Innovation-Driven Entrepreneurship

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June 2023

Entrepreneurship is a key driver of economic growth. While the definition of entrepreneurship ranges from self-employment, to small-and-medium sized enterprises, to technology- and innovation-driven startups, recent research suggests that economic growth is driven not by overall quantity of new firm entry, but rather by a small subset of high-growth entrepreneurial firms that are primarily categorized as innovation-driven. This paper provides a review of the growing literature on the economics of such innovation-driven entrepreneurship. We begin by distinguishing between the various forms of entrepreneurship, which are often confounded in both theory and empirical work. We then lay out the current state of knowledge across significant areas of economic research, and describe the challenges faced by researchers in the field, particularly around measurement, data, and identification. We conclude with an overview of the major open questions and directions for future research in the area.

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* Botelho: Yale University. Fehder: University of Southern California. Hochberg: Rice University and National Bureau of Economic Research (NBER). Andrew Hebert, Emma Kirby, Abigail Liu, Arden Onanian, Gabriel Rojas and Sidney Saint-Hilaire provided excellent research assistance. Daniel Lee provided valuable input to early proposal drafts. Opinions and conclusions expressed herein are solely those of the authors and do not represent the opinions or policy of the institutions with which the authors are affiliated.

1. Introduction

"…the entrepreneur is the single most important player in a modern economy."

–Edward Lazear (2005)

Entrepreneurship is an area of study that is not new to the economics literature. The introduction of new ideas into the economy sits at the front and center of our current understanding of economic growth (Romer 1990; Aghion and Howitt 1992). These new ideas take many forms, ranging from brand-new discoveries to innovative recombinations of existing material and labor, and are limited "only by the laws of nature" (Weitzman 1998). A significant source of integration of new ideas into the economy is the entrepreneur, described by Schumpeter (1942) as engaging in a process of "creative destruction," constantly replacing current modes of production with more productive ones. Schumpeter's observations spawned a large theoretical literature examining the nature of entrepreneurial discovery (see e.g., Kirzner 1997), which has since been incorporated into a coherent equilibrium account of endogenous economic growth that stresses the role of entry by new firms (Aghion and Howitt 1992).

These theoretical developments were followed by a raft of empirical studies that further emphasize the importance of new firm entry for economic growth (e.g., Davis and Haltiwanger 1992; Davis, Haltiwanger, and Schuh 1998; Haltiwanger, Jarmin, and Miranda 2012; Decker et al. 2014). These empirical studies have furthered the notion that economic growth is tied to business dynamics—the process of firm entry, expansion, contraction and exit (e.g., Jovanovic and MacDonald 1994). Studies using US Census data show that job growth is disproportionately driven by new firms (Davis and Haltiwanger 1992; Davis, Haltiwanger, and Schuh 1998; Haltiwanger et al. 2012; Decker et al. 2014; Fairlie, Miranda, and Zolas 2019). These young firms, however, exhibit positive skewness in their growth rate distribution, and the relationship between entrepreneurship and economic growth appears to be driven not by the overall quantity of new firm activity, but rather by a smaller subset of high-growth, innovation-driven startups (Haltiwanger et al. 2012; Decker et al. 2014). This is true not only in the US, but also across many other developed countries (Bravo-Biosca, Criscuolo, and Menon 2016).[1]

[1] Consistent with these findings, related work by Acemoglu and Cao (2015) shows that in innovation intensive sectors, young firms are also the most innovation intensive.

These patterns are perhaps not surprising. Although small business entrepreneurs are a vital part of the overall economy, studies of small business entrepreneurs emphasize the low growth prospects of the average self-employed individual (Evans and Leighton 1989; Hamilton 2000; Schoar 2010; Hurst and Pugsley 2011; La Porta and Shleifer 2014; Levine and Rubinstein 2017). Work in this area further suggests that most small business owners are different from the Kirzner or Schumpeterian view of "innovation-driven" entrepreneurs—with little desire to grow, innovate, or bring new products to market. Further emphasizing this distinction between types of entrepreneurs, studies such as Guzman and Stern (2015; 2020) document substantial regional and intra-regional variation in the growth potential for startups, even within the same industry.

Although this distinction between types of new ventures is not always straightforward to ascertain ex ante, it is of great importance to entrepreneurs, policy makers, and researchers. The drivers of discovery, founding, funding, growth, and success likely differ substantially across different types of entrepreneurship. Yet both policy makers and researchers often treat entrepreneurs as a homogenous group (Hurst and Pugsley 2011), confounding the true impacts of entrepreneurs on the economy. As an example, different definitions of entrepreneurship lead to different conclusions about the rate of entrepreneurship activity in the economy. Population-level indices such as the Business Dynamics Statistics Database suggest a secular decline in the rate of business dynamism and new firm formation overall (Hathaway and Litan 2014; Decker et al. 2016), while research focused on venture capital documents a sizable increase in the funding of innovation-driven entrepreneurial businesses (Gornall and Strebulaev 2021).

As researchers increasingly turn their focus to the topic of entrepreneurial activity, it is increasingly important that we distinguish between the varying types of entrepreneurial activity and their different dynamics and needs. This review takes this as a starting point, emphasizing the known and unknown regarding *innovation-driven entrepreneurship* in particular. Much of the empirical economics literature in entrepreneurship to date confounds multiple of the above categories of entrepreneurial activity, and, as a result, we often know less than we think we do about the specific mechanisms at work in the entrepreneurial production function of each of these groups. This review also aims to solidify what we know regarding innovation-driven entrepreneurship, while highlighting gaps and areas of particular interest for future research.

Definitions of entrepreneurs in economic theory vary from individuals who take economic risks (Knight 1921; Kihlstrom and Laffont 1979), to those who innovate and render older

technologies obsolete (Schumpeter 1942), to those who assemble human, physical, and information resources in an efficient manner (Lazear 2004). Policymakers and practitioners often define entrepreneurs as those who set up a business and take on financial risks in the hope of profit, consistent with the view of entrepreneurs as job creators and drivers of economic growth. In the popular press, in contrast, the image of the entrepreneur is often tied to the process of technological innovation that drives economic growth.

Certainly, many activities can be reasonably labeled as entrepreneurship, from creation of a new product or service line to establishment of a new company to self-employment, with many activities not being mutually exclusive. The types of entrepreneurship studied in the economics literature can be broadly classified into four buckets. First, a larger literature, primarily in development economics, has explored what we label here as *subsistence entrepreneurship*. Subsistence entrepreneurship has primarily been studied in the context of developing countries but is more generally defined as poverty-driven individual entrepreneurship that provides services in a local community in a variety of manners. Typically, subsistence entrepreneurs are providing for themselves and their families, often at a minimal level, as a substitute for low-wage employment. The typical subsistence entrepreneur has limited alternative employment opportunities. A second category are the *self-employed*. In the developed world, this category typically includes consultants, ad hoc self-employed doing freelancing or piece work jobs, lawyers and doctors in private practice, and gig economy workers. Importantly, this category of self-employed typically is not organized for growth. While both these categories of entrepreneurial activity are important and influential areas of research that deserve their own coverage, they are distinct from the process of creating an employer business (see Parker (2004) for an overview on the literature on self-employment and Schoar (2010) for a discussion of subsistence entrepreneurship).

The remaining two buckets in the entrepreneurship literature study incorporated employer businesses. These types of entrepreneurship are associated with the establishment of a new formal company, and have the potential to grow through the attraction of resources and capabilities to that firm. Even among opportunity-based businesses, however, there can be significant heterogeneity in the nature of the firms formed. We distinguish between *innovation-driven entrepreneurship* (IDE), which is characterized by the introduction of either novel ideas or a novel combination of ideas into a new venture, and *traditional business entrepreneurship* (TBE), which is characterized

by the use of existing business approaches to solve existing problems in existing markets.[2] Innovation in an IDE venture may be the product of technological or scientific advances, business model innovation, or business process innovation. In contrast, a TBE venture will typically be dealing with a product or service that has already achieved product market fit, and for which there is significantly less uncertainty. Our categorization intentionally abstracts away from the size aspect of the management literature's definition of small and medium-sized enterprises (SME) and IDE. Small firms with regional aspirations may still be characterized by significant innovation, and traditional businesses with limited innovation may still grow large and compete globally.

Note that the distinction between the categories can be considered a matter of degree. Although we discuss these groupings as two distinct categories in this review, at the margin the categories may overlap, and assignment to a specific category may be subjective and dependent on the assignor's perception of the degree of innovation involved. New ventures may vary substantially in the degree to which they pursue radical innovations, incremental innovations, or any innovations at all. Small innovations may be present even ventures some may think of as "traditional." In this sense, IDE and TBE can be thought of as two ends of a spectrum. While researchers have begun to explore how distinct these two types of entrepreneurship are, and where they overlap, significantly more work remains to be done.

One way to characterize the difference between the two poles of IDE and TBE ventures is to consider how the two types of ventures differ in terms of uncertainty on a variety of dimensions. A TBE venture, because it is engaged in known markets, with known business models and known technology, faces demand and technology *risk*, but limited *uncertainty* on these dimensions in the Knightian sense, as the distributions of outcomes along these dimensions are well characterized and known. TBE ventures primarily face uncertainty regarding the entrepreneur's place in the productivity distribution (e.g., Jovanovic, 1982). In contrast, IDE ventures, which are based in

[2] Our definition builds upon the typology first offered in the management literature by Aulet and Murray (2013), who coined the term IDE and delineated between IDE and small and medium-sized enterprises (SMEs). Aulet and Murray (2013) define IDE ventures as those that pursue global opportunities based on bringing customers new innovations that have clear competitive advantage and high growth potential, and SME ventures as those that address local or regional markets using established approaches. In a sense, the concept of SME offered by Aulet and Murray (2013) uses size to proxy for the underlying attributes of a firm that in turn generate its long-term small scale. From an economics perspective, however, it may be more useful to think about the underlying attributes of the startups in question that determine likely scale. More generally, the SME term has been used by both researchers and policy makers to refer to smaller firms that enter relatively non-innovative areas of the economy (e.g., construction or restaurants) and are often limited in their size and scope.

novel ideas or novel combinations of ideas, often face large uncertainties on multiple dimensions, as, on top of the uncertainty regarding the entrepreneur's productivity, their markets may be new and undefined, and their technologies new and undeveloped. These uncertainties in turn lead to a fundamentally more complex entry decision (e.g., Agrawal, Gans, and Stern 2021), creating different needs in terms of human capital, strategic choices, and financing.

Another way to characterize IDE versus TBE ventures is to cast "innovation" in the light of differentiation, as in Rajan (2012). Rajan characterizes differentiation as the process whereby the entrepreneur brings together a group of people and assets to create an organization that produces distinctive goods and services. In Rajan's framework, the differentiated nature of the venture's activities is critical to its ability to generate value, but the risk and uncertainty associated with such differentiation makes it harder to coordinate enterprise-building activities and to access financial capital. Rajan (2012) argues that differentiated products often require producers to acquire special skills that have little outside market value, place facilities in locations where there are few other uses, and put together machinery in new ways that make them not just hard to sell but also hard to replace. The initial structure of the firm, with the entrepreneur having significant ownership of assets, and thus control, is intended to allow for differentiation while giving collaborators the incentive to follow the entrepreneur. Here too, differentiation exists on a spectrum, and the categories may overlap at the margin.

An IDE firm under this characterization is a firm that introduces significant differentiation from existing approaches and competitors. Within IDE, differentiation typically occurs in two main forms: creating a new class of products that satisfy the same need in a radically different way (e.g., the car versus a horse cart), or providing a novel input to an existing product that significantly improves it (e.g., a solid-state hard drive versus spinning disk). Importantly, as differentiation increases, firms need to organize differently to achieve their objectives. The more differentiated the product or service, the more different the resources required to realize the value from the opportunity being pursued by that entrepreneurial team. As a result, optimal structure, human capital, financing, and even location choice will often differ for TBE and IDE.

The capacity for creating vertical differentiation also suggests that IDE entrepreneurs have a very different role in the economy relative to TBE firms. The capacity for time-limited monopolies driven by innovation is at the heart of modern endogenous growth theory (Romer 1990; Aghion and Howitt 1992). Firms—entering and incumbent—invest significant resources in innovation in

order to sweep the market and become product market monopolists, creating the conditions for creative destruction that sit at the heart of the modern market-based capitalist economy (Schumpeter 1942). Moreover, new innovations can create significantly different output value relative to their inputs of capital and labor, inherently improving returns to scale. This observation is critical to the Schumpeterian engine at the heart of modern economic growth theory: An IDE firm can create a new "recipe" in the economy for which they alone can create a "markup" in value relative to their competitors (Aghion and Howitt 1992; Klette and Kortum 2004). Empirically, IDE firms frequently grow by orders of magnitude in a few short years (Luttmer 2011), suggesting that a massive reallocation of both demand and productive factors is inherent in IDE. This reallocation of talent and capital to more innovative firms has been proposed as an explanation for differences in productivity growth across industries and regions (Acemoglu et al. 2018; Hsieh et al. 2019).

