EE) framework by Davidsson and colleagues (2020), which has renewed scholarly interest in understanding the role of exogenous changes on entrepreneurial action. The emergence of the EE framework by Davidsson et al. (2020) and the subsequent refinement of the framework (Chen et al., 2020) necessitates research that identifies and explains core concepts that predict the relationship between external environmental changes and entrepreneurial action. Following this, a spate of studies (e.g., Chandra, 2022; Chalmers et al., 2021; Schade & Schuhmacher, 2022; Kimjeon & Davidsson, 2021; Wood et al., 2022; Juma et al., 2023) have offered empirical investigation and theoretical advancement of the effect of different exogenous changes, ranging from non-fungible tokens (NFTs) and blockchain, to COVID-19, by providing "structures and terminology" (Cestino et al., 2023, p. 1) to enhance the understanding of the relationship between exogenous changes and entrepreneurial action. Increasingly, scholarship has highlighted the presence of variation in entrepreneurial action from changes in the external environment. For instance, Wood et al. (2022) note the role of opacity related to the exogenous changes in undertaking action or inaction. However, the emergent work in this

regard has largely been descriptive and lacks predictive abilities in explaining the presence of variance in entrepreneurial action (Kimjeon & Davidsson, 2021; Manocha et al., 2021).

As the above review suggests, the macro-level perspective has been deployed to understand entrepreneurial action and outcomes and, to an increasing degree, the acknowledgement of heterogeneity of entrepreneurship. However, the variance of entrepreneurship across the temporal dimension has not received much attention. In recent work, Cestino et al. (2023, p. 4) note that while some effects emanating from exogenous changes are immediate, others require “time,” thus, highlighting the scholarly acknowledgement of issues related to temporality. Fundamentally, I argue that work on linking external changes to entrepreneurial action requires a strong theoretical toolkit to underscore the temporal variation of exogenous changes by tapping into the core concepts, such as opacity. Chen et al. (2020, p. 17) suggest that the “mitigation of information asymmetries” of an exogenous change over time and space can dictate the presence of variance in its influence on entrepreneurial action. Exogenous changes can vary in type, such as technological, natural-environmental and the degree of onset. For instance, some exogenous changes are readily identifiable, such as the NCAA’s rule change on the use of name, image, and likeness, whereas others unfold over a period, such as the aging of a population, and cultural changes, including women’s rights. Studies have underscored the need to develop a richer theoretical toolkit to understand how exogenous changes impact entrepreneurial action (e.g., Davidsson et al., 2020);

correspondingly, it is critical to understand the variation of exogenous changes across time (Chen et al., 2020), by understanding the opacity related to the effects of exogenous change (e.g., Davidsson et al., 2022).

Multi-temporal Nature of Opacity

The crux of this study lies in unraveling the relationship between opacity and time. To do so, I focus on the level and nature of opacity over time.

Entrepreneurship research has focused on understanding entrepreneurial action under different KP levels and types of KPs. For instance, McKelive et al. (2011) show that entrepreneurship action varies significantly based on the level of uncertainty. By undertaking action, the entrepreneurial environment shifts from being uncertain to one characterized by risk (Alvarez & Barney, 2005). Recent research has acknowledged the presence of different types of KPs (e.g., Hunt et al., 2023). Further, Fisher and Neubert (2022) argue for entrepreneurship as a process in environments characterized by equivocality and ambiguity. In fact, Townsend et al. (2018) suggest the need to examine the temporality of KPs. Therefore, understanding opacity in terms of different KPs is timely. As a result, I argue it is critical to examine the multi-temporality of opacity in terms of level and nature/composition.

Level of Opacity

Opacity refers to the degree of obstructiveness in understanding the impact of exogenous changes on entrepreneurial action (Wood et al., 2022). Opacity is a configuration of five types of KPs: uncertainty, equivocality, ambiguity, complexity,

and risk. Uncertainty refers to Knight's (1921) notion of indeterminism, while equivocality refers to the existence of different and often competing perspectives. These two KPs are solved through the refinement of information with the passage of time. As a result, their impact is generic. Ambiguity refers to sensemaking (Weick, 1993). It essentially is a KP relating to understanding the relationship between two or more variables in a different environment. Complexity is a KP relating to permutations and combinations associated with the number of variables and the relationships among those, while the risk is a KP related to parametrization. These KPs can be solved through the use of individual characteristics. As a result, the KPs of ambiguity, complexity, and risk are agentic in their impact. Thus, as a configuration of KPs, opacity can be thought of as a relative composition of generic and agentic elements.

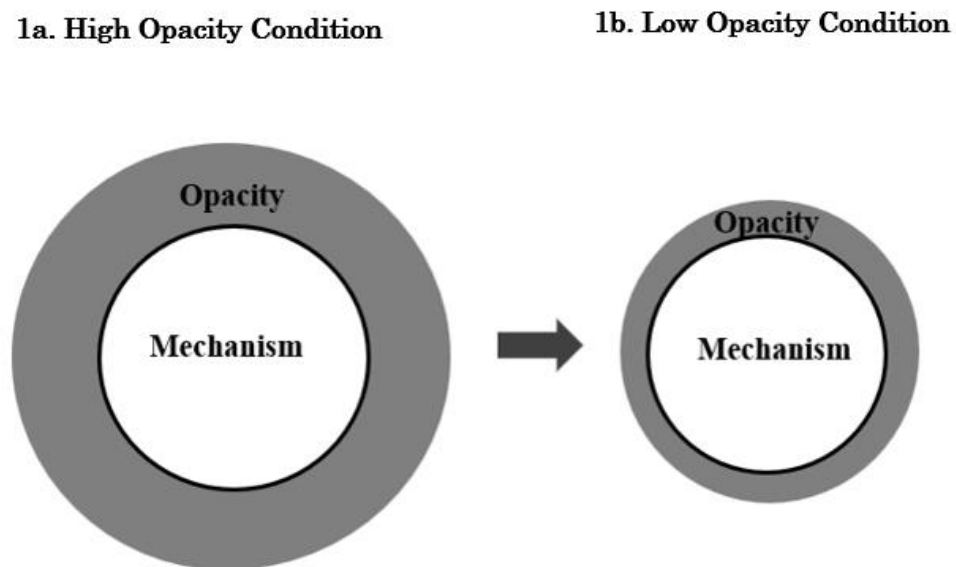
In an attempt to undertake a panoramic view of opacity, the insights developed here argue for unraveling the temporal nature of opacity. Opacity, as a configuration of KPs, is multi-temporal in nature (cf. Townsend et al., 2018). Increasingly, undertaking a temporal approach to entrepreneurial action and outcomes has become a key stance for theories of entrepreneurial action (e.g., Korsgaard et al., 2016; Wood et al., 2021). Further, scholars have noted the temporal nature of KPs, including uncertainty (Arai, 1997). Recent scholarship has suggested the role of information and the learning process in the resolution of uncertainty (e.g., FeldmanHall & Shenhav, 2019). Research has long acknowledged the relationship between time and uncertainty (Epstein, 1980). For instance, extant

research has shown that uncertainty declines over time (Chew & Epstein, 1989; Meissner & Pfeiffer, 2022; Strzalecki, 2013). Following this, there has been a spate of work examining how uncertainty changes over time. Crucially, studies have shown that generation of information seeks to reduce uncertainty, ambiguity, and other KPs (e.g., Ju & Miao, 2012). In entrepreneurship studies, studies have noted, “Over time, entrepreneurs face different uncertainties as decisions are made, new information is obtained, and the entrepreneur or environment changes. As a result, entrepreneurial judgments are regularly revisited, renewed, and revised” (Packard et al., 2017, p. 1). While Packard and colleagues (2017) acknowledge the temporal nature of uncertainty, it is not entirely true that entrepreneurs face “different” uncertainties as information is collected/refined or information asymmetries are resolved (Chen et al., 2020). In fact, as asserted before, each KP, including uncertainty, is unique in its resolution.

Therefore, it is important to note that collecting new information does not lead to a different type of uncertainty. However, it does lead to a different type of KP. While Chapter 2 asserted that uncertainty is solved through the passage of time and ambiguity, complexity, and risk can be mitigated through the application of correct tools, this empirical treatment tests the assertion that KPs are multi-temporal (Townsend et al., 2018). Essentially, research has shown that KPs, such as uncertainty, vary over time. For instance, Bloom (2007) shows uncertainty spikes following major exogenous shocks, including political and economic changes. Further, I argue that when an exogenous shock arises, actors face different KPs

owing to different underlying circumstances. Those who face ambiguity, complexity, and risk undertake action, and with time this results in the mitigation of these KPs. In addition to mitigating the KPs of ambiguity, complexity, and risk by actors, there can be situations where KPs migrate from one type to another. Subsequently, the opacity level related to an exogenous change reduces over time. In a stylized fashion, Figure 1 describes the relationship between opacity and time. The opacity corresponding to Figure 1a is higher than that in Figure 1b, suggesting that opacity declines over time.

FIGURE 1- Stylized Depiction of Changing level of Opacity Over Time.



As a result, I posit that the level of opacity related to the exogenous change declines over time. This leads to the following hypothesis:

H1: *The level of opacity related to the exogenous change decreases over time.*

Composition of Opacity—Generic and Agentic Elements

“Time does not unfold sequentially from one moment to the next, nor do entrepreneurs necessarily experience it as a linear movement through space,” note Lippmann and Aldrich (2016, p. 3). Further, McMullen and Dimov (2013) note that, “If new information is consistent with these knowledge structures, it is likely to augment or extend them, but in some instances, new information demands a reorganizing of existing knowledge structures in order for the information system to realize the full benefit of the new information.” (p. 1491). Subsequently, I argue that it is important to understand how the nature of opacity related to exogenous change evolves over time. While the above discussion points to the change in the opacity level, next, I argue for the change in the composition of opacity over time. Broadly, opacity is constituted of generic and agentic elements. Generic elements pertain to the KPs of uncertainty and equivocality, whereas the agentic elements pertain to the KPs of ambiguity, complexity, and risk. These five KPs vary in their mitigability and the degrees to which they elicit heterogeneous entrepreneurial action and outcomes. Consequently, it is critical to understand the changing nature of opacity related to the impact of exogenous changes on entrepreneurial action as a configuration of KPs.