Although entrepreneurial firms that do not set out to innovate ex ante can do so, the ex ante innovation-orientation of IDE firms is important. The idea that the IDE entrepreneur is prospectively focused on creating a product that is vertically differentiated means that the structure of their work is substantially different: teams are more common, development within the firm might take years before market entry, and the capital requirements are different. These differences manifest across a wide variety of aspects of the entrepreneur and venture, including entrepreneur characteristics, human capital, funding and growth opportunities, competitive dynamics, the nature of the intermediaries they deal with, and ecosystem and policy needs. The differences are often largest in areas where the differences between risk and uncertainty are most important (financing, incentives) and in optimal deployment of human capital (for innovation versus exploitation). The distinction between categories of entrepreneurs is thus of substantial import—it affects how policy, regulation and entrepreneur support programs should be designed, depending on the type of entrepreneurship the social planner wishes to encourage or support. Yet much of the economic literature to date does not distinguish between these very different types of entrepreneurship.

This review specifically focuses on IDE, and leaves coverage of TBE, self-employment, and subsistence entrepreneurship to future work. IDE firms play an outsized role in the economy: venture capital-backed firms (which are almost exclusively IDE) account for (i) over 50% of the new public offerings on US stock markets (Kaplan and Lerner 2010), (ii) 20% of US stock market capitalization, and (iii) 44% of research and development spending in the US (Gornall and Strebulaev 2021). Importantly, this is not to dismiss the importance of the other categories of

entrepreneurship, which have important roles to play in the economy. The nature of IDE firms and the business plans they pursue is sufficiently different from other types of entrepreneurship, and their economic impact is significant enough, however, that we believe they deserve separate treatment. Importantly, many sources of data used by researchers make it difficult to distinguish between types of entrepreneurs, and, as a result, distinguishing between types of entrepreneurship involves both conceptual and empirical challenges.

We begin with a discussion of entry into IDE. While a large literature has explored individual and structural factors that influence entry into self-employment or the formation of a new business generally, very little is known about IDE entry specifically. We discuss the theoretical underpinnings that provide insight into how IDE entrants are likely to be different than other entrepreneurs, identifying potential areas for future research. We then discuss the formation of entrepreneurial teams more generally, and how human capital inside the firm is organized and incentivized. Next, we turn to entrepreneurial strategy. The uncertainties inherent in the IDE venture call for a set of strategic choices and experimentation that are not typically present in TBE. An emerging theoretical and empirical literature in economics has begun to rigorously address these choices. We follow this with a discussion of the financing of the IDE firm. Due to the existence of high quality, commercially available data on venture capital (VC) investors and their investments, research on the VC financing of IDE firms has been plentiful, with significant empirical work confirming the hypotheses of early theoretical work on financial contracting in entrepreneurial ventures. Less explored are other sources of entrepreneurial finance. Finally, we discuss the literature on place-based policies and interventions intended to foster the growth of IDE clusters and activity. We conclude with a discussion of promising developments and directions for future research in the field. While the scope of this review is primarily limited to economic studies of IDE, we provide additional references drawn from a wider range of disciplines as well as additional coverage of TBE-related studies in the online appendix.

2. Who Enters into Innovation-Driven Entrepreneurship?

Presumably, individuals should enter entrepreneurship only if the utility of entry into entrepreneurship exceeds their utility for wage employment. Many factors may enter this utility function: Entry may happen when an individual expects to earn more from entrepreneurship than from wage employment, and/or when they highly value the non-wage aspects of entrepreneurship.

In the theoretical literature, the mechanisms that separate entrepreneurs from wage workers can be grouped into four broad buckets: (i) individuals with distinct behavioral preferences such as low risk aversion (e.g., Kihlstrom and Laffont 1979); (ii) individuals with distinct non-pecuniary preferences against wage labor (e.g., Hamilton 2000); (iii) individuals with distinct human capital or entrepreneurial quality (e.g., Levine and Rubinstein 2018); and (iv) individuals with greater access to resources, such as wealth or credit (e.g., Evans and Jovanovic 1989). Ultimately, these different theoretical models propose different mechanisms by which the rewards of entrepreneurship outweigh the risks for some individuals but not others. The applicability of each mechanism to IDE depends on how likely the channels is to shape or constrain the decision-making of the populations of individuals that are predisposed to engage in IDE activity.

The distribution of reward, risk and uncertainty presented to a potential entrepreneur is substantially different as we move along the spectrum from TBE to IDE entrepreneurship. IDE startups show substantially greater differentiation relative to incumbents at entry and, as a result, it is likely that the individuals capable of creating such highly differentiated firms differ substantially from TBE.

For example, new firms with a higher level of differentiation will likely have higher returns to investments in individual effort and specialized human capital, potentially limiting the relevance of behavioral factors such as risk aversion, or a preference for non-pecuniary rewards, when comparing wage labor to IDE entry. Similarly, the potentially large profits created by IDE might change the role of credit and wealth constraints in driving IDE entry. Although successfully incorporating novel technologies or novel recombinations into a new startup presents the opportunity for higher profit, it also increases the amount of uncertainty in the future value of the venture. For example, a startup looking to commercialize a new technology might face significant uncertainty as regards the future performance of this new technology as it co-develops the technology and the company (Gans et al. 2021). As a result, IDE founders may be less uncertainty-averse. Below, we discuss the economic theories of entrepreneurial entry and relate key theoretical mechanisms to entry into IDE in particular.

2.1. Behavioral Preference Differences

Following on Knight (1921)'s argument that bearing risk is one of the essential characteristics of entrepreneurship, a substantial stream of economic theory posits that entrepreneurs and wage

workers vary substantially in the way in which they value riskier and more uncertain future cashflows. In these behavioral preference-based theories of entrepreneurship, individuals sort into entrepreneurship because they have behavioral preferences that value these future cashflows more highly relative to the certainty equivalent of wage labor. Risk aversion has been at the center of multiple canonical theories of entrepreneurial entry that serve as strong benchmark models for entry patterns in TBE (Kihlstrom and Laffont 1979; Evans and Jovanovic 1989). While the details vary, these models share multiple core features: 1) all individuals in the economy have access to the same project/opportunity with a known distribution of payoffs, 2) individuals vary in a productivity shifter that locates their expected future profits, and 3) entry and exit is determined by individual risk preferences. The key insight of these models is that the proportion of entrepreneurs in the economy is determined by the distribution of risk aversion amongst individuals and the distribution of profitability of the entrepreneurial project. Entrepreneurs will show higher levels of risk aversion relative to wage workers, but the critical value of risk aversion decreases with the improved distribution of the profitability of the shared entrepreneurial project.

There is mixed empirical evidence that risk aversion is higher amongst entrepreneurs than the general population. While some studies relate lower risk aversion to self-employment (e.g., Hvide and Panos 2014), other studies show no systematic differences when compared to wage workers (e.g., Andersen and Nielsen 2012; Puri and Robinson 2013). These conflicting results may arise in part from differences in populations and methods of measuring risk aversion.

These indeterminate results may also hinge in part on the conflation of TBE and IDE entrepreneurs across these studies. TBE entrepreneurs fit the primitives of the canonical risk-aversion-centered models of entry, but IDE entrepreneurs can be quite different. While the distribution of potential earnings from TBE entrepreneurship might be well characterized by a normal distribution, IDE entrepreneurs are sampling from a distribution of outcomes that is skewed towards zero with potentially fat tails (Gans, Stern, and Wu 2019; Jones 2023). As such, the expected payoff to some IDE opportunities might be so high that entry would be rational for individuals across nearly the entire distribution of risk preferences (e.g., Google). Although there is certainly some amount of risk bearing for IDE entrepreneurs, access to such opportunities, rather than individual risk preferences, likely dominate entry. As such, we would expect to see very different risk preferences across TBE and IDE entrepreneurs, where risk aversion would strongly predict entry into TBE, but less so for IDE, all else equal. To date, however, we are not aware of

any attempts to characterize the behavioral underpinnings of entry while differentiating between entrepreneur types.

Though not as central to the theoretical literature on entry, overconfidence and optimism have been linked theoretically and empirically to entry (Camerer and Lovallo 1999; Bernardo and Welch 2001; Malmendier and Tate 2005; Landier and Thesmar 2009; Galasso and Simcoe 2011). Individuals with high levels of confidence might overestimate where they lie in a distribution, or they may underestimate the variance of a distribution. In contrast, individuals with high optimism will have positively biased expectations more broadly (Hey 1984). Theoretically, individuals with higher levels of optimism and confidence will be more likely to undertake a risky project for a given level of risk aversion. Similarly, where the supply of early-stage capital is limited, and substantial information frictions limit an investors ability to screen entrepreneurs, overconfident entrepreneurs may crowd out less confident individuals (de Meza and Southey 1996).

Like the empirical literature on risk aversion and entrepreneurial entry, empirical work on overconfidence and optimism uses a variety of methods to characterize behavioral preferences for a broad range of entrepreneurs, without differentiating between TBE and IDE. Early economic work on overconfidence and entry utilized laboratory environments (Anderson and Holt 1997; Camerer and Lovallo 1999). Using nationally representative surveys, multiple studies show that individuals with higher levels of optimism and overconfidence are more likely to become entrepreneurs (Landier and Thesmar 2009; de Meza et al. 2019). Similarly, current entrepreneurs exhibit higher optimism and overconfidence when compared to non-entrepreneurs (Arabsheibani et al. 2000; Puri and Robinson 2007; Holm, Opper, and Nee 2013).

We are aware of only one study that specifically focuses on optimism in a population of potential IDE entrepreneurs (Åstebro, Jeffrey, and Adomdza 2007). Related work, however, shows that higher levels of optimism is associated with higher levels of innovative behavior (such as patenting) that is strongly conceptually tied to IDE (Galasso and Simcoe 2011; Hirshleifer, Low, and Teoh 2012).

In an economy with only TBE entrepreneurs making entry decisions into a project with only one distribution, optimism and overconfidence can only serve to misallocate resources as entrepreneurs misperceive their likelihood of having high potential profits as entrepreneurs leading to over-entry. As IDE entrepreneurs face significant uncertainty about the shape of the distribution for the opportunity they are pursuing (Gans, Stern, and Wu 2019), characterizing whether

optimism should be connected to over-entry is less clear. In situations where individuals know there are high value opportunities in their environment but are uncertain about where they are, higher levels of optimism and confidence might be necessary preconditions for exploratory behavior (March 1991; Ederer and Manso 2013; Herz, Schunk, and Zehnder 2014).

In addition, optimism or overconfidence in IDE founders might have a substantially positive spillover effects for the economy more broadly. Theoretical work on optimistic entrepreneurs has noted that their exploration of new opportunities creates new information for other agents in the economy (Bernardo and Welch 2001). Whereas this type of exploration might be of limited value for TBE entrepreneurs (who are pursuing opportunities with well-known characteristics), for IDE, such exploration is likely more valuable, allowing them to resolve uncertainty as to the shape and parameters of the distribution of the value of new technology or new combinations of technologies. Increasing the number of recombinations in a valuable space of innovations may be critical to driving economic growth (Romer 1990; Kortum 1997; Weitzman 1998; Jones 2023). While such experimentation by IDE entrants provides a valuable but costly public information good, it might be undersupplied (Bolton and Harris 1999). Thus, understanding the behavioral underpinnings of IDE entry may be particularly valuable in crafting policies that help increase economic growth.

There are a range of other behavioral preferences and personality traits that might be similarly different between IDE and TBE, but we will limit our discussion of them here to merely noting ideas and sources. Moskowitz and Vissing-Jørgensen (2002) posit that higher order risk preferences may provide one (of many) possible explanation for their private equity premium puzzle—entrepreneurs may have a preference for skewness. Kerr, Kerr, and Xu (2018) provide an extensive review of research in economics, psychology, and sociology literature on the personality traits that entrepreneurs possess and how some differ from non-entrepreneurs (see also Sauermann (2018) for an example of employee motivations in IDE versus established firms). For example, recent work in economics has shown that individuals with higher levels of internal locus of control (Rotter 1954) are more likely to start incorporated businesses relative to starting self-employed businesses or engaging in wage labor (Levine and Rubinstein 2017).

Emerging research in economics has begun to characterize a variety of decisions faced by IDE entrants as distinct from those faced by TBE entrants (Chavda, Gans, and Stern 2019; Agrawal, Gans, and Stern 2021). These models do not, as of yet, incorporate behavioral preferences. Different behavioral preferences are likely to matter more for IDE versus TBE, however, because

as these models show, the decisions the two types of entrepreneurs face are quite different. Studies tying behavioral preferences to clear and empirically relevant theoretical models of the entry decision faced by IDE firm founders are a fruitful area for future theoretical research.

2.2. Non-Pecuniary Preferences

Most theoretical entry models posit that entrepreneurs start firms when the expected returns to business formation exceed their certainty equivalent or outside option, yet research suggests that entrepreneurship, broadly defined, does not appear to have positive returns. The mean small business entrepreneur earns less than a similar salaried worker (Borjas and Bronars 1989; Evans and Leighton 1989; Hamilton 2000). Similarly, the broader financial returns to entrepreneurial activity are insufficiently high to justify entry into entrepreneurship (Moskowitz and Vissing-Jørgensen 2002; Hall and Woodward 2010). These findings are used to suggest a puzzle that requires a new element in the entrepreneur's utility function that rationalizes these choices.

Researchers have argued that other elements must play into the decision to start one's own small business, such as non-pecuniary benefits, higher order risk-preferences, and so forth. Indeed, Hurst and Pugsley (2011) find that a large share of US business owners were originally motivated to enter into entrepreneurship for reasons other than money, such as wanting flexible work hours, to be their own boss, or to pursue a passion. Only 32.2% entered because they felt they had a good business idea, and a further 2.2% enter because of lack of other job options. For a large proportion of TBE founders, entrepreneurship fits into a broader set of labor market choices that emphasize workplace autonomy (Hyytinen and Ilmakunnas 2007; Benz and Frey 2008). Recent work, however, has suggested that there is a dramatic difference in the returns to entrepreneurship as we move along the intellectual ability curve or focus on entrepreneurs that incorporated firms (Levine and Rubinstein 2017; 2018; Queiró 2022). As a result, it is unclear whether the types of non-pecuniary preferences listed above (flexible work hours, pursuing a passion/hobby, etc.) are a dominant driver of IDE entrepreneurs. Non-pecuniary preferences might play an important role in IDE, but specific non-pecuniary preferences may differ between IDE and TBE founders.

There is a different class of non-pecuniary preferences which may be particularly important for IDE but play almost no role in TBE: engagement with the norms of open science. The institutions of science provide a set of norms and incentives that differ substantially than traditional economic systems (Dasgupta and David 1994). Scientists will forgo higher wages to engage in the

openness and exchange required by open science (Stern 2004) and firms in innovation-intensive industries are often organized around these preferences (Cockburn and Henderson 1998; Murray 2010). The management of the non-pecuniary preferences of innovators has even been posited theoretically as a key function of universities (Aghion, Dewatripont, and Stein 2008) because academic scientists and engineers, a population with significant IDE potential, are more driven to commercial activity by the potential for impact and recognition than they are by profit (Cohen, Sauermann, and Stephan 2020). Understanding how academic entrepreneurs differ from non-entrepreneurs in their preferences and motivations is an important opportunity to increase our ability to promote and improve IDE in the economy, but to date there has been little work in economics in this area.[3]

2.3. Human and Social Capital Differences

Human capital likely plays a particularly strong role in entry into IDE. Several leading theories emphasize that entrepreneurs have unique human capital traits—including creativity, analytical skills, education, and managerial acumen (Schumpeter 1942; Lucas 1978; Evans and Jovanovic 1989; Gennaioli et al. 2013; Hvide and Oyer 2018). Entrepreneurs with elite schooling have a wider breadth of human capital relative to non-entrepreneurs (Lazear 2004), and more recent work has suggested that the human capital backgrounds of the self-employed differ substantially from founders of incorporated firms (Levine and Rubinstein 2017; 2018).

In key theory models of entrepreneurial entry, the decision to start a firm is governed at least in part by a skill parameter which can be interpreted as the portion of an individual's human capital profile useful for entrepreneurship (Lucas 1978; Kihlstrom and Laffont 1979; Levine and Rubinstein 2017). This has led to both theoretical and empirical exploration of what characterizes this entrepreneurship-specific human capital. On the one hand, "jacks-of-all-trades" theories suggest that entrepreneurs require a wide breadth of human capital in order to overcome the organizational limitations of new, small firms (Lazear 2004; Åstebro and Thompson 2011). On the other hand, other theories emphasize non-routine cognitive skills, such as creativity, analytical flexibility, and generalized problem solving (Levine and Rubinstein 2017; Bernstein, Colonnelli, et al. 2022).

[3] Related work on academic patenting appears to be the closest counterpart in the literature. We provide some references in the online appendix.

Overall, there is strong evidence to support differences in the pre-entry human capital accumulation and cognitive traits of IDE and TBE founders. Across samples of engineers and inventors more broadly, there is evidence that the probability of IDE entry increases when individuals develop more exposure to varied tasks either through more frequent job hopping or exposure to smaller firms (Elfenbein, Hamilton, and Zenger 2010; Åstebro and Thompson 2011). In addition, experience in areas associated with R&D and innovation are particularly important for IDE entry relative to less innovative tasks (e.g., sales and finance) (Burton, Sørensen, and Beckman 2002). It is not surprising therefore, that there is a relationship between age and impactful entrepreneurship: It takes time to acquire the skills required to successfully enter growth entrepreneurship, especially in societies where key roles are already filled by older individuals (Liang, Wang, and Lazear 2018; Azoulay et al. 2020). Although it is not a perfect proxy for IDE, incorporating a business signals growth intentions and the perception of higher levels of opportunity because it is a costly action. Incorporated entrepreneurs tend to be more educated and scored higher on learning aptitude tests as a teenager (Levine and Rubinstein 2017).

IDE founders are more likely to have graduate degrees, especially in science, technology, engineering and mathematics (STEM) (Burton, Sørensen, and Beckman 2002), but there is little systematic work attempting to understand why certain degrees and certain universities are more fecund producers of IDE, despite the fact that IDE spinouts from the university have a profound impact on their local economy (Kolev et al. 2022). Recently, administrative data sets on the US population have shown that educational inputs distinguish both patenting and entrepreneurship, although not specifically IDE (Bell et al. 2019; Chetty et al. 2022). In part, some universities might provide more IDE because they are closer to the frontier of academic knowledge, providing more valuable economic opportunities to their students. Certain universities and departments might provide more fertile ground for IDE because they were founded with a particular orientation towards positive impact on the economy, shaping the career expectations of both the professors and their students to create and commercialize technologies (Rosenberg 2009; Rosenberg and Steinmueller 2013).[4]

[4] There has been some discussion within economics about how the field might be more purposefully oriented towards practical impact (Roth 2002; Duflo 2017). Some work has provided focused and detailed accounts of the dynamics of IDE rich universities like MIT (e.g., Roberts 1991), but there is still not a more general account of why some universities are substantially better at IDE.

In addition to human capital accumulation from education and the workplace, IDE entrepreneurs are distinguished by their access to information about valuable opportunities obtained from working in highly innovative firms. IDE entrepreneurs can bring ideas and intellectual property that are unused or underutilized in incumbent firms into their new ventures, a phenomenon commonly referred to as spin-outs or spinoffs (Klepper and Sleeper 2005). Employees from innovation-driven firms that have spawned more entrepreneurs in the past are more likely to spawn subsequent IDE in the future (Habib, Hege, and Mella-Barral 2013; Babina 2020). Similarly, venture backed firms, a strong signal of IDE, tend to disproportionately spawn from innovative, fast-growing firms that themselves were previously venture-backed (Gompers, Lerner, and Scharfstein 2005; Babina and Howell 2018).

Relatedly, a number of studies show that individuals are more likely to enter entrepreneurship if they have contact with entrepreneurs through a variety of settings including the workplace, educational settings and the home (Nanda and Sørensen 2010; Lerner and Malmendier 2013; Lindquist, Sol, and Van Praag 2015; Hvide and Oyer 2018). This research suggests that an individual's social network provides an important set of resources that increase the likelihood of subsequent entrepreneurial entry. In much of this research, however, multiple types of entrepreneurship are simultaneously considered. Future research should consider the relevance of these channels on IDE.

2.4. Resource Constraints

Several leading theories posit that liquidity constraints limit entry into entrepreneurship (e.g., Bernanke and Gertler 1989; Evans and Jovanovic 1989; Kiyotaki and Moore 1997; Cagetti and De Nardi 2006). In our online appendix, we review a relatively large literature on the relationship between entry into self-employment and household wealth and health insurance coverage, two empirical proxies for liquidity constraints, in addition to government programs which subsidize entrepreneurial entry. Although the theory and empirical evidence to date point to a strong connection between TBE or self-employment and wealth, the connection to IDE entry is far less clear. On the one hand, IDE entry, and entry into R&D intensive industries in general, often requires higher upfront entry costs than TBE (Bajari, Benkard, and Levin 2007), although the costs of entry can change substantially over time due to technological change (Ewens, Nanda, and Rhodes-Kropf 2018). On the other hand, the potential upside of IDE is high enough that specialized

financing institutions have developed to service these opportunities (as we discuss in Section 5), and the equity contracts that predominate in these institutions allow IDE entrepreneurs to source capital inputs and earn income before the firm actually earns revenue, mitigating dependence on the entrepreneur's ex ante wealth (Ewens, Nanda, and Stanton 2020).

To date, there is little data on the connection between household wealth and entry into IDE. The disinhibiting effect of student debt on entrepreneurial entry seems particularly strong in high-tech industries (Krishnan and Wang 2018). Recent work has also connected household wealth, especially intergenerational wealth, on the likelihood of founding firms that exhibit steep growth trajectories (Chetty et al. 2022), which are more frequently observed with IDE firms (Guzman and Stern 2020). Relatedly, access to more flexible working conditions provide increase in entrepreneurship overall, but have more heterogenous effects on subpopulations more associated with IDE (Barrios, Hochberg, and Yi 2022; Gottlieb, Townsend, and Xu 2022). The heterogeneity in the impact of resource constraints on different subpopulations of entrepreneurs underlines the importance of IDE-specific studies. For example, exogenous changes to the cost of entry into IDE due to cloud computing spurred IDE entry (Ewens, Nanda, and Rhodes-Kropf 2018).

2.5. Optimal Entry

We note that there are still outstanding questions about the optimal-level of entry of innovation-driven firms for stimulating productivity growth and improving social welfare. Building off of canonical micro-founded dynamic macro models (Hopenhayn 1992; Klette and Kortum 2004; Lentz and Mortensen 2008), a burgeoning literature in macroeconomic dynamics has begun to give us a deeper understanding of the interplay between industry structure and innovation on productivity growth (Acemoglu et al. 2018), tempering our largely positive view of the role of innovation-driven entrepreneurship on productivity growth and social welfare (Garcia-Macia, Hsieh, and Klenow 2019). While these topics are connected to innovation-driven entrepreneurship, coverage of this large and fast-growing literature falls out of the scope of this review.

3. Founding Teams and Organization

Having discussed why individuals enter into IDE, natural and related questions are (i) whether individuals choose to be solo founders or co-founders, and (ii) the implications of this choice for the venture.

Many TBE companies are solo-founded ventures, there is reason to expect that IDE ventures will be more likely to be co-founded than solo founded. The Small Business Administration estimates that there were 31.7 million small businesses in the US in 2017. Of these businesses, 25.7 million (or 81%) did not have at least one employee and 22.3 million (or 70%) were sole proprietorships.[5] IDE firms seeking to introduce differentiated products through the introduction of novel ideas, as our IDE definition highlights, and this requires the acquisition of specialized skills which may be achieved through the addition of teammates (Rajan 2012). Not much is systematically known, however, about the likelihood of observing solo founders versus founding teams in IDE or the mechanisms driving observed differences. Work on the performance implications of this choice is similarly limited.

Given the expectation of founding teams in IDE ventures, discussion of the optimal composition and incentivization of founding teams is also warranted. Finally, although small businesses are often thought of as being led by the founder in perpetuity, or as generational—handing the firm to one's progeny, research on IDE demonstrates that stakeholders, namely funders, often look to replace founders as the firm continues to grow (Hellmann and Puri 2002), and these firms are often sold to other entities by the founders, who often will then depart the combined enterprise (Kim 2022). Succession is accordingly a topic of interest. We dig into each of these areas in detail below.

3.1. Solo Founders Vs. Founding Team

Entrepreneurs have to take on many tasks (Lazear 2004), and this breadth of tasks introduces the risk that an entrepreneur is limited by their weakest skill. In other words, "entrepreneurs must be good at a number of different skills" (Lazear 2004: 208). Individually, entrepreneurs tend to have a more diverse skill-base than non-entrepreneurs (Lazear 2004). Investors in IDE firms are more likely to attend to information about founders than other aspects of a startup (e.g., market traction) (Bernstein, Korteweg, and Laws 2017; Gompers et al. 2020).

Given the increased importance for novel skill combinations in IDE (Rajan 2012), solo-founded IDE firms may be at a disadvantage relative to founding teams. In one of the few systematic academic studies of IDE ventures, having multiple founders doubles the likelihood of

[5] https://cdn.advocacy.sba.gov/wp-content/uploads/2020/11/05122043/Small-Business-FAQ-2020.pdf

commercialization, and increases expected revenue by 29% relative to having a solo founder (Åstebro and Serrano 2015). Measuring the performance differences between solo founded ventures versus founding teams is particularly difficult because many new IDE ventures may fail early, creating empirical challenges in finding data on unsuccessful ventures, especially in the earliest phases. A greater effort is needed to collect data on failed ventures (Botelho and Chang 2023; Botelho and Marx 2023; Botelho, Fehder, and Miric 2023). Field studies, such as Bailey et al. (2023), offer one avenue for gathering such data at the early stages of a venture's development.

3.2. Founding Team Composition

A substantial body of research on founding team composition in management, psychology, and sociology (reviewed in our online appendix) stresses the importance of teams for problem solving yet notes that team formation processes may yield teams that are not optimal. This complements the perspective of canonical models in economics suggest that high performing teams should be characterized by cooperative specialization of skills (Alchian and Demsetz 1972), but also warn of potential challenges, such as biased self-perceptions (Gervais and Goldstein 2007) and moral hazard in teams (Hölmstrom 1982).