Scholarship has acknowledged that “ventures in the formative years face a different set of circumstances” (Aldrich & Fiol, 1994, p. 645). As an exogenous

change evolves, the KPs generated by the exogenous change migrate. This suggests that undertaking action in the initial periods requires mitigating the KPs of uncertainty and equivocality, vastly different from the KPs of ambiguity, complexity, and risk in the later periods. McMullen and Shepherd (2006) underscore the key role of uncertainty arising out of exogenous changes as a key differentiator between those who undertake entrepreneurial action versus those who do not. Further, research has shown that uncertainty affects types of entrepreneurial action differently (Khurana et al., 2021). While entrepreneurship research has acknowledged the role of uncertainty in entrepreneurial action, consensus is missing concerning whether it is an aversive or facilitated state for entrepreneurial action. Taking stock of this situation, Griffin and Grote (2020) offer reconciliation in these opposing views by noting the need to examine the level of uncertainty. They note the importance of understanding the positive role of uncertainty for actors—entrepreneurs and organizations—by understanding the role of human agency in taking advantage of uncertainty. Undertaking action in the early periods offers cognitive legitimacy to understand the impact of exogenous change (Aldrich & Fiol, 1994).

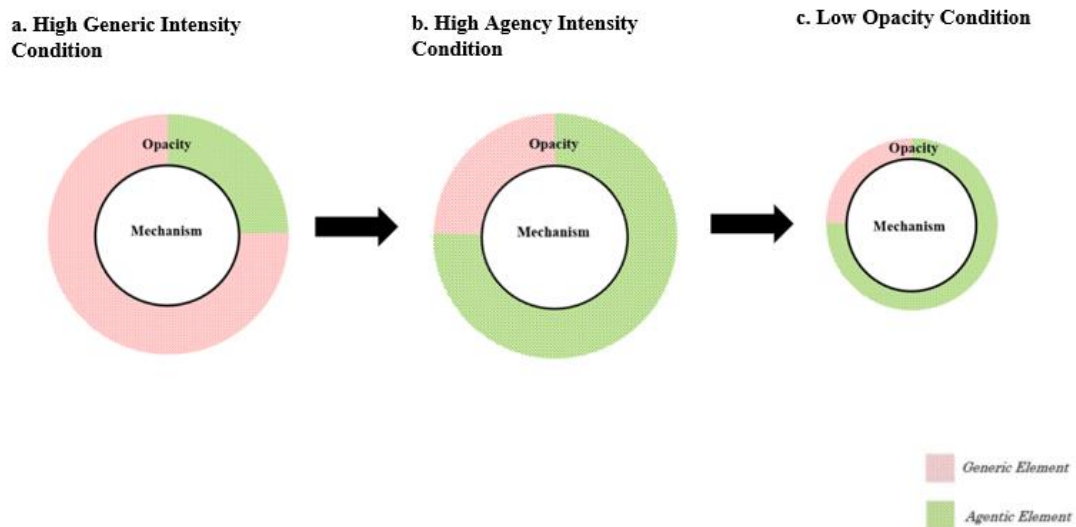
I argue that in the initial periods of an exogenous change, unknowingness is marked by the generic elements of opacity—uncertainty and equivocality. Equivocality is marked by the co-existence of multiple and sometimes divergent perspectives (Eriksson et al., 2016). However, over time, I argue that through the refinement of existing information, equivocality migrates to the KPs of ambiguity,

complexity, and risk, which are the agentic elements of opacity. Extant scholarship focusing on exogenous change, such as technological change, has argued that various actions are undertaken in the initial periods of a change (Suarez & Utterback, 1995). Empirical evidence has suggested that periods marked with high uncertainty are associated with higher levels of innovation (He et al., 2020). Correspondingly, Zhao et al. (2017) argue that in the initial periods of (an industry's) evolution, action by the new entrants is highly heterogeneous. Consequently, there is a high level of experimentation by the entrants before convergence toward a dominant design, after which action is marked by less differentiation.

Davidsson et al. (2022) suggest that accumulating knowledge over time reduces barriers to entrepreneurial action. "As information accumulates and evidence mounts, we can increasingly rely on patterns of reliability and reputation" (Aldrich & Fiol, 1994, p. 650). Congruently, over time, as existing information is refined and new information collected, opacity related to an exogenous change's impact on entrepreneurial action and outcomes is characterized by the KPs of ambiguity, complexity, and risk. Simply put, over time, the mitigation of uncertainty and equivocality to the agentic KPs of ambiguity, complexity, and/or risk provides a strategic approach to undertaking entrepreneurial action. Thus, over time, opacity changes from high in generic elements to high in agentic elements. Accordingly, the increasing level of agentic element characterizes the KPs of ambiguity, complexity and/or risk, providing greater room for using existing or new

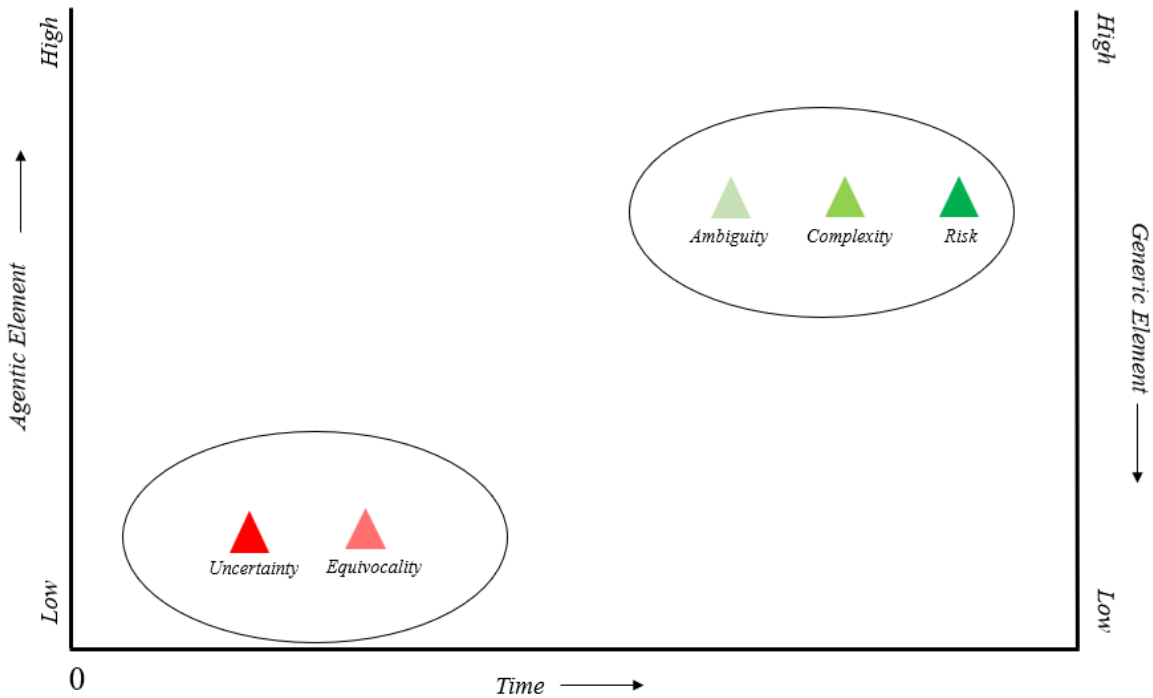
tools to understand the effects of exogenous change on entrepreneurial action. As a result, I argue that over time, the nature of opacity changes from high in generic element to high in agentic element. In a stylized fashion, Figure 2 describes the relationship between the generic and agentic elements of opacity and time. In a stylized fashion, Figure 2 shows the change in the composition of opacity over time. Figure 2a shows a high generic element condition, Figure 2b shows high agentic element condition, whereas Figure 2c shows high agentic element condition with low overall opacity.

FIGURE 2- Stylized Depiction of the Degree and the Configuration of Generic and Agentic elements of Opacity Over Time.



Further, as shown in Figure 3, over time, the KPs of uncertainty and equivocality migrate to the KPs of ambiguity, complexity, and risk. As a result, the generic element of opacity declines over time, and the agentic element increases.

FIGURE 3- Generic and Agentic Elements of Opacity Over Time



This leads to the next hypothesis:

H2: *Over time, the nature of opacity changes from high in generic element to high in agentic element.*

Consequences of Changing Levels and Nature of Opacity

While the ongoing discussion acknowledges the variation in the level and nature of opacity related to the influence of the exogenous change, next, I explain the consequences in terms of entry by actors. Crucially, I assert that as opacity becomes high in agentic element, it creates more room for individual actors to use the available toolkit in undertaking action. Recent work by Davidsson et al. (2022) suggests that the role of agentic elements in undertaking action in light of

exogenous changes increases over time. Given that the heightened role of actor characteristics, such as “specialized knowledge . . . ingenuity, tenacity, and willingness to bear the risk” (Davidsson et al., 2020, p. 319) becomes pronounced as opacity becomes high in agentic element, an increased number of actors will undertake entrepreneurial action. As a result, the number of entrepreneurial actors taking action in light of exogenous change increases as the opacity of the exogenous change becomes high in agentic element compared to generic element. Further, entrepreneurial action increases as the opacity related to the influence of exogenous change falls. More formally:

H3a: *As the nature of opacity changes to high in agentic element, , the quantity of entrepreneurial action increases*

H3b: *As the relative level of opacity declines, the quantity of entrepreneurial action increases*

DATA AND METHODS

Given that the research questions in the study pertain to understanding the relationship between the relative level of opacity, time, and entrepreneurial action, it necessitates the development of the research design that spans over time. In accordance with Townsend et al.’s (2018) view of the temporality of KPs, the study underscores the temporality of KPs in terms of (a) the relative level of opacity over time and (b) the relative tempos at which different actors mitigate the KPs.