As a new firm adds founders to build the proper portfolio of skills, several challenges emerge as the size of the team increases. First, the chance of team-related moral hazard increases (Hölmstrom 1982), and the uncertainty associated with IDE could potentially provide fertile ground for team incentive research. Given that entrepreneurs tend to be overconfident (Camerer and Lovallo 1999), self-perception biases may prove problematic in terms of forming teams with the correct level of skills, yet may provide more subtle positive spillovers to the productivity of other founders and workers in the firm (Gervais and Goldstein 2007).

Because there are few databases that provide comprehensive information on founding teams, and none with rich data on their characteristics and backgrounds, there are few studies connecting founding teams to the performance of their startups. Overall, a founding team with skill and experience diversity is associated with higher performance (D'Acunto, Tate, and Yang 2020). In contrast, founding team homogeneity with regard to ethnicity appears to be positively related to venture performance (Gompers, Huang, and Wang 2017).

Importantly, in addition to forming the founding team, the IDE entrepreneur needs to recruit employees and partners. These individuals may respond differently to the signals being produced

by original entrepreneur's experimentation. This setting is one where theoretical work on the optimism and persuasion within firms might be particularly important (Van den Steen 2005; Gervais and Goldstein 2007). In these theoretical models, the strong beliefs of a focal individual induce effort and coordination among others in the organization that can observe both these beliefs and corresponding actions. One of the key insights of these related models is that these beliefs, even if miscalibrated, can induce better outcomes than situations without strong beliefs because of their coordinating effect in the face of uncertainty. The various strands of economic theory discussed above suggest that IDE entrepreneurs face a delicate balance between persuading others and being persuaded by new information.

Given the importance of the exchange of information to both persuade and learn, it is not surprising that a broad range of institutions have emerged in which IDE founders can pitch their ideas to receive feedback and recruit resources. In addition to venture capital, recent work has documented the growth of other programs such as accelerators and pitch competitions which decrease the cost of access to experts who can sharpen early-stage ideas (Gonzalez-Uribe and Leatherbee 2018; Fehder, Hochberg, and Lee 2019; Yu 2020; Howell 2020). The provision of expert advice within these startup programs appears to impact different populations of IDE founders differently (Fehder 2020; Howell 2020), suggesting that the "coachability" or "persuadability" of IDE entrepreneurs varies substantially (Bryan, Tilcsik, and Zhu 2017). Recent field experiments have attempted to design efficient interventions to improve experimentation and learning by IDE entrepreneurs (Camuffo et al. 2019; Bailey et al. 2023). Overall, there is still substantial work to be done both theoretically and empirically to understand how IDE entrepreneurs learn, experiment, and persuade others to join their efforts.

3.3. Founding Team Organization

Once the founding team is in place, Holmstrom (1982) serves as a reminder that founding team members must be correctly incentivized. Many IDE founding teams create formal agreements that outline the potential value they may extract from the firm, mainly through the equity split (i.e., percentage) given to each founder. Although this decision is consequential, with the exception of a single study (Hellmann and Wasserman 2017), research has not explored what leads to observed equity splits or how these splits incentivize subsequent founder action affecting venture outcomes. There are many economically interesting features of founders agreements that make the optimal

contract difficult to determine: founders cannot know ex ante who will contribute the most to the new firm; whose contribution will respond most to equity incentives; and how to separate the individual value of the contributions of each founder.[6] Other issues of note in this category include contracting between founders and non-founding team members (Hellmann and Thiele 2015), and managerial compensation in VC-backed ventures (Ewens, Nanda, and Stanton 2020). Much work is needed in this area to further our understanding of venture performance.

3.4. Succession and Evolution

A venture's founding team evolves over time, and changes to the team, such as a founder being replaced or a founder leaving, may have significant effects for the venture's future performance. There is some disagreement regarding the importance of founders altogether. Research has suggests that, especially in successful ventures, the venture's core business idea remains mostly stable and is paramount (Kaplan, Sensoy, and Strömberg 2009). Consistently, researchers have documented that founders, especially of IDE ventures, are often replaced (Hellmann and Puri 2002). There is an increased likelihood of founder departure after VC investment (Hellmann and Puri 2002), with "professionalization" a likely mechanism, and investors often replace founder CEOs (Kaplan, Sensoy, and Strömberg 2009). For example, one recent study finds that about 20% of founders of VC-backed ventures are replaced (Ewens and Marx 2018). The reasoning for this replacement is varied; it may be due to disagreement on vision, the need for a different skill set, or valuing the idea more than the founder. Although replacement is more common when the venture is struggling, it does appear to lead to better performance. More generally, the premature death of a founder appears to have a persistent negative effect on venture performance (Choi et al. 2019; Becker and Hvide 2022). This effect is consistent across IDE and TBE, which is stronger when team size is small.

4. Strategic Choices

The process of choosing and executing corporate strategy is fundamentally different for IDE firms relative to TBE firms, because IDE firms face a larger set of choices and more uncertainty about the mapping from a strategy choice set to the value of the firm. The larger search space faced

[6] Psychological studies have explored the perception of fairness in the unequal division of equity amongst founders. We review some literature on this topic in our online appendix.

by IDE entrepreneurs relative to TBE entrepreneurs derives from two sources: the multiplicity of opportunities provided by recombinant innovation, and the way in which IDE allows multiple entrepreneurial strategies for the same opportunity (Gans, Stern, and Wu 2019). A complication from this larger search area is that entrepreneurs have imperfect information and limited resources to use to discern which strategic choices are "correct" (Agrawal, Gans, and Stern 2021). Thus, this resource constraint creates a fundamental search problem for IDE entrepreneurs which distinguishes IDE from TBE, while simultaneously affecting the nature of individuals who will be likely to succeed in IDE.

4.1. Multiplicity of Paths

Perhaps the most fundamental difference between IDE and TBE is the nature of the opportunity being pursued by the entrepreneur. As discussed above, IDE entrepreneurs pursue opportunities that are novel recombinations of technologies or business models that have not been seen previously in the economy. By the nature of the recombination process, there are many variations possible with potentially high economic value. This point is perhaps clearest when considering a general purpose technology (GPT) which admits a whole new broad class of possibilities into the economy.[7] The full impact of a GPT often takes decades to fully manifest in the economy and society more broadly (Rosenberg 1982; Bresnahan and Trajtenberg 1995).[8]

More generally, GPTs offer perhaps the easiest way to understand two related points: new technologies and other innovations can enter the economy in a broad set of ways, and many of these slightly different recombinations can have significant economic value in a non-rival sense (Weitzman 1998). As an example, consider the computer, an important GPT which impacted the broader economy by dropping the overall cost of numeric calculation substantially. This in turn created not only a new set of labor to capital substitutions (e.g. spreadsheets versus accountants), but also opened up a new set of economic possibilities, such as computer graphics, which could not have been immediately foreseeable for the initial innovators (Rosenberg 1963; Agrawal, Gans, and Goldfarb 2018). As new ideas and technical capabilities are created across the economy through research and development from companies and universities, the applicability of these new-

[7] See Bresnahan (2010) for a literature review on general purpose technologies.

[8] For example, recent work on the introduction of artificial intelligence technologies into the economy have attempted to use modern economic tools to understand how these transformative set of technologies enter and impact the economy (Brynjolfsson, Rock, and Syverson 2021; Goldfarb, Taska, and Teodoridis 2023).

to-the-world recipes and awareness of them varies across firms depending on their position in the economy (Griliches 1992; Bloom, Schankerman, and Van Reenen 2013). While a particular idea or recipe can be combined with many more ideas across the economy, the range of potential recipes available to any particular individual might be limited by their educational or work experience (Shane 2000). This creates a situation in which multiple people confronted with the same recombinative opportunity might see different paths to pursue this opportunity (Gans, Stern, and Wu 2019). For example, there might be different choice of ideal customers across different possible industries, or faster paths to commercial viability versus deeper technological development (Gans et al. 2021).

In addition to the multiplicity of potential paths of introducing new innovations into business opportunities, IDE also differs in the different relationships that IDE entrants can have with incumbents. When a TBE entrepreneur enters an industry, there only relationship with incumbents is competition: for TBE, entry does not fundamentally change demand, only adding additional supply in a zero-sum game. On the other hand, while many IDE founders may view incumbents as direct competition, incumbents can also offer benefits to IDE, and vice versa: new entrants provide both a source of competition and a potential source of value for incumbents through cooperation (Reinganum 1983; Anton and Yao 1995; Lerner 1997; Gans and Stern 2000; 2003; Hsu 2006).

IDE entrepreneurs face a fundamental choice of whether to cooperate or compete with incumbents. The role of hard-to-reproduce complementary assets appears to structure the degree to which new entrants pose an immediate threat to incumbents in a particular market (Teece 1986). For many incumbents, the control of sales channels, critical IP, and key inputs ensures that they can protect their most profitable products (and often customers) from new entrants. Depending upon the existing assets of the incumbent firm versus the startup, and the incentive effects of ownership to the startup founders, an innovative idea might be worth more to an incumbent firm than to a startup (Teece 1986; Aghion and Tirole 1994). This creates the potential for bargaining between incumbents and new entrants in the form of investment, partnerships, and alliances, such as that often seen in industries such as pharmaceuticals, where the required regulatory infrastructure and expertise is costly (in time and money) to develop. In the face of limited patent life, new biotech firms often choose to license their IP to established players for clinical development.

Relatedly, IDE entrepreneurs must choose whether to compete in the traditional product market, or whether to compete in the market for ideas (Winter 1984; Teece 1986; Arora, Fosfuri, and Gambardella 2001). Whether an entrepreneur enters the product market versus the market for ideas appears to depend on many factors, such as competition in the market (Arora, Fosfuri, and Gambardella 2001), regulations (Chatterji and Fabrizio 2016), control of intellectual property (Gilbert and Newbery 1982; Gans, Hsu, and Stern 2002), and the ability to contract (Arora, Fosfuri, and Gambardella 2001; Arora and Gambardella 2010). Uncertainty related to the scope and degree of IP rights will facilitate cooperation and the sharing of knowledge within an industry (e.g., Gans, Hsu, and Stern 2008; Hoberg, Li, and Phillips 2018). Relative to the product market, entrepreneurship through the market for idea is less common (Gans and Stern 2010).

The importance of access to ideas also changes the role of location in IDE as compared to TBE. For TBE entrants, colocation of similar firms can potentially create competitive pressures and is observed only when there are limitations on access to key inputs or transportation costs (Ellison and Glaeser 1999). In contrast, the clustering of IDE firms is frequently observed even in the absence of these cost advantages, because firms predicated on the recombination of ideas benefit from close access to new perspectives, information and technology (Krugman 1991; Saxenian 1994). These benefits, in fact, may extend beyond the entrepreneurs themselves to their founding teams and employees, who are more likely to remain in the industry in the startup fails if there are more geographically proximate competitors, thus preventing a brain drain from the industry (Botelho and Marx 2023). Indeed, while TBE firms often demonstrate substantial home bias (Michelacci and Silva 2007), IDE firms show substantially higher rates of mobility as they are more likely to move to areas of higher IDE activity like Silicon Valley (Guzman 2019).

4.2. Search and Commitment

The multiplicity of options available to IDE entrepreneurs relative to TBE entrepreneurs creates a significant search problem. All entrepreneurs, regardless of type, face substantial resource constraints in exploring the potential of their idea. For IDE, however, the potential application of an innovative idea across multiple industries in multiple different modes of competition discussed above creates a significant search problem. While IDE entrepreneurs may attempt to test the attractiveness of different approaches before committing to any one path (Gans, Stern, and Wu 2019), tests conducted in one area of the search space may not be informative of the value of other

paths because of the complementarity between the elements of the strategy (Milgrom and Roberts 1995). This stands in stark contrast with TBE entrepreneurs, who can quickly learn their unique productivity and profitability in a known business simply by entering and operating for a period of time without any search (Evans and Jovanovic 1989).

Recent literature characterizing IDE founder search across strategies builds upon foundational treatment of search and optimal stopping under conditions of uncertainty, which characterize tradeoffs between experimentation costs and the outside opportunity usually characterized as reservation wage (Adam 2001; Nishimura and Ozaki 2004; Bergemann and Hege 2005). The IDE setting is further complicated by the inability of experimenting entrepreneurs to fully separate out the fundamental quality of their innovation from the total value of the innovation and their strategic choices (Chavda, Gans, and Stern 2019; Gans, Stern, and Wu 2019; Agrawal, Gans, and Stern 2021). Fundamentally, the ability of IDE founders to experiment with different strategies impacts their expected payoffs from IDE, and thus the cost of experimentation across time and across industries serves as a fundamental governor to the rate and diversity of IDE entry (Kerr, Nanda, and Rhodes-Kropf 2014; Nanda and Rhodes-Kropf 2016a).

5. Financing

One of the most important issues facing entrepreneurial firms is their ability to access capital to fund their growth and operations. Canonical results in financial economics suggest that in standard market conditions debt is preferable to equity in the pecking order of external financing (Myers 1984) for a variety of reasons, including costly state verification (Townsend 1979; Diamond 1984) and adverse selection (Myers 1984; Myers and Majluf 1984; Nachman and Noe 1994). For IDE firms, who are often commercializing unproven technologies and services, attracting external capital through debt channels can be extremely difficult (Leland and Pyle 1977; de Meza and Webb 1987), because the startup's value rests on intangible assets which are had to ex ante value, give rise to strong information asymmetries, provide little collateral, and are difficult to sell ex post (Fresard, Hoberg, and Phillips 2020; Conti, Guzman, and Rabi 2020; Leland and Pyle 1977; Stiglitz and Weiss 1981). As a result, collateralizing a loan is often impossible for IDE entrepreneurs. Furthermore, theoretical models indicate the pecking order can be reversed if the investor has superior knowledge to the entrepreneur (Garmaise 2001). Even though loans would allow entrepreneurs to avoid costly dilution of ownership stakes, theoretically and practically,

external debt is widely viewed as an unlikely way to fund risky projects in the absence of tangible assets or stable cash flows to secure the loan (Hall and Lerner 2010).

As a result, most IDE efforts are financed through equity, and much of the empirical literature in entrepreneurial finance has focused on understanding this financing channel. From a theory perspective, in raising startup capital in general, and equity capital in particular, new ventures face four fundamental problems that form the basis for much of corporate finance theory: agency problems, information asymmetries, control issues post-investment, and hold up problems. Many of these issues are exacerbated for IDE versus TBE, as both internal uncertainties and external risks associated with market acceptance are magnified in the presence of untested innovation.

Table 1 lists primary categories of available sources of financial capital for IDE and the stage of company development to which they typically are allocated. The most well-known type of equity financing provider for IDE startups is venture capital (VC), for which many thorough survey papers have been written (see e.g., Da Rin, Hellmann, and Puri 2013; Lerner and Nanda 2020), and the associated venture debt industry. Over the last decade, however, the price of early stage experimentation in certain types of IDE has fallen significantly, shifting the allocation of financial and human capital towards smaller, faster, higher-risk projects, which has led to the emergence of new forms of financing and support programs. At the later stage, changes in securities laws and market dynamics have led to the entry of non-traditional investors such as hedge funds and mutual funds. With this evolving landscape in mind, we next turn to describing the typical financing channels for IDE ventures and the associated economic research.

Funding Source	**Funds allocated in 2022 ($ Billion)**	**Typical Development Stages of Company**	**Data Source**
Equity Crowdfunding	$ 0.47	Idea to Entry	Crowdwise
SBIR	$ 4.39	Idea to Entry	SBIR.gov
Angel & Seed	$ 22.50	Idea to Entry	NVCA Yearbook 2023
Initial Coin Offering	--	Idea to Entry	--
Reward Crowdfunding	--	Idea to Entry	--
Venture Debt	$ 30.00	Development to Growth	Pitchbook
Early-Stage VC	$ 66.30	Entry to Development	NVCA Yearbook 2023
Late-Stage VC	$ 94.69	Growth	NVCA Yearbook 2023
Growth Equity	$ 128.40	Growth to Maturity	NVCA Yearbook 2023

Table 1: Funding Resources for IDE: Dollar Volume and Development Stage

This table lists primary categories of funding sources for innovation-driven entrepreneurial ventures. For each category, the table displays an estimate of total funds allocated in 2022 ($ billions), and the typical stage of startup that accesses this funding source.

Sources for the estimates are presented in the final column. No credible estimates of Initial Coin Offerings or Rewards-Based Crowdfunding currently exist.

5.1. Venture Capital

VCs specialize in investment in new ventures characterized by high risk and uncertainty, but also high growth potential (Sahlman 1990).[9] The VC industry plays an outsized role in the economy, with VC-backed firms constituting over 50% initial public offerings on US stock markets (Kaplan and Lerner 2010). VC-backed firms account for 20% of US stock market capitalization, and 44% of research and development spending in the US (Gornall and Strebulaev 2021). In addition, regions and industries that receive more venture capital are more likely to see subsequent increases in regional patenting, employment, and aggregate income (Kortum and Lerner 2000; Samila and Sorenson 2010), likely in part because VC-backed startups grow larger and employ more people (Puri and Zarutskie 2012; Kerr, Nanda, and Rhodes-Kropf 2014). There is an extensive literature on VC financing and on VC firms themselves. Many good surveys of the literature exist, so we will not try to be comprehensive, but instead focus on main issues.

5.1.1. Structure and Performance of VC Funds

VCs are equity investors who in addition to capital provide a range of value-added services to their investments (Sahlman 1990). There are a number of different types of VC organizations. These include independent, financially driven, VC firms, corporate VCs who represent the strategic interests and invest the capital of large corporations, and bank-affiliated VC firms. Much of the literature to date (with some notable exceptions) has focused on traditional independent VCs. VC firms and the funds they raise vary widely in both size and industry and geographic specialization (Gompers et al. 2008; Hochberg and Westerfield 2010; Hochberg, Mazzeo, and McDevitt 2015). Specialization and fund size appear to be substitutes: smaller funds tend to be specialized, while larger funds tend to be more generalist (Hochberg and Westerfield 2010), and specialization serves as a product differentiator for VC funds (Hochberg, Mazzeo, and McDevitt 2015). In addition to the wide variation in fund specialization and size, there is significant

[9] For a description of the origins of the VC industry and its institutionalization in the 1980s as a result of reductions in the capital gains tax rate and amendments to the Employee Retirement Income Security Act, see e.g. Gompers (1994). In addition, Nicholas (2019) provides a historical account of the emergence of venture capital and Korteweg and Sensoy (2023) connect this historical account to the fundamental economics of funding innovation in the face of uncertainty.

heterogeneity in fund returns, with an inter-quartile spread between managers that dwarfs that seen in other asset classes, such as mutual funds. Fund performance within a given VC firm appears to persist over time (Kaplan and Schoar 2005; Hochberg, Ljungqvist, and Vissing-Jørgensen 2013; Harris et al. 2023), suggesting VCs have skill, either in selection of which ventures to invest in, or in adding value to their portfolio companies (Sørensen 2007).

In addition to private, independent VCs, many large corporations also maintain VC investment arms, to mixed results (Gompers and Lerner 2000; Masulis and Nahata 2009; Chemmanur, Loutskina, and Tian 2014). Corporate VCs often have strategic goals in addition to (or instead of) financial goals, and their portfolio companies are frequently acquired by the corporate venture capitalist's parent corporation (Benson and Ziedonis 2010) .

5.1.2. Staged Capital Commitment and Experimentation

Because IDE ventures requires a sequence of experiments over time, each reducing the risk and uncertainty associated with the venture (Nanda and Rhodes-Kropf 2016b; Ewens, Nanda, and Rhodes-Kropf 2018), investment in IDE ventures is typically done through staged capital commitment, in the form of sequential rounds of financing meant to help the startup company achieve milestones that reduce the riskiness of the venture. Theoretical work suggests that staged investment represents the optimal approach in this setting, and that outside investors should be present in each new round of financing (Admati and Pfleiderer 1994). Empirically, the setup and nature of VC investing matches closely with these theoretical predictions (Sahlman 1988; 1990; Gorman and Sahlman 1989). Staged capital commitment is particularly valuable in the IDE setting, where most ventures fail completely (Hall and Woodward 2010). Investing in stages allows the VC investor to learn more about the venture's chances of success and preserve the real option to abandon the venture (Gompers 1995; Cornelli and Yosha 2003; Bergemann and Hege 2005; Fluck, Garrison, and Myers 2005; Tian 2011a).

5.1.3. Contracting

Financial contracting theories in the entrepreneurial setting typically address how conflicts between the principal and agent affect ex ante information collection, contract design, and ex post monitoring. This literature typically takes one of four approaches to understanding the principal agent problem between the investor and entrepreneur: (i) principal-agent theories (e.g., Hölmstrom 1979; Lazear 1986); (ii) incomplete contracting (Grossman and Hart 1986; Hart and Moore 1990);

(iii) contingent control theories (e.g., Aghion and Bolton 1992; Dewatripont and Tirole 1994); and, (iv) hold up problems (e.g., Hart and Moore 1994).

Empirically, the terms and contract structures used in venture capital align themselves to the uncertain nature of IDE startups and the staged investment process (Kaplan and Strömberg 2003; 2004). Theoretical models of financial contracting predict that the characteristics of the contracts between VCs and entrepreneurs will be related to the extent of the agency problems in place. In some cases, the predictions across the various model approaches are consistent. For example, theory models of all approaches have clear predictions for management of internal risks, given that entrepreneurial ability is unknown, operations are hard to monitor, and that the entrepreneur has discretion over actions, decisions, and funds usage. Theory in this setting predicts that when internal risks such as these are higher, performance sensitive contracts should be used (e.g. Holmstrom, 1979), that contingent compensation should be more pronounced (e.g., Lazear 1986), that the VC should receive control in more states of the world (e.g., Aghion and Bolton 1992; Dessein 2002; 2005), that the VC should have a greater ability to liquidate the investment if the startup is performing poorly (e.g., Ross 1977; Diamond 1991), and that entrepreneurs should be tied tightly to the startup through vesting of their equity holdings (e.g., Hart and Moore 1994).

In contrast, theory models have less consistent predictions regarding the contractual terms that should be in place in the presence of external risks and uncertainties. As the potential for significant changes in an IDE startup's external environment increases (e.g., rate of new information about customers, competitors, or the arrival rate of new technologies), the role of the control rights becomes complicated by the need for both the entrepreneur and investor to invest in costly information acquisition to arrive at better decisions. Work following in the canonical incomplete contracting tradition (i.e., Grossman and Hart 1986) has argued that control rights should be allocated to the entrepreneur in settings where the acquisition of external information will be more likely to improve outcomes to minimize underinvestment in information acquisition (Aghion and Tirole 1994). On the other hand, work stressing the information asymmetries between the investor and entrepreneur suggest that entrepreneurs will cede formal control to investors in environments with higher uncertainty because they can use their more developed information to push choices that they prefer giving them higher real authority (Dessein 2005). Relatedly, external uncertainty may also make monitoring of the entrepreneur more difficult, leading to changes in optimal allocation of incentives and control (Dessein 2002; 2005; Prendergast 2002).

Empirical evidence is consistent with the importance of agency and hold-up problems in the design of VC contracts with entrepreneurs, but are inconsistent with theories of optimal risk sharing between investors and entrepreneurs (Kaplan and Strömberg 2004). VC contracts, however, are highly consistent with the predictions of models such as Prendergast (2002) and Dessein (2002; 2005). VC financings separately allocate cash flow rights, board rights, voting rights, and other control rights, and incorporate contingent contracting features that allocate increased control to the VC investor in the event of poor performance, and to the entrepreneur in the event of good performance (Hellmann 1998; Kaplan and Strömberg 2003). VC contracts further include non-compete and vesting provisions that make it more expensive for the entrepreneur to leave the firm, thus mitigating potential hold-up problems between the entrepreneur and the investor. More generally, VC contracts are structured in a manner that upholds many of the central theories of financial contracting between an investor and an entrepreneur (e.g., Hölmstrom 1979; Lazear 1986; Grossman and Hart 1986; Hart and Moore 1990; Aghion and Bolton 1992; Dewatripont and Tirole 1994; Ewens, Gorbenko, and Korteweg 2022).

5.1.4. Value-Added Activities

Importantly, unlike the arms-length transactions often modeled in the finance literature, VC investors are widely believe to offer more than just capital: VCs are active investors (Bottazzi, Da Rin, and Hellmann 2008) and have been shown to offer value-add in the form of professionalization of startup teams (Hellmann and Puri 2002), time to product market (Hellmann and Puri 2000), monitoring of behavior (Bernstein, Giroud, and Townsend 2016; Tian, Udell, and Yu 2016), board involvement (Lerner 1995; Gompers et al. 2020), improvement of firm governance structures (Hochberg 2011), and active matchmaking between portfolio companies to create strategic alliances (Lindsey 2008). VC's understanding of the uncertain nature of IDE startups and their tolerance for failure allows their portfolio companies to pursue innovation more successfully (Tian and Wang 2011). A substantial portion of the performance differential between VC and non-VC backed firms is attributable to the value-added services VC firms provide (Nahata 2008).

The capabilities for venture capitalists to provide these value-added activities stem in large part to their network connections with other venture capitalists. Better networks add more value to their

portfolio companies, with better-networked VCs exhibiting higher performance both for individual portfolio companies and their overall funds (Hochberg, Ljungqvist, and Lu 2007). Networks between venture capital partners and firms are often built through their syndication practices. Rather than investing alone, VCs typically invest in portfolio companies in syndicates, pooling expertise and capital in pursuit of better investment performance (Admati and Pfleiderer 1994; Lerner 1995; Brander, Amit, and Antweiler 2002; Hellmann 2007; Tian 2011b; Hochberg, Lindsey, and Westerfield 2015) . In addition to syndication that stems from the desire to combine or trade scarce resources and skills (Hochberg, Lindsey, and Westerfield 2015), other factors also drive syndication patterns, such as educational ties between VCs and ethnic similarity (Bhagwat 2013; Gompers, Mukharlyamov, and Xuan 2016).