Accomplishing the first item necessitates the development of a research design that explains the relative level of opacity across a wide range of periods, whereas the second item corresponds to understanding the opacity as the relative tempos across

a wide range of actors. The research context described below seeks to answer the research question by considering the above-identified criteria for understanding opacity. In different ways, these two criteria explain the temporality of KPs constituting the opacity. Individually, these relate to the different dimensions of opacity—the relative level and the nature of opacity and collectively explain the relationship between opacity and time.

Research Context

To empirically validate the above hypotheses, this study conducts an empirical investigation of AI. Scholarship has made strides in understanding how AI can change the landscape for entrepreneurship research (Burström et al., 2021; Townsend & Hunt, 2019) and practice (Obschonka & Audretsch, 2020) by revolutionizing organizational design (Chalmers et al., 2021), business models, and value creation for organizations (Raisch & Krakowski, 2021). AI is transforming the state of entrepreneurship research and practice (cf. Townsend & Hunt, 2019). AI is increasingly regarded as an exogenous change with implications for entrepreneurial action and outcomes (Chalmers et al., 2021). Complementing the existing digital entrepreneurship theories, scholars, including Chalmers et al. (2021) and Obschonka and Audretsch (2020), argue for the role of AI as a key driver of entrepreneurship research. Yet, research that underscores the opacity related to the emergence of AI as an exogenous change remains an undiscovered terrain.

Specifically, I consider the growth of the startups in AI and the investments made by VCs, CVCs, angel investors, and PE firms in the startups in the artificial

intelligence industry. Extant research has underscored the impact of different types of investors on the portfolio company's venture performance (e.g., Drover et al., 2017; Dutta & Folta, 2016). For instance, by drawing upon a sample of U.S. biotechnology companies, Alvarez-Garrido and Dushnitsky (2016) show that the innovation output varies for portfolio companies based on whether the investor is CVC or VC. Research has established that PE firms invest in the later rounds (Bonini & Capizzi, 2019), whereas VCs invest in earlier stages (Dutta & Folta, 2016). "(VCs) reduce information asymmetries at later stages" noted Roma et al. (2021, p. 3). Scholarship has suggested that angels invest in early-stage and seed rounds (Block et al., 2018) that are marked with a high degree of uncertainty (e.g., Hellmann & Thiele, 2015), whereas CVCs invest in later rounds (Hellman & Thiele, 2015). Cavallo et al. (2019) suggest that angels and VC invest under high uncertainty. Alternatively, PEs invest later in the lifecycle of the portfolio company (Block et al., 2018).

Understanding the differences between the types of investors is critical to understanding the nature of opacity related to AI. Given that in addition to the level of opacity, this study attempts to capture the nature of opacity, understanding key differences between different types of investors—VCs, CVCs, angels, and PE firms—is important. Those that invest in the initial periods of the AI's emergence correspond to undertaking action and face opacity that is high in generic intensity, whereas those investors that invest in the later stages of AI's emergence face opacity that is high in agency intensity. Given that the generic element of opacity

captures the KPs of uncertainty and equivocality, I argue that those who invest under this opacity are the VCs and angel investors. Further, in line with extant scholarship that suggests that CVCs and PE firms invest in a later stage, I assert that in terms of opacity, they operate when the opacity is high in agentic element. To underscore the temporality of opacity related to the effect of exogenous change, I conduct an analysis of AI over time to understand the emergence of an exogenous change and to examine the chronology of investor action. This way, the research design aligns with the research question posed in this study.

Due to the longitudinal structure, the data are drawn from CrunchBase, an ideal data source for this line of inquiry. Equally important, CrunchBase contains granular-level data on investments and investors, allowing for comparisons between diverse investor categories. Crunchbase has been used in recent research (e.g., Block et al., 2015; Brown & Rocha, 2020; Cumming et al., 2019; Fisch & Block, 2021; Haddad & Hornuf, 2019; Ko & McKelvie, 2018; Nuscheler et al., 2019; Savin et al., 2022; Wise et al., 2022). The final dataset spans from 1996 to 2002, resulting in 26 event years comprising over 3,900 funding rounds involving 2,025 portfolio companies operating in the AI industry globally, 1,289 VCs, 178 CVCs, 176 Angels, and 280 PE firms.

Dependent Variables

Opacity is calculated based on the following three dimensions:

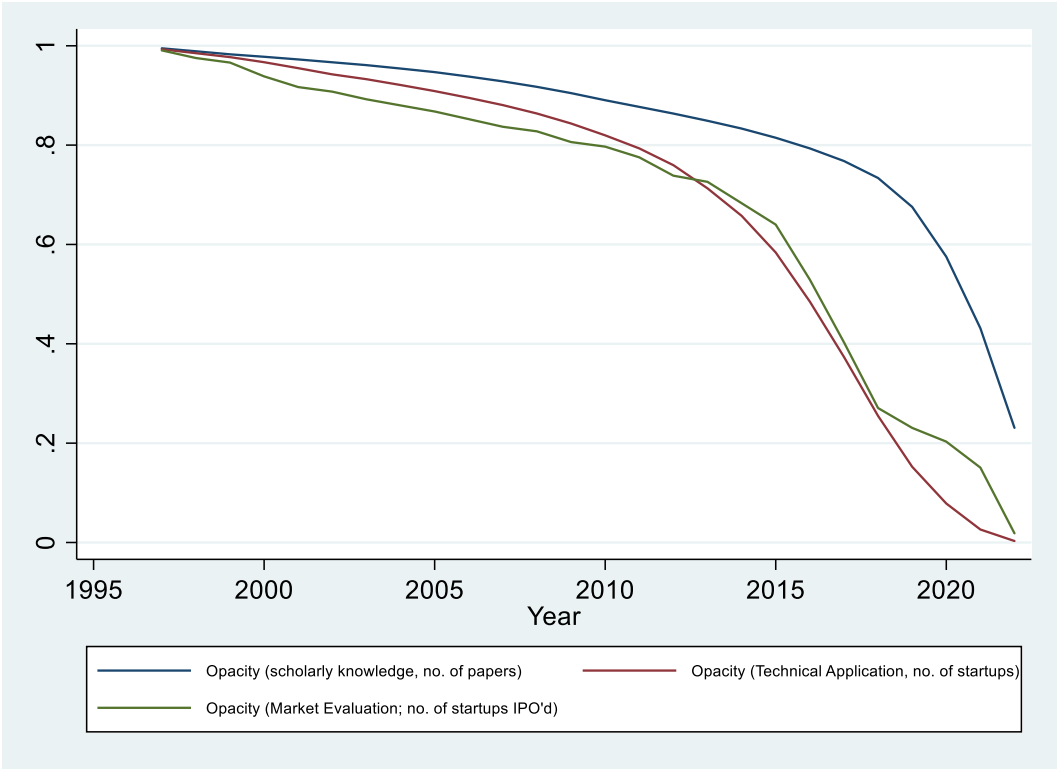
- (a) *Opacity related to scholarly knowledge*: This variable captures the opacity related to scholarly knowledge on AI every year between 1996-2022. The data to calculate this variable are drawn from the Web of Science. Opacity is calculated in two steps. First, I calculate the cumulative scholarly knowledge. It is based on the total number of scholarly pieces, including articles, book chapters, and books published on AI. The data in Crunchbase related to AI investment range from 1996-2022. Thus, to match the data to this time frame, in calculating this variable, the starting point is the year 1996. For each year, the value is calculated as the cumulative scholarly pieces up to that year divided by the total number of scholarly pieces published until 2022. For instance, the value associated with the year 2000 is the total number of articles published between 1996 to 1999 divided by the number of articles published between 1996 to 2022. This gives a value that ranges between 0 and 1. In step two, I calculate the opacity related to scholarly knowledge by deducting the value generated in step 1, from 1, for each year.
- (b) *Opacity related to technical application*: This variable captures the opacity related to the technical application of AI every year between 1996-2022. This variable is calculated by drawing upon Crunchbase. It is calculated in two steps. First, I calculate the cumulative technical application. It is the total number of startups in the AI industry founded

between 1996 and 2022. For each year, the value is calculated as the cumulative number of startups in AI founded up to that year, divided by the total number of startups in AI founded until 2022. In step two, I calculate the opacity related to technical application by deducting the value generated in step 1, from 1, for each year.

(c) *Opacity related to market valuation*: This variable captures the opacity related to the market valuation of startups operating in the AI industry every year between 1996-2022. This variable is calculated using data collected from Crunchbase. First, I calculate the total number of startups operating in the AI industry that went public between 1996 and 2022. For each year, a value is assigned based on the cumulative public startups (IPO, initial public offering) up to that year, divided by the total number of startups in AI that went public until 2022. In step two, I calculate the opacity related to the market valuation by deducting the value generated in step 1 from 1, assigning a value for each year between 1996-2022.

Figure 4 shows the level of the three sub-measures of opacity from 1996-2022.