These network formation processes have consequences for the division of value created by IDE firms and who can partake in the IDE process. The creation of strong co-investment networks in a well-performing region act as a barrier to entry by new investors (Hochberg, Ljungqvist, and Lu 2007). Consequently, entrepreneurs are forced to accept lower valuations in order to access the limited supply of high-quality value-added activities (Hsu 2004; Hochberg, Ljungqvist, and Lu 2007). In addition, an entrepreneur's access to venture capital proceeds at least in part through their networking with social and professional connections. Thus, it is not surprising that factors such as co-ethnicity also drive selection of startups to invest in (Hegde and Tumlinson 2014; Bengtsson and Hsu 2015). In addition, gender differences in proactive networking with VCs are at least driving gender differences in venture capital allocation (Howell and Nanda 2023). Thus, the networked basis of venture capital is a source of substantial inequality in IDE, a point we return to in Section 7.

5.1.5. Cyclicality

The VC market, much like the equity market itself, is cyclical, and affected by macroeconomic factors (Gompers and Lerner 1998). Hot markets, with large influxes of capital into VC funds, are characterized by "money chasing deals" (Gompers and Lerner 2000). Companies of lower quality can be funded during these hot periods, and valuations rise. The pro-cyclicality of early stage VC investment has implications for innovation more generally, with VC-backed firms producing lower quality innovation during recessions (Howell et al. 2020) In recent years, the large influx of capital into the VC industry, particularly into VC funds that invest in later stage startups, has led to

relatively larger investments in a smaller number of firms, as VC firms struggle to scale. This has filtered down and affected the decisions of early stage investors, who have responded by reducing funding to firms that show less early promise (Bernstein et al. 2020).

5.1.6. Venture Debt

While IDE firms generally rely on equity financing, and are often unable to utilize debt markets, there are a few exceptions to the "no debt" rule. The first and foremost of these exceptions is venture debt. Venture loans are typically arm's-length (formal) loans supplied by banks and other for-profit financial institutions to science and technology start-ups. Although technology start-ups and outside debt seem poorly suited for one another in theory, evidence suggests that the venture lending market is surprisingly large and active, accounting for roughly $5 billion to startups annually (Ibrahim 2010; Robb and Robinson 2014). There is an especially large and active market for innovation-driven startups with patent portfolios where the size of the debt issued is tied to the firm-specificity of the patents and the presence of existing equity investors (Hochberg, Serrano, and Ziedonis 2018) consistent with Holmstrom and Tirole (1997). Venture debt is often used by entrepreneurs to "extend the runway" and delay the need for further equity financing rounds (Davis et al. 2008).

5.2. Other Early-Stage Financing

While VCs are the investors most often associated in the public's mind with IDE ventures, VCs are typically not the first investors in new IDE ventures. Most IDE startups obtain their initial financing from angel investors, and, more recently, from various forms of crowdfunding.

5.2.1. Angel Investors and Friends and Family Financing

Angel investors and family and friends are the prototypical first investors in new IDE startups, and are an important source of entrepreneurial financing (Lindsey and Stein 2019). Angels are individuals or groups of individuals who make small equity investments in new companies, either via a priced sale of equity, or through the use of convertible debt notes or simple agreements for future equity (SAFEs) that convert to equity upon achievement of certain milestones, typically the raising of a significant equity capital round from institutional investors. Unfortunately, the literature on angel and friends and family financing of IDE is less robust than that for VC, primarily due to relative difficulty in obtaining large representative data sets for analysis. Early research has

suggested that friends and family finance is a poor source of risk capital for entrepreneurs (Lee and Persson 2016), while empirical examinations of angel financing suggests that angel investment may add value to new ventures (Kerr, Lerner, and Schoar 2014; Lerner et al. 2018).

Angel financing is often a precursor to VC financing, establishing a complicated relationship between angel and venture capital investors with aspects of both substitutes and complements (Hellmann and Thiele 2015). Angel financing appears to provide substantial value added effects in regions with well-developed IDE communities (Kerr, Lerner, and Schoar 2014), while globally, proper table setting policies are needed to ensure its effectiveness (Lerner et al. 2018). Likely because angel financing is often used at the earliest stages of the venture, angel investors appear to respond most strongly to information about the founding team, rather than product or market traction indicators (Bernstein, Korteweg, and Laws 2017).

5.2.2. Crowdfunding and Tokens

A newer source of initial financing for IDE entrepreneurs is crowdfunding (CF), which refers to the use of online platforms or intermediaries to solicit funding from a large number of smaller investors, either through pre-sales of product—typically referred to as rewards-based crowdfunding—or through sale of equity stakes (see Agrawal, Catalini, and Goldfarb 2014 for an overview of rewards-based crowdfunding).

While pre-sale of products has always been allowed, rewards-based CF platforms have made this process simpler, increasing usage. For consumer-based startups, the attraction of CF lies both in the raising of funds and in the ability to obtain market validation of demand for their product or service, thus mitigating the uncertainty associated with entry into new markets or with new technologies (Chemla and Tinn 2020). More recently, legislation has opened the door to equity crowdfunding (also referred to as securities-based CF). Theoretically, the increased investor base provided by equity CF may alter the efficiency of capital allocation for startup ventures (Hellmann, Mostipan, and Vulkan 2019; Brown and Davies 2020), yet conflicts of interest may arise if experienced investors drive capital flow towards investments in which they have prior stakes (Agrawal, Catalini, and Goldfarb 2016; Catalini and Hui 2017; Itenberg and Smith 2017). Empirically, experienced investors on CF platforms appear to drive capital allocation toward higher quality startups (Agrawal, Catalini, and Goldfarb 2016; Catalini and Hui 2017).

A final form of CF that has taken form in the last few years with the emergence of blockchain technologies is the initial coin offering (ICO) (Cong, Li, and Wang 2021). An ICO enables a startup to raise funds through the sale of cryptographically secured tokens which will in future be used as the sole form of payment for the startup's products or services. An emerging literature on this topic provides descriptive evidence on the nature and scale of the ICO market (Howell, Niessner, and Yermack 2020; Lyandres, Palazzo, and Rabetti 2022), retention of tokens by entrepreneurs (Davydiuk, Gupta, and Rosen 2023), and exploration of the theoretical underpinnings (Bakos and Halaburda 2020; Lee and Parlour 2022).

5.2.3. Grants and Other Non-Dilutive Financing

In addition to angel financing and crowdfunding, early-stage IDE entrepreneurs may also access certain source of non-dilutive funding specifically designated to promote innovation and economic growth. Governments across the globe dedicate funding for innovation-driven small businesses. In the US, Federal Agencies manage the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, which award non-dilutive funding to startups across a large range of technology areas, markets, and risk levels. State-specific noncompetitive matching programs offer some awardees additional funds (Lanahan and Feldman 2018). SBIR/STTR awards appears to lead to faster growth (Lerner 2021) and enable the production of patents by awardee firms (Howell 2017), with the effects concentrated in regions and industry segments that also exhibit high volumes of VC (Lerner 2000; Gans and Stern 2003).

A second form of non-dilutive funding for IDE entrepreneurs comes in the form of cash prizes awarded through venture competitions. In these competitions, early-stage startup founders pitch their startup businesses to a panel of expert judges, whose scores determine which ventures will win monetary (and, sometimes, non-monetary) prizes. In the US context, competitions help startups through the certification channel, helping to resolve the very large information problems that exist in new venture finance (Howell 2020). The certification effect seems to be particularly important for science-based startups (de Rassenfosse and van den Heuvel 2020). In the developing world, competition winnings appear to help early stage IDE startups primarily through alleviation of financial constraints (McKenzie 2017).

5.3. Late-Stage Capital

Finally, one recent emerging trend in IDE entrepreneurial finance has been the emergence of hedge funds, pension funds, mutual funds, sovereign wealth funds, and other non-VC investors as late stage investors in private, venture-backed companies (Kwon, Lowry, and Qian 2020; Ewens and Farre-Mensa 2020; Chernenko, Lerner, and Zeng 2021). The entry of these financiers, who traditionally did not fund uncertain private growth stage startups, has occurred alongside the more general growth of the growth equity fund industry (Lattanzio, Litov, and Megginson 2023). Together, these sources of late-stage financing have allowed venture-backed startups to remain privately-owned for longer, and to raise significantly more private capital. This trend, combined with the emergence of global markets, the move towards software and mobile, and the rise in importance of economies-of-scope in winner-take-all global markets (Gao, Ritter, and Zhu 2013), have led to a significant drop in IPO activity in the US and abroad, and to the rise of "superstar" global firms (Autor et al. 2020).

6. Fostering Regional Entrepreneurial Activity

The final set of literature we discuss moves away from the entrepreneur and the venture to the question of how policy makers can act to encourage and support entrepreneurial activity in their geography. The spatial distribution of IDEs with the potential for high growth shows a high degree of concentration. Firms in Silicon Valley account for close to 50% of venture capital allocations and nearly 20% of patents in the US, leading the world in both venture capital investment and the number of "unicorn companies"—despite only representing 2.5% of the US population (Kerr and Robert-Nicoud 2020).[10] Even within the Silicon Valley region, high growth firms are remarkably clustered (Kerr and Kominers 2014; Guzman and Stern 2015) and this clustering seems to have a dramatic impact on the productivity of inventive labor (Moretti 2021).

Such geographic clusters appear to be major engines of economic growth for their states and for the US more broadly. Increases in venture capital, a key marker for IDE activity in a region, are associated with increases in both employment and aggregate income (Samila and Sorenson 2010). This in part because VC-backed firms grow larger and employ more people on average (Puri and Zarutskie 2012; Kerr, Nanda, and Rhodes-Kropf 2014) and in part due to the existence

[10] A "unicorn" company is an informal designation for a company that has been valued at least at $1 billion dollars by investors.

of wage multipliers for workers in other sectors of the economy in regions with robust IDE-driven growth (Moretti and Thulin 2013). It is not surprising, therefore, that many regions have attempted to institute policies and programs to increase local rates of IDE to foster the creation of self-sustaining startup hubs.

Despite their supposed ex ante promise, however, the success of most government programs has been limited at best (Lerner 2013; 2021). Still, place-based policy to encourage IDE entrepreneurship has become an increasing focus for policymakers, and a focus of both public and private funding. Numerous organizations around the world, including the European Commission Smart Specialisation Strategies, the Kauffman Foundation in the US, and global efforts such as Endeavor and MIT's Regional Entrepreneurship Acceleration Program (REAP), have established programs with the explicit aim of nurturing and accelerating IDEs to encourage regional economic growth. These programs are rooted in the realization that implementing effective place-based innovation and entrepreneurship policies depends not only the ambition and capabilities of local entrepreneurs, but on the broader ability of regions to nurture innovators and entrepreneurs in the contexts of their regional ecosystem.[11]

The last two decades have witnessed an explosion of innovative programs that attempt to intervene or strengthen the entrepreneurial process in ways that might impact the rate, direction and success of IDE (Cohen et al. 2019). In what follows, we discuss the regional resources that impact IDE and the types of policies and programs that may accelerate the economic dynamics governing IDE clusters.[12]

6.1. Human and Social Capital

An IDE firm requires its founders and employees to invest in developing human capital that is novel, and thus of more uncertain value (Rajan 2012). Colocation of IDE firms may help mitigate these uncertainties. Theoretical models of colocation of firms and workers within cities have

[11] MIT REAP for example, has emerged as a leading framework drawing on academic research to inform place-based innovation and entrepreneurship development policy, highlighting critical differences from traditional economic development policy. Specifically, there is no "one" agency or actor that oversees a regional IDE ecosystem, and so effective place-based policies involve bringing together both public and private stakeholders, including universities, corporations, government, risk capital, and of course innovators and entrepreneurs.

[12] Our coverage of clustering in technology-focused industries will be concentrated on IDE. For a more general overview of technology clusters considering both established and entrepreneurial firms, we recommend Kerr and Robert-Nicoud (2020).

emphasized how greater pools of firms and workers create better matches between skills and jobs, providing incentives for workers to develop new and useful skill combinations (Helsley and Strange 1990; 2002; Glaeser 2007). Relatedly, theoretical work has suggested that the collocation of firms and workers allows firms to engage in riskier R&D projects (Gerlach, Rønde, and Stahl 2009). As the range of human capital in a local economy grows, so too does the ability to develop new products and processes through IDE (Duranton and Puga 2001).

When radically new ideas enter the economy, they can require novel human capital to transition from a fundamental scientific or technical discovery into a viable commercial product, and the supply of such novel human capital might be limited in the short term. For example, the ability to enter the emerging biotechnology industry during the 1970s and 1980s was tied to co-authorship with the star scientists that were creating the underlying scientific discoveries and these networks of connections created clusters of biotechnology in the cities where these star scientists were located (Zucker, Darby, and Brewer 1998). Similar patterns have been documented in the pursuit of integrated circuits in Silicon Valley, the assembly line production of automobiles in Detroit, and the pursuit of the petrochemical revolution in Cleveland (Bresnahan, Gambardella, and Saxenian 2001; Lamoreaux, Levenstein, and Sokoloff 2006; Klepper 2010). Importantly, access to information about technical and scientific advances attenuates quickly with increased geographic distance. Citations to patents show strong geographic localization, especially when a cited technology is new (Jaffe, Trajtenberg, and Henderson 1993). Regions with higher population density, where chance encounters occur more frequently, have higher patenting rates per capita with higher rates of novel technologies arising in the densest regions (Carlino, Chatterjee, and Hunt 2007; Berkes and Gaetani 2021). This relationship between geographic distance and novelty of new ideas has also been observed in academic research, another key input to IDE (Catalini 2018).[13]

The amount and density of collocation of firms and works alone, however, cannot explain the ability of regions to foster the creation of new economic experiments inherent in IDE. Sociological studies suggest that networks and social capital between individuals and firms in a region improve

[13] Researchers have also suggested that Silicon Valley's regional advantage is built in part upon the close proximity of many talented individuals in geographic and social space that allows the recombination of new ideas together into new economic experiments. In our online appendix, we provide some key citations in economics, sociology, management and regional studies which unpack the performance of Silicon Valley and other IDE clusters.

the extent to which the random interactions enabled by regional density can be leveraged into successful startups (Powell et al. 1999; 2005; Samila and Sorenson 2017). Similarly, recent work has shown that long-run historical and cultural factors, such as "rugged individualism" along the western frontier of the US (Bazzi, Fiszbein, and Gebresilasse 2020), impact the extent of modern-day IDE activity (Barrios, Hochberg, and Macciocchi 2022).

Questions remain for future work about the balance of these forces in fostering the types of collisions and cooperation that generate valuable experiments in the economy. Moreover, the impact of human capital accumulation in a region goes beyond initial entry to scaling, growth, and the ability to adapt to opportunities, all of which require a deep pool of human capital. While the scale of human capital pooling has figured prominently in broader explanations of entrepreneurial agglomeration (Chatterji, Glaeser, and Kerr 2014), we have less understanding of how the depth, breadth and density of human capital in a region impacts the performance and growth of nascent ventures across regions.

Appropriate policy can increase the rate at which individuals with the appropriate human capital endowments can utilize their insights in the formation of new IDE. Much attention has been paid to the role of non-compete clauses in moderating new firm formation and the flow of information between firms more broadly. Empirical work suggests that the freeing up of technical talent through the non-enforcement of non-compete clauses is strongly tied to the ability of employees to depart to IDE activity as both founders and labor (Fallick, Fleischman, and Rebitzer 2006; Jeffers 2020).

Beyond policy, because potential IDE entrepreneurs often have substantial outside options (Levine and Rubinstein 2018), entrepreneurship support programs can increase the entry of higher quality entrepreneurs by reducing the cost of experimenting with novel ideas (Nanda and Rhodes-Kropf 2016a; Manso 2016). Pitch competitions can provide early go/no-go signals to entrepreneurs as to whether they should continue to pursue ideas, while also providing easier access to capital through certification (Howell 2020). Startup accelerator programs serve similar roles in helping to quickly shut down low-quality startups (Yu 2020), as do more resource-efficient programs such as entrepreneurial education programs (Bailey et al. 2023), with the effects of such programs moderated by the social capital and networks of the startup's founding geography (Fehder 2020). Additionally, programs such as accelerators seem to encourage the emergence of latent entrepreneurial activity, creating spillovers that lead to higher levels of IDE activity in regions in

which they are founded (Fehder and Hochberg 2021). Understanding the magnitude of benefits for different program elements and establishing the welfare effects of encouraging high human capital individuals to engage in IDE, however, remains an open topic for future research.

6.2. Universities

One key source of both novel ideas and the human capital necessary for IDE are universities. University basic research is often turned into formal IP, which is then hopefully transferred into the economy through licensing mechanisms. Moving property rights to universities (the Bayh Dole Act of 1980) seems to have had a stimulating effect on both IP creation and innovative activity (Sampat and Mowery 2009). Similarly, institutional differences in licensing policies and incentives to professors at the university-level seem to impact the rate of out-licensing and university spin-outs (Lach and Schankerman 2008; Belenzon and Schankerman 2009; Hvide and Jones 2018). Interconnections between local industries and universities mean that the location of universities and the nature of their ecosystems matter for their ability to transfer new ideas into the economy (Hausman, Fehder, and Hochberg 2020; Hausman 2022), and programs that accelerate the translation of basic research out of universities can impact the supply of IDE activity in a region. While universities may be perceived as fixed features that are stable from decades and centuries past, recent efforts by policy makers have suggested that research and human capital training specifically related to IDE can be brought by policy makers into new regions, as New York City has done with the solicitation and fostering of the Cornell Tech campus.

There is tremendous variation across universities in the degree to which they seek to facilitate the academic spinouts and the programs they use to do so. Some universities have formal programs (Scott, Shu, and Lubynsky 2019), and recent efforts by federal funding agencies have the aim of creating more such programs.[14] Many universities provide space for new startups to grow near to university labs through science parks. Overall evidence on the impact of these programs, however is far more modest (Rothaermel and Thursby 2005; Link and Scott 2007). Recently, the federal agencies have attempted to encourage the academic spin-out process through the NSF's I-Corps program and DARPA's Embedded Entrepreneur initiative. These efforts, however, have received limited evaluation (Kearney 2019).

[14] For example, see the the National Science Foundation's Accelerating Research Translation Program: https://new.nsf.gov/funding/opportunities/accelerating-research-translation-art.

Perhaps more importantly, we do not fully understand the welfare effects of academic entrepreneurship. A growing number of studies suggest that there are tradeoffs to academic entrepreneurship. On the one hand, academic spinouts produce more important and valuable intellectual property which has larger spillovers to local invention (Kolev et al. 2022), and innovation output from academia serves to attract private capital investment to the region to launch new IDE companies, igniting a virtuous cycle of innovation and capital (Kortum and Lerner 2000; Hausman, Fehder, and Hochberg 2020). On the other hand, academics that focus on entrepreneurship seem to generate fewer knowledge spillovers in the form of impactful research from their students (Roche 2023), and the departure of academics to industry to pursue entrepreneurial activity may negatively affect the productivity of their university's students (Gofman and Jin 2023). More work exploring the cost-benefit tradeoffs of academic entrepreneurship would be valuable.

6.3. Industry Clusters and Incumbent Corporations

Another key source of novel ideas and human capital are established corporations that invest substantially in R&D. The knowledge produced from these R&D efforts can lead to innovation within the company that benefits subsequent entrepreneurship in at least two ways. First, working within companies at the vanguard of new technologies seems to yield a higher likelihood of starting a high impact firm (Gompers, Lerner, and Scharfstein 2005), and this relationship seems tightly tied to corporate R&D allocation (Babina and Howell 2018). Second, not all new product avenues and innovations are used by incumbents. Spinouts can leverage the ideas and intellectual property that are unused or underutilized in incumbent corporations as a source of entrepreneurial entry, especially in the early stages of an industry's lifecycle (Klepper and Graddy 1990; Klepper 1996; Klepper and Sleeper 2005). Clusters of related industries in a region can facilitate entrepreneurship by allowing novel recombinations drawn from firms in multiple related industries (Delgado, Porter, and Stern 2010). Unsurprisingly, there is a strong empirical relationship between the industrial structure of a region in the past and the likelihood of new firm entry and employment in the current period (Klepper 2007; 2010; Glaeser, Kerr, and Kerr 2015; Hausman 2020).

Despite these empirical findings, our understanding of the levers available to policymakers that wish to capture the benefits of the industrial organization in their region for spawning firms is limited at best. Emerging work, however, has begun to explore policies designed to enhance

positive relationships and spillovers between established and startup firms. For example, Economic Technological Development Zones in China appear to have produced measurable increases in both IDE and innovation in existing firms (Tian and Xu 2022). These zones and the incentives they provide are targeted toward the development of technology and IDE, and thus are substantially different from other special economic zones for which there are mixed evidence of efficacy (Busso, Gregory, and Kline 2013). Similarly, for example, the attraction of large plants has been shown to increase regional productivity through spillovers (Greenstone, Hornbeck, and Moretti 2010), and to have impacts on innovative activity in the region (Xue 2022). There has been limited systematic exploration of the effects of incentives such as tax credits to attract technology firms, despite high profile examples such as the competition between cities over attracting Tesla's Gigafactory in 2014 and Amazon's HQ2 in 2019 (Soper, Day, and Goldman 2020).

6.4. Funding Sources

Once a discovery and an opportunity are recognized, whether inside a university, corporation, or garage, IDE typically requires early-stage capital to reach the market. From a practical standpoint, however, VCs and other early-stage investors show a substantial preference for firms that are geographically proximate (Chen et al. 2010). Lack of access to capital to grow innovative new companies is a frequently cited hypothesis as to why regions may not have a well-functioning IDE ecosystem, and funding has been one of the most frequently targeted areas for intervention by policy makers.

One prominent example of such interventions is tax-credit schemes to encourage angel-investing. While these programs do appear to lead to the allocation of more early-stage capital, they do not lead to increases in employment, patenting, or other markers of IDE entrepreneurship (Lindsey and Stein 2019; Denes et al. 2023). The lackluster effect of such interventions may be found in the compliance issues surrounding the solicitation and acceptance of money from angel investors (Denes et al. 2023), and may also create incentives for inexperienced investors to enter the early-stage market in ways that are inefficient for the allocation of capital to the best firms (Lerner 2009; Denes et al. 2023). Another avenue favored by policy makers are efforts to attract existing, experienced VC investors to invest in the local region. One of the few programs that has successfully stimulated IDE in a region in this manner is the Yozma program in Israel. Yozma provided matching, non-dilutive funds for established venture capitalists that wanted to invest in

Israeli high-tech companies, thereby increasing the attractiveness of investments in Israeli firms by increasing the marginal impact of each dollar invested by a VC without impacting their equity stake (Lerner 2009). Finally, other interventions aim to create local VC firms funded by economic development funds provided by the local government. Evidence on the role of government venture capital programs is scant, though programs which focus on joint investment with established venture capitalists appear to succeed in increasing performance of IDE startups in their region more than programs that "go it alone" (Brander, Du, and Hellmann 2015).

While policy makers have often focused on endowing the region exogenously with new sources of capital, recent work suggests a more effective way to spur new funding availability in a region is to focus on spurring innovative activity itself. Shocks to innovative output in a region appear to spur venture investment and VC activity through the provision of new investment opportunities which draw private capital to the region, igniting a virtuous cycle of innovation and capital (Hausman, Fehder, and Hochberg 2020). Another path to increasing venture capital investment in a region appears to be the provision of non-dilutive financing grants at the earliest stage of an IDE's development to support translational research needed for successful commercialization and attraction of private market investment capital. In the US, grant programs such as the SBIR program have attempted to serve this role, yet the impact of the SBIR program seems to be mixed. Due to vagaries in the design of the program, SBIR grants seem to be allocated more towards larger, more established small businesses (Wallsten 2000), leading to potential crowding out of some types of investment and to no large impact on employment. On the other hand, receiving an SBIR grant appears to improve the performance of firms, though much of the impact seems to have been isolated to regions with well-functioning venture capital pools (Lerner 2000). Grant programs such as the SBIR program might serve a role beyond simple allocation of capital. Because the evaluation panels of the SBIR program are staffed with top scientists, their evaluation of the technical merit of the applicants can provide a certification signal for the winners of the grant. Indeed, the impact of the SBIR grant program seems to flow mostly through the certification signal itself rather than the total number of dollars allocated (Howell 2017), so that the largest impact of the SBIR and SBIR-like programs might be in stimulating downstream investments, especially for firms established in regions where venture capital investment is less common (Zhao and Ziedonis 2020). Indeed, these results suggest that some particularly valuable

programs and policies might be targeted towards more efficient information aggregation and or dynamic incentives for more novel or experimental entrants (Bolton and Harris 1999).

Encouraging investment in regions that lack an existing VC cluster, while challenging, may potentially be addressable. Venture capitalists are willing to invest in startups outside of their home region if the startup has a higher chance of creating a significant return (Chen et al. 2010). Investments that decrease the amount of time required for an investor to evaluate or monitor a startup in a region increases the venture capitalist's willingness to allocate capital there (Bernstein, Giroud, and Townsend 2016). Program design, therefore, may best focus on both improving the quality of startups in a region and certifying the best startups to receive attention from potential funders. An increasing number of programs appear to serve this latter role. Programs such as pitch competitions and accelerators provide certification signals that allow investors to allocate their limited attention and other resources to higher quality startups earlier in the startup process, yielding significant improvements in startup performance (Gonzalez-Uribe and Leatherbee 2018; Howell 2020). By creating a pool of high-quality startups, accelerators can draw outside investors that may have previously overlooked opportunities in the region (Hausman, Fehder, and Hochberg 2020; Fehder and Hochberg 2021).

7. Future of the Field and Directions for Future Research

Relative to other areas of research in economics, the study of innovation-driven entrepreneurship is a new development that has grown in importance across various fields of economic study over the past few decades. There remain many open questions and areas for future research, however, as we discuss below.

7.1. Data

At a basic level, our understanding of certain aspects of IDE is fundamentally limited by the availability of data. Some areas of research (such as VC) are well-developed, simply because of the availability of relatively comprehensive data through commercially available databases. In contrast, other areas of IDE remain black boxes primarily because no data is available for empirical exploration. More generally, the availability of data presents a clear constraint for progress in the field. One of the most significant challenges is the lack of data covering representative samples of IDE entrepreneurs. Population-level databases on employer firms such as the Census LEHD and representative sample surveys of prospective entrepreneurs such as the PSED present population-

level data, but with limited ability to distinguish between IDE and TBE entrepreneurs. As a result, analyses of these data often confound different types of entrepreneurship. Researchers often attempt to restrict samples by industry or to match firms to USPTO data, but both of these methods provide imperfect identification of IDE.[15] In contrast, data sources such as Crunchbase and Pitchbook collect near-population-level data on early-stage entrepreneurs through self-reporting and webscraping. Inclusion in these databases thus requires entrepreneurs to reach early milestones or make certain choices on public visibility, limiting the inclusion of "stealth" entrants and early failures in the data. Furthermore, many TBE companies can and do list their information on these databases, further confounding the data for the researcher.