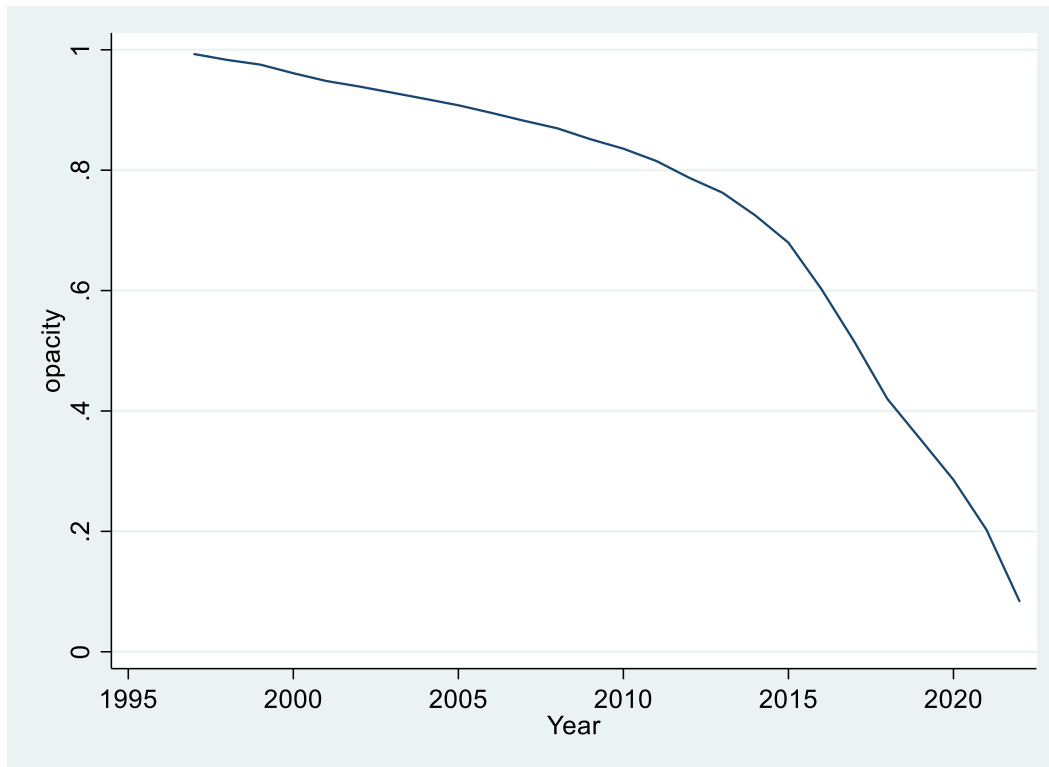
FIGURE 4- Sub-measures of Opacity calculated Over Time.



Finally, *opacity* is calculated as the average of the above three dimensions.

Figure 5 shows the level of opacity from 1996-2022.

FIGURE 5- Opacity calculated Over Time.



Nature of opacity. This variable captures the ratio of the generic element to the agentic element of opacity. As suggested earlier, the generic element is comprised of emanating from the KPs of uncertainty and equivocality, whereas the agentic element is a manifestation of effects arising as a consequence of ambiguity, complexity, and risk. Extant research has suggested that VCs and angels invest in early-stage funding rounds marked with opacity comprised of the generic element (i.e., KPs such as uncertainty) (Dutta & Folta, 2016), while CVCs and PE firms invest in later rounds (Block et al., 2018) that are marked with opacity comprised of the agentic element (i.e., KPs such as ambiguity, complexity, and/or risk). Statistics reported by the European Early-Stage Market Statistics Report (2021) suggest that

angels and VCs make the majority of early-stage investments. As a result, to calculate the generic element, I use the total number of angels and VCs investing in a round, whereas to calculate the agentic element, I use the total number of CVCs and PE firms investing in a round. Finally, the nature of opacity is measured as the ratio of the generic element to the agentic element. The variable is log-transformed.

Independent Variables

Time (year) This variable corresponds to the year in which investment is made, the publication year of the scholarly work, the year founded, and the year of the IPO. Given that there are 26 years in the sample, this variable lies between 1 to 26, as it is coded corresponding to the actual year, such that the value of 1 corresponds to 1996, and the value of 26 corresponds to 2022.

Time (speed of investment): This variable captures the difference between the date of the investments and July 3, 2022—the data analysis date. This captures the early action in terms of investments made in the AI industry by the investors. This variable is reverse coded, such that the higher the value, the later the investment was made. Similar techniques have been deployed to calculate variables in prior work related to timing and speed of action (e.g., Mitteness et al., 2012; Tataulicar et al., 2005).

Controls

Funding rounds This variable captures the total number of funding rounds a portfolio company has entered. This variable has been used in prior work, including Dutta and Folta (2016) and Reese et al. (2020).

Total amount raised This variable captures the total amount raised in the round in U.S. dollars. This variable has been used in extant work (e.g., Ko & McKelvie, 2018).

The age of the portfolio company is calculated as the difference between the founded date and July 2022. This variable has been used in prior work (e.g., Dutta & Folta, 2016; Ko & McKelvie, 2018).

The size of the portfolio company is calculated based on the number of employees. Crunchbase reports the number of employees in intervals—1 to 10, 11-50, 51-100, . . . 10000+. I created an ordinal variable to capture the size of the portfolio company that ranges from 1-9. A higher value corresponds to a larger size. This variable is included in prior research (e.g., Block et al., 2015).

Descriptive Statistics

The descriptive statistics for the above-described variables are available in Table 1 and Table 2. The correlation matrix in Table 2 suggests that time (year) and opacity are negatively related ($\beta = -0.906$, $p < 0.05$), which is in line with the relationship in hypothesis 1. Further, the correlation coefficient between time (speed of investment) and nature of opacity is negative and significant ($\beta = -0.033$, $p < 0.05$), suggesting that with time, the nature of opacity becomes high in agentic element compared to generic element, which is in line with a hypothesized relationship in H2. While not the focal point of this study, some correlation coefficients are worth discussing here. For instance, the correlation coefficient between the opacity and the nature of opacity [generic element/agentic element] is

positive and significant ($\beta = 0.111, p < 0.05$), which suggests that as opacity declines, the nature of opacity becomes low in generic element, in other words, the agentic element increases.

TABLE 1- Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Opacity related to Scholarly knowledge	4546	0.87	0.092	0.431	0.995
Opacity related to Technical Application	4546	0.718	0.24	0.026	0.993
Opacity related to Market Valuation	4546	0.717	0.208	0.151	0.991
Opacity	4546	0.768	0.179	0.203	0.993
Time (year)	4546	14.546	6.539	1	26
Nature of Opacity	4546	0.093	0.019	0	0.2
Total Investors	4546	709.558	283.405	1	991
Time (speed of investment)	4546	1418.43	1101.952	0	9415
Number of Funding rounds	4546	4.412	2.675	1	19
Total raised Amount	4546	16100533	41457290	17	1.00E+09
Age of the Portfolio Company	4535	7.541	3.972	0	39
Size of the Portfolio Company	4493	2.743	1.328	1	9

TABLE 2- Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Opacity related to Scholarly Knowledge											
(2) Opacity related to Technical Application	0.971*										
(3) Opacity related to Market Valuation	0.960*	0.995*									
(4) Opacity	0.977*	0.999*	0.997*								
(5) Time (year)	-0.922*	-0.897*	-0.896*	-0.906*							
(6) Nature of Opacity	-0.115*	-0.110*	-0.108*	-0.111*	0.136*						
(7) Total Investors	-0.219*	-0.238*	-0.240*	-0.237*	0.227*	0.385*					
(8) Time (speed of investment)	-0.308*	-0.316*	-0.318*	-0.317*	0.282*	-0.033*	0.078*				
(9) Number of Funding rounds	0.067*	0.073*	0.070*	0.071*	-0.045*	-0.01	-0.031*	-0.126*			
(10) Total raised Amount	0.045*	0.047*	0.046*	0.047*	-0.041*	-0.021	0.005	0.114*	0.220*		
(11) Age of the Portfolio Company	0.221*	0.220*	0.220*	0.222*	-0.211*	-0.01	-0.039*	-0.628*	0.245*	0.102*	
(12) Size of the Portfolio Company	0.153*	0.157*	0.153*	0.156*	-0.136*	-0.013	-0.014	-0.185*	0.453*	0.393*	0.327*

* p<0.05

RESULTS

The purpose of this empirical treatment is to assess the temporality related to opacity; it is the relative level and nature and consequences of entrepreneurial action. While the relative level of opacity is assessed over the 26 event years included in the study, the assessment of the nature of opacity necessitates undertaking a granular investigation of the tempos at which KPs are mitigated. Therefore, it is calculated at the funding round level.

Hypothesis 1 predicted the relationship between the overall level of opacity and time. First, I ran regression models to test the relationships between sub-measures of opacity (i.e., opacity related to scholarly knowledge, technical application, and market evaluation) and time (models 1-3, Table 3). The coefficients of these sub-measures of opacity are negative and significant. To test the relationship in hypothesis 1, I ran model 4 (Table 3). Since the dependent variable, opacity, is a continuous variable. I ran OLS regression. The coefficient of opacity is negative and significant ($\beta = -0.0315$, $p < 0.01$), which provides statistical support for the negative relationship between opacity and time. This suggests that over time, the opacity related to the influence of AI reduces.

TABLE 3- Regression Results. Level of Opacity and Time

Dependent Variable	Opacity related to Scholarly Knowledge	Opacity related to Technical Application	Opacity related to Market Evaluation	Opacity
Hypothesis tested				H1
Model #	Model 1	Model 2	Model 3	Model 4
Time (year)	-0.0202*** (0.00266)	-0.0395*** (0.00352)	-0.0348*** (0.00303)	-0.0315*** (0.00290)
Constant	41.43*** (5.341)	80.02*** (7.076)	70.67*** (6.088)	64.04*** (5.835)
No. of funding rounds	4,546	4,546	4,546	4,546
No. of event-years	26	26	26	26
R-squared	0.706	0.840	0.846	0.831

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Next, in hypothesis 2, I predicted the relationship between the nature of opacity (generic element/agentive element) and time. Specifically, I hypothesized that the composition of opacity would change from high in generic element to high in agentive element. As suggested earlier, this hypothesis pertains to the different tempos at which KPs are mitigated. As a result, the main variables are at a granular level—the funding round. As such, the dependent variable and the independent variable (time 33—speed of investment) are at the funding-round level, and opacity relates to the AI industry at the macro level. Therefore, I used a mixed-effects, multi-level model. Scholarship has suggested that multi-level modeling should be used when hypotheses to be tested are at different levels or some controls are at different levels of analysis (Peterson et al., 2012). This aligns with recent work in entrepreneurship by Crowley and Barlow (2022) and Schade and Schumacher (2022). Thus, to test hypothesis 2, I ran the multi-level regression as in model 7. Since the coefficient of nature of opacity is negative and significant ($\beta = -6.89e-06$, $p < 0.05$), it suggests that the value of the generic element relative to the agentive element declines, providing support for the hypothesized relationship.

³³ Note that the value of time corresponding to hypothesis 1 is the year, whereas that in hypothesis 2 is the speed of investment (i.e., earlier the investment made, larger the value of time) which is calculated at the funding round level. Opacity from hypothesis 1 is included as a control when testing hypothesis 2. Therefore, hypothesis 2 is multi-level analysis. This is because the study seeks to investigate temporality of Opacity (as a configuration of KPs) by both undertaking an over time perspective corresponding to the overall level of opacity and considering the difference across the investors' tempo of investment, corresponding to the change in composition of opacity from high in generic element to high in agentive element.

TABLE 4- Regression Results. Nature of Opacity and Time

Dependent Variable	Nature of Opacity = log(Generic Element / Agentic element)	Nature of Opacity = log(Generic Element / Agentic element)	Nature of Opacity = log(Generic Element / Agentic element)
Hypothesis tested			Hypothesis 2
Model #	Model 5	Model 6	Model 7
<i>Independent Variable</i>			
Time (Speed of investment)		-2.60e-06**	-6.89e-06**
		(3.32e-06)	(4.55e-06)
<i>Controls</i>			
Number of funding rounds for the Portfolio Company	-0.000472		-0.000463*
	(0.00149)		(0.00149)
Total Amount Raised	-1.15e-11***		-4.64e-11***
	(9.17e-11)		(9.42e-10)
Age of the Portfolio Company	0.00132***		-0.000166*
	(0.00012)		(0.00125)
Size of the Portfolio Company	-0.000105		-6.06e-06
	(0.000383)		(0.00317)
Opacity (lagged)	-0.274***		-0.281***
	(0.0673)		(0.0674)
Constant	-2.207***	-2.406***	-2.202***
	(0.0607)	(0.00737)	(0.0607)
Year Controls	Yes	Yes	Yes
Observations	3,917	4,047	3,917
Number of years	25	25	25

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Next, in hypothesis 3a, I predicted that the number of investors would increase as opacity decreases. To test this, I ran model 10 (Table 5). Since the opacity coefficient is negative and significant ($\beta = -0.0615$, $p < 0.01$), the analysis supports hypothesis 3a.

TABLE 5- Regression Analysis. Number of Investors and the Level of Opacity

Dependent Variable	Number of Investors (log transformed)	Number of Investors (log transformed)	Number of Investors (log transformed)
Hypothesis tested			H3 A
Model #	Model 8	Model 9	Model 10
<i>Independent Variable</i>			
Opacity	-0.827***		-0.0615***
	(0.149)		(0.229)
<i>Controls</i>			
Number of funding rounds for the Portfolio Company		-0.000912	-0.000682
		(0.00510)	(0.00503)
Total Amount Raised		5.55e-11	2.02e-10
		(3.13e-10)	(3.10e-10)
Age of the Portfolio Company		0.00330	0.00353
		(0.00343)	(0.00343)
Size of the Portfolio Company		0.00313	0.00217
		(0.0108)	(0.0107)
Constant	6.985***	6.021***	6.283***
	(0.119)	(0.0903)	(0.206)
Year Controls	Yes	Yes	Yes
Observations	3,987	4,018	3,936
Number of years	25		25

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Next, hypothesis 3b predicted that the number of investors increases as the nature of opacity changes from high in generic element to high in agentic element. To test this hypothesis, I ran model 13 (Table 6). Since the coefficient of nature of opacity (log [generic element/agentic element]) is negative and statistically significant ($\beta = -1.692$, $p < 0.01$), hypothesis 3b is supported.

TABLE 6- Regression Analysis. Number of Investors and the Nature of Opacity

Dependent Variable	Number of Investors (log transformed)	Number of Investors (log transformed)	Number of Investors (log transformed)
Hypothesis tested			H3 B
Model #	Model 11	Model 12	Model 13
<i>Independent Variable</i>			
Nature of Opacity = log (generic element/agentive element)	-1.693*** (0.0429)		-1.692*** (0.0432)
<i>Controls</i>			
Number of funding rounds for the Portfolio Company		-0.000912 (0.00512)	-0.00253 (0.00403)
Total Amount Raised		5.55e-11 (3.15e-10)	1.57e-10 (2.49e-10)
Age of the Portfolio Company		0.00330 (0.00344)	0.00556** (0.00273)
Size of the Portfolio Company		0.00313 (0.0109)	-0.00422 (0.00856)
Constant	10.44*** (0.108)	6.021*** (0.0906)	10.28*** (0.127)
Year Controls	Yes	Yes	Yes
Observations	4,047	4,018	3,995
Number of years	26	26	26

Standard errors in parentheses
 *** p<0.01, ** p<0.05, * p<0.1

Given the increasing practitioner interest in understanding the AI landscape (cf. Townsend & Hunt, 2019), it is important to draw a parallel between this study’s findings and the widely available data on AI and investment trends. The figures reported by Statista suggest that the funding (in U.S. billion dollars) in AI is increasing over time from 2011 to 2021. Further, major investments are made mostly by VCs (Statista).

Robustness Checks

To rule out the possibility of alternative explanations, I ran the following robustness checks (Tables 7-10). First, given that the study's context is AI, the opacity is calculated related to AI. However, changes in environmental factors can impact the results (Hsieh et al., 2021). To control for this, I include a variable that captures the unknowingness created by other environmental changes—global economic policy uncertainty (GEPU). GEPU is a measure based on the newspaper count of the mentions of “uncertainty” related to macro-environmental factors (e.g., Brexit, 9/11, elections) (Baker et al., 2016). This variable has been used in recent work (e.g., Alola et al., 2020; Tajaddini & Gholipur, 2021). Next, I ran the regression after removing 2008-2009 to rule out the possibility that the effects of the Great Recession drove the results. Third, given that the VCs are highly represented in the investors, I ran the analysis by creating a measure of the nature of opacity using only the investments by angels, CVCs, and PEs firms.

TABLE 7- Robustness Analysis for Hypothesis 1

Dependent Variable	Opacity	Opacity
Robustness	Remove years 2008, and 2009	Add GEPU as a control
Hypothesis tested	H1	H1
Model #	Model 14	Model 15
Time (year)	-0.0255*** (0.000194)	-0.0159*** (0.000237)
Global Economic Policy Uncertainty (GEPU)		-0.0015946*** (0.0000302)
Constant	1.141*** (0.00317)	1.203*** (0.00256)
Observations	24	25
No. of funding rounds	3,559	3,910
R-squared	0.827	0.895

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

TABLE 8- Robustness Analysis for Hypothesis 2

Dependent Variable	Nature of Opacity = log[Generic Element/ Agentic element]	Nature of Opacity = log[Generic Element/ Agentic element]	Nature of Opacity = log[Generic Element/ Agentic element]
Robustness	Remove years 2008 and 2009	Add EPU as a control	Remove VCs
Hypothesis tested	H2	H2	H2
Model #	Model 16	Model 17	Model 18
<i>Independent Variable</i>			
Time (Speed of investment)	-4.69e-06	-3.44e-06	-2.05e-06
	(4.68e-06)	(4.57e-06)	(5.49e-06)
<i>Controls</i>	Yes	Yes	Yes
Global Economic Policy Uncertainty		0.0004275	
		(0.000064)	
Constant	-2.215***	-2.212***	-3.495
	(0.0597)	(0.0610)	(0.074)
Year Controls	Yes	Yes	Yes
Observations	3,559	3,910	3,936
Number of years	23	25	25

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

TABLE 9- Robustness Analysis for Hypothesis 3 A

Dependent Variable	Number of Investors (log transformed)	Number of Investors (log transformed)	Number of Investors (log transformed)
Hypothesis tested	H3 A	H3 A	H3 A
Robustness	Remove years 2008, and 2009	Add EPU as a control	Remove VCs
Model #	Model 19	Model 20	Model 21
<i>Independent Variable</i>			
Opacity	-0.0716 (0.227)	-0.0294062 (0.229)	-0.01614 (0.104)
<i>Controls</i>	Yes	Yes	Yes
Global Economic Policy Uncertainty		0.0029 (0.00023)	
Constant	6.270*** (0.204)	6.3062*** (0.192)	4.138*** (0.093)
Year Controls	Yes	Yes	Yes
Observations	3,578	3,983	3,995
Number of years	23	25	25

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

TABLE 10- Robustness Analysis for Hypothesis 3 B

Dependent Variable	Number of Investors (log transformed)	Number of Investors (log transformed)	Number of Investors (log transformed)
Robustness	Remove years 2008 and 2009	Add GEPU as a control	Remove VCs
Hypothesis tested	H3 B	H3 B	H3 B
Model #	Model 22	Model 23	Model 24
<i>Independent Variable</i>			
Nature of Opacity	-1.643*** (0.0457)	-1.630456*** (0.0457522)	-1.085* (0.024)
<i>Controls</i>	Yes	Yes	Yes
GEPU		0.001829 (0.00052)	
Constant	10.17*** (0.132)	10.259*** (0.133)	8.3887*** (.0718)
Year Controls	Yes	Yes	Yes
Observations	3,636	3,964	3,995
Number of years	24	25	26

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Overall, the results are robust as they are supported under different settings (Newbert et al., 2022) and are consistent with the regression analysis.

DISCUSSION

This study sought to understand the temporality of opacity arising from external changes in entrepreneurial action and outcomes through the lens of the KP framework (Townsend et al., 2018). Understanding temporality in entrepreneurial action and outcomes is timely (Juma et al., 2023). “Integrating the passage of time has the potential to highlight elements of the entrepreneurial process that are invisible if entrepreneurship is treated as an analog to arbitrage,” noted Korsgaard

and colleagues (2016, p. 876). By tapping into the AI industry, this study's findings show the presence of opacity variation related to AI in both the level and composition of opacity as a function of time. In doing so, the study joins ongoing conversations in entrepreneurship and related fields of study and opens vistas for future research, as explained below.

Scholarly Contributions

This study extends entrepreneurship literature by introducing the temporality of opacity as a mechanism to uncover heterogeneity in action. Extant research has argued that time has been undertheorized in entrepreneurship research and has called for a stronger theoretical and empirical investigation (e.g., Davidsson et al., 2021; Lévesque & Stephan, 2020). Highlighting the omission of time as a central element in entrepreneurship, McMullen and Dimov (2013) note that time has been “conspicuously absent from empirical work supposedly devoted to understanding the emergence of new ideas, products, firms, industries, etc.” (p. 1482). Toward this end, this study undertakes a centripetal approach to understand the role of time in entrepreneurship. By unraveling AI's temporal dynamics on entrepreneurship, this study joins and enriches recent scholarship focusing on understanding the temporality in entrepreneurial action and outcomes (e.g., Kotha et al., 2022; van Lent et al., 2021). While Wood et al. (2021) provide a fresh perspective by acknowledging the temporal dimensions in entrepreneurial action, this study integrates key insights from the KP framework and asserts that time influences the level and nature of opacity related to the impact of exogenous change

on entrepreneurial action. Consistent with the theorization, the results show a negative relationship between time and opacity, suggesting that opacity declines over time. Further, results reveal that the nature of opacity changes from high in generic element to that in agentic element over time. Taken together, these findings are consistent with the idea that understanding opacity's multi-temporality is imperative for theories of entrepreneurial action. Consequently, it provides a new approach to explaining how time matters (Wood et al., 2021). In doing so, this study responds to McMullen and Dimov's (2013, p. 1485) call to understand "how things change and develop over time."

Second, this study contributes to extant work seeking to link the macro- to the micro-level entrepreneurial action and outcomes (Davidsson et al., 2020) in two ways: (a) theoretically, the study offers a refined approach to understand the impact of macro-level changes on micro-level action (e.g., Cowen et al., 2022; Kim et al., 2016) by undertaking a panoramic view by accounting for the temporality of exogenous changes, and (b) at a methodological level, this study operationalizes the construct of opacity, that has not been the focus of empirical work in entrepreneurship yet. It is one of the first studies empirically investigating the relationship between opacity and entrepreneurial outcomes—heterogeneity. While studies have used frameworks, including Coleman's boat (1986), to understand the relationship between the macro and the micro level (e.g., Kim et al., 2016), this study offers a nuanced conceptual and empirical investigation to provide a multi-level study in entrepreneurship, thereby responding to calls to offer multi-level

understanding (Terjesen et al., 2013) of KPs (Townsend et al., 2018). This way, the study joins recent work examining the multi-level relationship in entrepreneurship (e.g., Schade & Schumacher, 2022).

Third, to the emergent work on the KP framework (Mitchell et al., 2022; Townsend et al., 2018), the study offers an enhancement by discussing the multi-temporality of KPs emanating from exogenous changes (Manocha, 2022; Rindova & Courtney, 2021). Technological exogenous changes have been extensively studied in research (e.g., Arend, 1999; Haddad & Hornuf, 2019; McMullen & Shepherd, 2006). While McMullen and Shepherd (2006) argue for the role of uncertainty from technological change in undertaking entrepreneurial action, this study undertakes a nuanced understanding of opacity—as a configuration of KPs and asserts that opacity is time-calibrated. This way, the study lends critical insights into the role of time in the impact of exogenous changes on entrepreneurship. Subsequently, by focusing on the temporality of opacity, this work opens vistas to investigate the relationship between opacity and entrepreneurial ideation, decision-making, action, and outcomes that have yet to receive scholarly attention. Economic theory has discussed the temporal resolution of uncertainty and its effects on individuals (Ahlbrecht & Weber, 1995; Chew & Epstein, 1989). Entrepreneurship research considers uncertainty and other KPs as the focal point of entrepreneurial action theory (McKelvie et al., 2011; Packard & Clark, 2020; Townsend et al., 2018). Thus, the ideas developed in this study shape the ongoing conversation on uncertainty, KPs, and entrepreneurial action. Subsequently, the study responds to Townsend et

al.'s (2018) calls for conducting research by undertaking a multi-temporal approach to KPs. The results of the study align with recent work, for instance, Brown and Rocha (2020) and Rocha et al. (2020) by drawing on CrunchBase data to investigate the financing landscape when COVID-19 hit, show that the portfolio companies are adversely affected from seeking early-stage and seed financing, suggesting uncertainty in the initial periods of COVID-19. The critical insights developed in this study offer a theoretical framework in this regard by arguing that the opacity related to an exogenous change is high at the emergence of the exogenous change and is largely composed of generic intensity (i.e., uncertainty and equivocality).

Fourth, this study enriches the conversation on the chronology related to investments by different types of investors (Block et al., 2018). Correspondingly, given that understanding heterogeneity among the investors such as VCs, CVCs, angels, and PE firms is considered important and timely (Tykova, 2019), the arguments developed in this study related to the composition of opacity and the relevant toolkit to mitigate the KPs constituting the opacity offers novel insights in this intriguing area of research spanning across the streams of entrepreneurship, finance, and entrepreneurial action. This study joins ongoing scholarly conversations by focusing on investors' profiles (e.g., Alvarez-Garrido et al., 2014). Next, by tapping into a key stakeholder in the entrepreneurship landscape—investors—this study responds to Wood and colleagues' (2021, p. 165) call for understanding the relationship between the temporal dimension and investor action. Aside from this, by tapping into the heterogeneity across the different

investors that constitute a critical part of the entrepreneurship landscape, the study extends to research that has sought to uncover heterogeneity primarily based on gender (Manocha et al., 2021) and sector (Korsgaard et al., 2020). While studies in entrepreneurial finance (Block et al., 2018) have argued for the differences across investors, by tapping into an important predecessor of entrepreneurial action, the external environment (Davidsson et al., 2020), the study provides a rich foundation for the application of entrepreneurial action theories across the spectrum of actors in the entrepreneurship landscape.

Next, the study's findings lend fresh insights into understanding the industry structure. McMullen and Dimov (2013) indicated using time as the focal predictor to understand the growth of the industry. The study's findings provide insights into the industry structure related to the chronology of different investors in an evolving industry. Understanding the industry structure has been a topic of key interest to strategy scholars. Studies have drawn upon Porter's five forces model (1980) to understand the industry structure (e.g., Agarwal & Gort, 1996). Extant scholarship has acknowledged "strategies must be matched with complementary environments and structures to promote success" (Miller, 1988, p. 280). Toward this end, the study injects fresh insights into understanding the evolution of industry structure in terms of the chronology of action by different investors. The underlying argument is that successful mitigation of the KP emanating from environmental change requires the correct match between the toolkit and the actual KP faced. To be clear, the study does not claim that the contribution made here is anywhere near that of

Porter's five forces. However, it provides a novel approach to understanding industry structure as an enactment of KPs. "Incubating new industries requires multiple actors—not just firms," noted Agarwal et al. (2017, p. 302). In this vein, the study's focus on investors responds to Agarwal et al.'s (2017) call to understand the role of various actors in industry structure.

Finally, the study's context is the AI industry. Largely driven by the practical application of AI, the scholarly interest in understanding the impact of AI on entrepreneurial action, decision-making, and outcomes is increasing (Lévesque et al., 2022; Obschonka & Audretsch, 2020; Shepherd & Majchrzak, 2022; Townsend & Hunt, 2019). Toward this, the study's position of undertaking a panoramic approach toward the effect of AI on entrepreneurship enriches the ongoing conversation on the role of AI in entrepreneurship (e.g., Chalmers et al., 2021; Chandra, 2022). As a result, the study's findings showcase the importance of viewing action following such technological changes along the different periods of time. The recent AI Index Report (2023) shows a recent increase in private investments and the total number of newly funded companies.

Given that there has been a key interest among policymakers worldwide related to AI, as evidenced by the increased spending on AI (AI Index Report 2023), the findings are also of key importance to the policymakers. Given that action increases when the opacity related to AI translates into high in the agentic element, policymakers should fund efforts to generate actions that move the generic KPs to agentic KPs. Early-stage money is well-spent on pure research because it involves

action when the generic element of opacity is very high. Government innovation policies can be very beneficial at this point, while the private sector can tackle the KPs germane to scaling issues involving ambiguity, complexity, and/or risk.

Limitations and Opportunities for Future Research

Several limitations of this study highlight avenues for future research. First, the operationalization of opacity is one of the first attempts to do so and has limitations. For instance, the sub-measure of opacity related to scholarly knowledge is a cumulative measure of articles, books, etc., published on AI across various disciplines. This sub-measure does not offer a nuanced understanding of the role of AI. Future work can take the next step and chalk out scholarship that informs the role of AI in entrepreneurship. Similarly, the opacity sub-measure related to technical application is operationalized using the number of new startups founded in AI. However, AI's technical application can include new business models and offerings in existing companies. The operationalization does not take it into consideration. As a result, future work can incorporate this possibility in operationalizing opacity. Next, the sub-measure opacity related to market valuation is measured based on the total number of startups that went public. Research has shown that while IPO is one factor that captures the market valuation of a company or an industry, other factors impact valuation, such as revenue growth potential (Penman, 1996) and board size (Yermack, 1996). Future work could include such factors to offer a more comprehensive measure of opacity.

Second, the research context of this study is the AI industry, which raises concerns about the generalizability of the findings. While AI is a technological exogenous change (Chalmers et al., 2021), scholars can utilize other types of exogenous changes (e.g., sociocultural, demographics, political) (Davidsson et al., 2020) to provide an enriched understanding of the temporality of opacity related to exogenous changes related to entrepreneurial action and outcomes. Third, the investors in the AI industry form the focal unit of understanding in this work. Future work could tap into understanding the multiplicity of KPs faced across the spectrum of actors (e.g., customers, suppliers, startup founders) in the entrepreneurship landscape. Next, due to the limitations of the archival data, the study does not differentiate AI across the sub-categories such as machine learning, natural language processing, and computer vision. A recent AI report (2023) suggests the presence of variation across these categories in terms of the total amount of investments made. Future scholarship can tap into this source of variation to refine the framework developed in this essay. Finally, this study focuses on the nature of opacity in terms of generic and agentic elements. Future scholarship can undertake a comprehensive understanding across the five KPs by undertaking nuanced conceptualization and organization of KPs. Toward this end, future studies could undertake scale development of the five KPs based on tools such as surveys and questionnaires, to offer a comprehensive understanding of opacity beyond the generic and agentic elements.

Conclusion

In sum, this study advances the understanding of the often-overlooked impact that the changing nature of exogenous changes across the temporal dimension might have on entrepreneurial action and outcomes. By asserting the temporality of KPs generated by exogenous changes that transform the relative level and the composition of opacity related to the exogenous changes, the study demonstrated the presence of variance in tempos in undertaking action. While research has offered individual-level differences in accounting for explaining the variance in the timeframe for action, this study introduces and tests the temporality of the opacity related to the influence of exogenous changes, thereby shaping the conversation to consider the temporality of the external environment (Wood et al., 2022). By tapping into the investments made in the AI industry, the study shows the presence of variance in the timing of entry for different investors and joins a growing body of work on KPs that has demonstrated the important influence of accurate diagnosis of the KPs and mitigating of the KPs in entrepreneurial action and outcomes (Hunt et al., 2023). Finally, the study injects a new dimension—temporality, to understand the heterogeneity of action from exogenous changes.

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CHAPTER FIVE

CONCLUSION

CONCLUSION

The objective of this dissertation is to offer a theoretically original and practically useful contribution to entrepreneurship research. By employing a knowledge problem (KP) perspective to understand heterogeneity in entrepreneurial action and outcomes, this dissertation simultaneously addresses the variance along the spatial and temporal dimensions in the effect of exogenous changes on entrepreneurial action and outcomes. Subsequently, the study joins a timely conversation in entrepreneurship research (Carter et al., 2021; Cestino et al., 2023; Juma et al., 2023; Davidsson et al., 2020; Wood et al., 2022). Entrepreneurship research has called for research that connects through the different yet inter-related level of analyses (e.g., Low & MacMillan, 1988). Increasingly scholars have focused on different frameworks, including Coleman's bathtub model (1986) to examine the impact of macro-level changes to the micro-level action and outcomes (e.g., Cowen et al., 2022; Kim et al., 2016), however, the problem is that these frameworks do not fully explain the heterogeneity of entrepreneurial action and outcomes.

There has been an increasingly scholarly interest in the understanding of how exogenous changes impact entrepreneurial action (e.g., Chen et al., 2020; Davidsson et al., 2020), specifically, by tapping into the “*variance* (related) to the environmental side of the equation” (Davidsson, 2020, p. 322, italics intact). This dissertation undertook a three-essay approach to understand the consequences of the variance in external environment in terms of heterogeneity of entrepreneurial action and outcomes. Individually, each essay offers fresh insights on the

heterogeneity of entrepreneurial action and outcomes. The first essay provides a theory that identifies and explains KPs as a causal link between exogenous changes and entrepreneurial action. Crucially, this essay offers a nuanced conceptualization of KPs, and suggests that KPs vary in their nature and the level of mitigation. The identification and mitigation of these KPs results in heterogeneous entrepreneurial action and outcomes. The second essay asserts the simultaneous occurrence of different KPs that explain heterogeneity in entrepreneurial action and outcomes. This study's research design undertakes an empirical investigation of a readily-identifiable exogenous change—NCAA's rule change on the use of name, image, and likeness (NIL), thereby aligning with the research question posed. As an exogenous change, NIL creates KPs for the potential entrepreneurs, including college athletes. Through the distribution of IRB-approved survey, the essay highlights the multi-dimensional nature of KPs, and associated heterogeneity in entrepreneurial action and outcomes. Methodologically, it pioneers the operationalization of KPs. The findings using survey data to operationalize KPs provides key insights for entrepreneurship practice and scholarship. This way, it addresses the challenge of relevancy in the field of entrepreneurship research (Wiklund et al., 2019). Entrepreneurship research has noted for the persistence of inequality (e.g., Lippmann et al., 2005). By tapping into the population of college athletes, the study's findings point to the presence of gender inequality, thereby, suggesting that exogenous changes can lead to differential effects (Manocha et al., 2021) that can exacerbate existing inequalities.

The third essay focuses on understanding the temporal dimension of KPs. Given that more than one KPs can occur simultaneously and sequentially, this study focuses on opacity, as a configuration of KPs, whose level and nature changes over time. Broadly, opacity can be understood as a relative combination of generic and agentic elements, where the generic element constitutes the less mitigable KPs—uncertainty and equivocality, whereas the agentic element constitutes the highly mitigable KPs—ambiguity, complexity, and risk. In this case, as necessitated by the research question, the research design uses longitudinal research setting to capture temporal dimension of KPs. This study pioneers the operationalization of opacity. It provides evidence that over time the level of opacity declines, and the composition of opacity changes from high in generic element to high in agentic element. By focusing on a critical group in the entrepreneurial landscape—investors, the study sheds light on the chronology with which the different investors participate when a new industry evolves. Through this, the study sheds insights into understanding the evolution of an industry’s structure (Agarwal et al., 2017).

Collectively, this dissertation offers a noteworthy contribution by developing a novel theory and offers usefulness to capture heterogeneity in entrepreneurial action and outcomes through the exposition of exogenous changes through two vastly distinct research designs and datasets. Scholars have urged to undertake a multi-level approach to link the macro-level to the micro-level to understand the heterogeneity across entrepreneurial action and outcomes (e.g., Jennings et al., 2013; Peterson et al., 2012), as sole reliance on undertaking an investigation that

links macro-level changes to the aggregated entrepreneurial action results in fallacy of aggregation (e.g., Foss, 2009; Stephan & Pathak, 2016). There is an increasing need to delve deeper into understanding the macro-factors and the changes in them as there is “*variance and similarity* across types and instances of environmental change” (Cater et al., 2021, p. 2, italics intact). Fundamentally, this dissertation provides a mechanism-based understanding of the effect of macro-environmental actor-independent factors on micro-level entrepreneurial action.

Given the theoretical originality and practical usefulness of the dissertation, I believe that it will shape, enrich, and enhance scholarly conversations in entrepreneurship and neighboring fields of scientific inquiry. For entrepreneurship to continue as a promising field of scientific inquiry it has to emphasize on “*relevance* (as) one of the perils of becoming a mature field is the development of a preoccupation with increasingly marginal questions and methodological subtleties, showing little interest for developments in other fields or real-world application, and being of little interest for others than devoted tribesmen” (Wiklund et al., 2011, p.7, italics intact). Subsequently, I can see three possible inter-related trajectories of future research from the contributions developed in this dissertation. First, future studies can focus on the nuanced understanding of the variance and similarities across different instances of exogenous changes. Given that these variances and similarities in the effect of exogenous changes on entrepreneurial action can be conceptualized and operationalized using KPs, future studies can explore the effect of different types of exogenous changes. Exogenous changes vary

across a spectrum of types, such as technological, institutional, natural environmental changes (Davidsson et al., 2020). Further, within these types of changes, such occur quickly compared to others (Cestino et al., 2023; Juma et al., 2023). For instance, natural-environmental changes such as Tsunamis are more sudden than other environmental changes, such as Pandemics. Entrepreneurship scholars can examine the KPs generated by such changes to understand entrepreneurial action and outcomes—their similarity and variation based on the exogenous changes. Consequently, this trajectory will offer improved operationalization of the KPs, thereby providing a refined understanding of the KPs (Townsend et al., 2018) and resultant entrepreneurial action and outcomes.

Second, given the large number of stakeholders in an entrepreneurial ecosystem (Stam & Van de Ven, 2021) that can be impacted by exogenous changes, future conversations can investigate if and how the different stakeholders face similar kinds of KPs. While this dissertation pioneers the operationalization of KPs through two vastly different channels—survey items and archival data, future work can take a step ahead on a more robust operationalization of KPs and offer additional insights to examine the presence of the heterogeneity across the spectrum of stakeholders in entrepreneurial ecosystem. This trajectory has key implications for policy as well. Given that essay two underscores the presence of gender gap in outcomes by undertaking entrepreneurial action in the light of name, image, and likeness. The findings report the persistence of gender gap that conflicts

with the broader objective ³⁴ of Title IX, providing need for entrepreneurship scholarship that offers policy implications. In a recent *Entrepreneurship: Theory and Practice* editorial, the Editors van Gelderen, Johan Wiklund, and Jeffrey McMullen (2021) suggested that in the near future, entrepreneurship as a field of study will be increasingly focused on addressing the grand societal challenges. One of the grand challenges that the policymakers, around the world, continue to address is that of inequality, as a consequence of exogenous changes such as COVID-19, climate change, and political conflicts (Sustainable Development Report, 2022). I believe that the dissertation offers fertile grounds for future studies to uncover variances that point to concerns related to gender and other inequalities. Subsequently, it offers an avenue to bridge theory to practice and policy, which is a key cornerstone of entrepreneurship field (cf. Muñoz & Dimov, 2023).

Third, in line with the ongoing scholarly conversation on the role of Artificial Intelligence (AI) in entrepreneurial decision-making, action, and outcomes (Lévesque et al., 2022; Obschonka & Audretsch, 2020), the insights developed in this dissertation offer predictions on the augmentative role of AI tools in entrepreneurship. Scholarship has noted that “AI holds great promise to transform entrepreneurship into a more relevant and impactful field”, however, the relationship between AI tools and entrepreneurship is complex (Shepherd, Majchrzak, 2022, p.2). Through the novel insights developed in this dissertation on the identification, and mitigation of KPs, there can be two broad ways the field’s

³⁴ Title IX requires that educational institutions create equal opportunities, irrespective of gender, however, the study’s findings suggest the presence of gender gap. This is not in direct violation of Title IX, however, at a societal level exacerbates the inequalities related to gender.

understanding of AI can be shaped. First, developments in AI can be used to accurately identify the actual KP faced by the entrepreneur. Recent work has shown that misdiagnosis between actual and perceived KP is a costly endeavor (Hunt et al., 2023). Entrepreneurship research can highlight the importance of using AI tools in decision-making to identify the KP. Recent work that suggests that the widespread availability of AI tools enables entrepreneurs to leverage these technologies in decision-making (Chalmers et al., 2021; Short & Short, 2023; Townsend & Hunt, 2019). Second, and in line scholarship (Townsend & Hunt, 2019), I suggest that AI be useful to detect the type of KP, but also, based on the identified KP, and taking a step ahead, AI can be used as a tool to mitigate the KPs of ambiguity, complexity, and risk. Consequently, this dissertation offers key practical applicability, and in doing so, seeks to offer an integrative voice in entrepreneurship scholarship (Dimov, 2016; Kapasi & Rosli, 2020).

By balancing theoretical originality and utility for the advancement of entrepreneurship discipline, in practical and scientific directions, this dissertation offers a novel approach to understand the heterogeneity of entrepreneurial action. Given the practical and scholarly usage of the topic, this dissertation provides a critical insight towards advancement of entrepreneurship—theory and practice. Through the examination of KPs as a causal link between the macro-level environmental factors and the micro-level entrepreneurial action, the dissertation opens new vistas for the continued progress of this promising area of entrepreneurship research.

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APPENDICES

APPENDICES

The following Appendices are related to the empirical study in Chapter 3.

Appendix A - IRB Approval Letter

	<p>Division of Scholarly Integrity and Research Compliance Institutional Review Board North End Center, Suite 4120 (MC 0497) 300 Turner Street NW Blacksburg, Virginia 24061 540/231-3732 irb@vt.edu http://www.research.vt.edu/siro/hrpp</p>
MEMORANDUM	
DATE:	April 14, 2022
TO:	Richard A Hunt, Parul Manocha
FROM:	Virginia Tech Institutional Review Board (FWA00000572)
PROTOCOL TITLE:	Game Change: Exploring the Impact of Name, Image and Likeness Rule Changes on NCAA Student-Athlete Entrepreneurial Opportunity Pursuit
IRB NUMBER:	21-936
<p>Effective April 14, 2022, the Virginia Tech Human Research Protection Program (HRPP) determined that this protocol meets the criteria for exemption from IRB review under 45 CFR 46.104(d) category (ies) 2(ii).</p> <p>Ongoing IRB review and approval by this organization is not required. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these activities impact the exempt determination, please submit an amendment to the HRPP for a determination.</p> <p>This exempt determination does not apply to any collaborating institution(s). The Virginia Tech HRPP and IRB cannot provide an exemption that overrides the jurisdiction of a local IRB or other institutional mechanism for determining exemptions.</p> <p>All investigators (listed above) are required to comply with the researcher requirements outlined at: https://secure.research.vt.edu/external/irb/responsibilities.htm (Please review responsibilities before beginning your research.)</p>	
PROTOCOL INFORMATION:	
Determined As:	Exempt, under 45 CFR 46.104(d) category(ies) 2(ii)
Protocol Determination Date:	April 14, 2022
ASSOCIATED FUNDING:	
<p>The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.</p>	
<p><i>Invent the Future</i></p> <p>VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY <i>An equal opportunity, affirmative action institution</i></p>	

Appendix B - Survey Items

This Appendix explains the measures included in the study (Chapter 3) that are produced using the survey items.

Knowledge Problems with high mitigability (Ambiguity, Complexity, and Risk)

To measure the high KP mitigability, participants were directed to respond to the following five survey items to understand the KP they face in the light of NIL. Each of the following items used to measure the high KP mitigability describes the extent to which the KP faced by the athlete in their monetization of NIL is related to ambiguity, complexity, and/or risk. The respondents were shown the following 5 items are asked to rate on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), their level of disagreement or agreement with each statement. The measure is a sum of the individual scores corresponding to each item. The Cronbach's alpha for this measure is 0.75 which is above the recommended value of 0.7 (Nunnally, 1978). The items included for this measure are as follows:

Item #	Description [Strongly Disagree (1)— Strongly Agree (5)]
1	There are significant opportunities for me to make money from NIL
2	There are significant risks to making money from NIL
3	Making money off NIL is a huge time commitment adding to my course loads and practice schedules
4	I am willing to undertake risks to make money from NIL
5	Any athlete in NCAA Divisions 1, 2, and 3 can make money from NIL

Knowledge Problems with low mitigability (Uncertainty and Equivocality)

To measure the low KP mitigability, I used the following 4 items that describe the extent to which the KP faced is uncertainty or equivocality. The respondents were shown the following 4 items and asked to rate using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), their level of disagreement or agreement with each of the following statements. The measure is a sum of the individual scores corresponding to each item. The Cronbach's alpha for this item is 0.88, which is above the acceptable value of 0.7 (Nunnally, 1978). The items included for this measure are as follows:

Item #	Description [Strongly Disagree (1)— Strongly Agree (5)]
1	Only the best college athletes in NCAA Divisions 1, 2, and 3 can make money from NIL
2	Only college athletes from top schools in NCAA Divisions 1, 2, and 3 can make money from NIL
3	Only college athletes participating in highly televised sports can make money from NIL
4	Only college athletes participating in football and men's basketball can make money from NIL

School Action

This study developed a measure of the following 4 items to measure the various actions undertaken by the school in creating opportunities for the athletes to monetize off NIL. The respondents were shown the following 4 items and asked to rate on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), their level of disagreement or agreement with each statement. Item responses are aggregated to produce measure for School Action. A higher score corresponds to a higher level of School Action and low scores indicate less School Action to create opportunities for athletes to monetize NIL. The measure produced a Cronbach's Alpha of 0.94, which exceeds criterion of 0.7 for internal consistency of a measure, as suggested by Nunnally (1978). The items included in this measure are as follows:

Item #	Description [Strongly Disagree (1)—Strongly Agree (5)]
1	My school has helped me in understanding how to ensure compliance with s'hool's NIL policy
2	My school has arranged information sessions (e.g., those by athletics department, outside agencies) to familiarize me with the NIL policy
3	My school is taking an active role in trying to create opportunities for college athletes to financially benefit from the NIL policy
4	My school has hired professional service provider(s) to create opportunities to financially benefit from the NIL policy

School Policy

This measure is developed using the following 4 items. The respondents were shown the following 4 items and asked to rate on a three-point Likert scale: 1 (Yes), 2 (No), and 3 (I don't know) their confinement with each statement. To calculate the measure, I coded Yes as 1, No as -1, and I don't know as 0. Item responses are aggregated to produce a measure for School Policy. A higher score corresponds to a higher level of School Policy and low scores indicate less School Policy to facilitate NIL monetization. The Cronbach's Alpha for this measure is 0.74 which is above the recommended value of 0.7 for reliability (Nunnally, 1978). The items included in this measure are as follows:

Item #	Description [Yes (1) , No (-1), I don't know (0)]
1	My school has an NIL policy in addition to the NCAA's NIL policy
2	My school allows college athletes to use the school's logo for any endorsement deals
3	My school is utilizing applications (such as Opendorse, INFLCR) as portals to upload the NIL contracts to be reviewed by the compliance department
4	It is convenient to use the platform provided by my school to upload NIL contracts for review and approval by the school

Appendix C - Odds Ratio

Given that the dependent variables to test hypotheses 1, 2 and 3b are binary, the following Table A provides the odds ratio. Research has suggested that odds ratio offers clear understanding of the effect size when the dependent variable is binary (Long & Freese, 2006). Hypothesis 1 suggested that higher knowledge problem mitigability (KP) will result in business model application. As shown in Model 16, the odds ratio for KP mitigability is greater than 1 (odds ratio = 4.145, $p < 0.01$), suggesting a positive relationship as suggested in hypothesis 1. Further, as shown in Model 17 the odds ratio for KP mitigability is greater than one, however not significant. Finally, Model 18 reports the odds ratio associated with KP mitigability and exit, which is less than 1 (odds ratio = 0.048, $p < 0.01$), providing support for hypothesis 3b, which suggested a negative relationship between KP mitigability and exit. The results indicate that there is a 95% decrease in exit rate when the KP faced is high in mitigability, compared to when the KP faced is low in mitigability.

TABLE A- Regression Analysis (Odds Ratio)

Dependent Variable	Business Model Application	Business Model Experimentation	Exit
Regression	Logistic (Odds Ratio)	Logistic (Odds Ratio)	Logistic (Odds Ratio)
Hypothesis tested	H1	H2	H3b
Model #	Model 16	Model 17	Model 18
<i>Independent Variable</i>			
Knowledge Problem Mitigability (=1 if high, 0 otherwise)	4.145***	1.495	0.048***
	(0.451)	(0.444)	(0.451)
<i>Controls</i>	Yes	Yes	Yes
Observations	160	160	203

Standard errors in parentheses

***p<0.01, **p<0.05,*p<0.1