The inability to clearly distinguish between IDE and TBE in the data sources that are the most representative on other dimensions means that some of the most fundamental empirical findings on entrepreneurship represent an average over TBE and IDE entrepreneurship. As mentioned in Section 3, basic questions, such as those regarding the returns to entrepreneurship, have largely been answered using data sets in which IDE entrepreneurs represent a relatively small portion (Moskowitz and Vissing-Jørgensen 2002; Hall and Woodward 2010). What are the differences in returns to IDE vs TBE? Under what conditions are the returns to IDE activity are significantly higher? Who selects into IDE? Answers to these questions are particularly important for regional and national level economic growth, but the literature to-date affords limited answers.

Similarly, in most existing large-scale data sources, it is difficult to identify when and why firms have exited, particularly in downside cases. The ability to distinguish between "lifestyle" firms, "living dead" firms, and firms that have been disbanded is substantially limited in many existing data sources either because reporting on the firms is periodic and does not require a yearly or quarterly update, or because data is sourced from web presence which often is not updated, nor removed immediately when the firm disbands. The lack of reliable data on entry and exit places bounds on the type questions researchers can inform.

An additional challenge with standard databases is the lack of information about founder characteristics and identities. Key theoretical issues around IDE entrepreneurship involve the relationship between the human capital investments of its founders and the performance of their

[15] Many IDE startups may not seek to patent new technology, preferring to rely on trade secrets or first-to-market advantages

ventures (Lazear 2004; 2005). Similarly, there remain many open questions regarding how individual-level differences in founder preferences and personality impact their decision making, and thus the performance of their ventures (Åstebro et al. 2014; Kerr, Kerr, and Dalton 2019). Yet currently available data does not allow the researcher to discern the specific role of an individual (e.g., founder versus early employee, manager versus engineer), or to gain an understanding of team composition. Data on key decisions, such as strategic tradeoffs made by the founders, is also lacking. As a result researchers are limited in their ability to test these theories and the interconnections between them.

Development of new sources of detailed data on ventures and their founders remains a key need for further development of knowledge in the field. One opportunity for such data development lies in the conduct of more extensive field studies, which we discuss in more detail later in this section.

7.2. Exits and Venture Failure

Although a large and substantive literature explores the notion of startup company exit via IPO (Ewens and Farre-Mensa 2020; Huang, Ritter, and Zhang 2023), much less is known about exit through other modalities, especially exit through venture failure. Whereas in decades past IPOs were the majority of successful venture-backed startup exits, they now account for only 10% of exits for venture-backed startups (NCVA 2020).[16] Despite this, there has been limited research exploring failure of IDE startups or exit through acquisition. This is a target-rich area for future research.

While some research has suggested that acquisition could be preferred by entrepreneurs in certain industry environments (Gans and Stern 2000; 2003; Gans, Hsu, and Stern 2002; 2008), acquisition as an exit strategy remains relatively unexplored in the literature. Researchers have recently begun to pick up on this gap in our understanding, with explorations of acquihires—acquisitions in which the startup is purchased as a way to hire its team for other purposes (Kim 2022), the role of the competitive landscape and competitor acquisitions (Conti, Guzman, and Rabi 2020), and exploration of killer acquisitions—acquisitions in which the incumbent purchaser buys

[16] The decline in IPOs and its causes has been the subject of a number of recent research papers in the finance literature. See e.g. Gao et al. (2013), Doidge et al. (2013; 2017), Ewens and Farre-Mensa (2020). No consensus has been reached on the cause of this decline, suggesting room for future research in this area.

the startup in order to dismantle it (Cunningham, Ederer, and Ma 2020; Callander and Matouschek 2021). While acquisitions often appear to be a desired outcome for many entrepreneurs, open questions remain with regards to how these acquisitions affect the founders, employees, investors, and the acquirers themselves.

Because a high proportion of IDE firms eventually fail, understanding the causes and consequences of venture failure is important yet still understudied. Estimates of the failure rates for IDE firms range between 75-91% (Ljungqvist and Richardson 2003; Puri and Zarutskie 2012; Startup Genome 2019). Economic theory suggests that IDE failure may still create human capital that is valuable to established firms (Manso 2016; Levine and Rubinstein 2018), yet few research studies have examined the labor outcomes of failed entrepreneurs. While management research has explored the effect of entrepreneurial experience on labor market outcomes (Campbell 2013; Botelho and Chang 2023; Botelho and Marx 2023; Botelho, Fehder, and Miric 2023), economic work understanding how failed IDE impacts human capital relative to remaining ex ante in wage labor is lacking. Relatedly, we do not understand the impact of prior entrepreneurial experience on future attempts at IDE (i.e., serial IDE founders). If IDE is about unique economic experiments, what portion of that experience serves a useful purpose in the economy if the experiment failed? Given that the vast majority of IDE ventures fail, these questions are of first order importance.

7.3. Individual Characteristics of Entrepreneurs

Much like data on other aspects of entrepreneurial firms, comprehensive data on the individual characteristics of IDE founders are typically unavailable. For example, the literature lacks a deep understanding of how founder gender and founder race affect the entrepreneurial process. The little evidence we have paints a stark picture regarding the founding rates of IDE by underrepresented individuals (Gompers and Wang 2017). While supply-side mechanisms may account for some of the discrepancy in founding rates, there are likely systematic demand-side barriers faced by underrepresented individuals who are attempting to found an IDE venture. Female entrepreneurs face biases at multiple stages of the entrepreneurial process, and in investment in particular (Brooks et al. 2014; Ewens and Townsend 2020). Furthermore, this bias is most likely cumulative, as entrepreneurs depend on positive evaluations in one area to assist in another. For example, if underrepresented founders face greater difficulty in attracting initial employees, and investors use

founder characteristics, as well as employee quality, to base their decisions, then bias in one domain magnifies bias in another. There is a need for research in this area that goes beyond documenting bias and focuses on possible policy levers to reduce such biases and improve outcomes.[17]

Many other important questions as to how founder characteristics affect their observed outcomes remain unanswered. Behavioral parameters, such as risk tolerance and overconfidence, have been connected theoretically to entrepreneurship in economics (Kihlstrom and Laffont 1979; Camerer and Lovallo 1999), but have not been explored empirically in IDE specifically. Empirical work has begun to document the heterogeneity in and effect of personality traits for various aspects of IDE activity (Kerr, Kerr, and Dalton 2019; Fehder et al. 2021; Fehder, Prasad, and Wakslak 2021).[18]

7.4. International Aspects

The US has been globally preeminent in fostering IDE entrepreneurship over the past 50 years. Yet it is unclear whether this global advantage in IDE activity can be maintained. Even within the US, regions have seen sustained periods of innovation and IDE, only to quickly fade in prominence (Duranton and Puga 2001; Lamoreaux, Levenstein, and Sokoloff 2006). Two primary factors that have underpinned the US' competitive advantage, but which face significant change in the coming decades, are (i) the battle for global talent, and (ii) global capital flows.

While Silicon Valley in particular and the US in general has been a wellspring of IDE entrepreneurship over the past century, a substantial portion of that IDE entrepreneurship has been generated by immigrants (for a review, see Pekkala Kerr and Kerr 2020). In part because they are more likely to migrate to areas of new technical opportunity (Kerr 2010), foreign-born innovators provide strong positive externalities for innovation in general, especially for native-born inventors (Moser, Voena, and Waldinger 2014; Bernstein, Diamond, et al. 2022).

In addition to contributing substantially to inventive activity, immigrants are more likely to enter into entrepreneurship than similarly educated native-born workers (Hunt 2011; Azoulay et

[17] Relatedly, future work could also focus on how improving a founder's initial resources can affect participation, given that both gender and race have been associated with more limited access to various resources and that resource access appears to affect entry into entrepreneurship and subsequent performance. See our online appendix for related literature.

[18] For an excellent review of personality traits and entrepreneurship writ large see Kerr, Kerr, and Xu (2018)

al. 2022). Despite the contribution of immigrants to entrepreneurship, multiple features of US immigration policy may limit the ability for immigrants to pursue entrepreneurship (Kerr and Kerr 2021) in the US and pushing them back to their country of origin (Khosla 2018). Given that it is unlikely that US citizens will be able to substantially substitute for the sheer quantity of immigrant STEM graduates demanded in Silicon Valley, or the US more generally, immigration policy may become increasingly important as cross-border investments increasingly drive convergence to the global technological frontier (Akcigit et al. 2020). Finally, increasing nationalistic competition for supremacy in certain key technological areas, such as semiconductors and artificial intelligence, may create an additional engine to spur technological development abroad. All of these topics deserve considerable additional attention and research.

Beyond the ability to access global talent, a key contributor to the US' primacy in IDE was its early creation of a successful venture capital industry. The availability of early-stage capital to fund risky new innovation-driven businesses attracted entrepreneurs from across to globe to Silicon Valley, contributing to an agglomeration of IDE ventures and talent. Changes to the geographic distribution of early-stage capital and other financial institutions globally, however, may change the calculus for startup ventures and their decisions of where to locate. Recent increases in early stage investment in Chinese startups, as well as in the market capitalization of listed firms on Chinese stock exchanges are just one set of examples of new developments that could create worthy rivals to Silicon Valley abroad (Jiang, Jiang, and Kim 2020). As funding availability and human capital availability increase in new regions, founder location decisions may shift. Economists have just begun to compare the efficacy of early-stage investors outside the US to US peers (Gompers and Wang 2017; Lerner et al. 2018). Because the institutional details, policies, and ecosystems of different countries can have a large impact on their ability to foster and sustain IDE (Lerner 2009), understanding the causal impact of these differences is key to understanding how the global distribution of entrepreneurial activity may shift going forward.[19] The fast-changing landscape of global IDE, however, means that any emerging agenda in international study of IDE must remain responsive to changes in the phenomena on the ground. The growth in IDE activity and financing globally has arisen in parallel to the reduction in

[19] For example, political control of economic decisions in China provides a useful window into the role of policy uncertainty in dampening IDE entry and performance (Cong and Howell 2021).

geopolitical barriers and the opening of global markets to outside activity (Lane and Milesi-Ferretti 2008). This, combined with the rapid adoption of mobile and internet globally, has resulted in startups that address global markets from the outstart (Hochberg 2017). Future research will need to look to the breadth of the global economy to capture these nuances.

7.5. Field Experiments

As noted previously, currently available data sets severely restrict our ability to explore many of the open questions in IDE, either due to lack of sufficient information about individual entrepreneurs and companies or because they do not provide the researcher enough context regarding choice sets and decisions. One approach to circumventing these limitations is through the generation of new data via the execution of field studies and experiments. In addition to generating data on otherwise opaque elements of the IDE phenomenon, randomized controlled trials (RCTs) in particular may serve to increase our understanding of IDE entrepreneurship through three channels: evaluation of interventions and policies that are prevalent in entrepreneurial communities, more precise measurement of effect magnitudes, and construction and validation of more nuanced models of entrepreneurial choices (Harrison and List 2004).

There are many areas in which well-designed RCTs could advance our understanding of key IDE-related questions. For example, the gender gap in entrepreneurship is larger in the high-technology fields that typically relate to IDE (Miric, Yin, and Fehder 2022), yet explaining the relative size of this gap without the use of field experiments would likely be difficult. Many possible theoretical mechanisms could explain this gap, from differences in behavioral preferences to prospective female entrepreneurs' expectations of discrimination in access to financing and other resources. Careful selection of populations in the field and well-designed field experiments could help identify the most impactful channels, and in doing so, identify and validate new interventions designed to improve the rates of female entry and success. Similar approaches have led to useful insights into the causes of gender wage differences (Niederle and Vesterlund 2007; Gneezy, Leonard, and List 2009).

More broadly, field experiments can help unpack individual and environmental factors which lead to entry and better performance in IDE. For example, if (similar to other types of entrepreneurs) IDE founders have higher risk tolerance than non-entrepreneurs, do entrepreneurs with higher risk tolerance make different decisions regarding financing, contracts, or competition,

among other things? If so, do these decisions to lead to better or worse performance for their ventures? Of course, field experiments cannot randomly induce variation in individual characteristics such as risk tolerance, but recent work in causal inference using machine learning allows researchers the opportunity for ex post exploration of patterns of treatment heterogeneity connecting individual differences to differences in choices without p-hacking (see e.g. Bailey et al. 2023). Use of such tools is likely to offer important insights from post hoc analysis, offering insight into previously unexplored areas of entrepreneurial behavior and outcomes.

Field experiments and RCTs, however, are not limited to providing insight solely on entrepreneurs. IDE startup success often involves multiple stakeholders outside of the startup. Field experiments can offer new insights into these stakeholders and their choices. For example, recent field experiments attempt to understand how investors perceive and rank opportunities (Brooks et al. 2014; Bernstein, Korteweg, and Laws 2017; Bapna 2017). Similarly, other recent randomized studies attempt to understand how entrepreneurs value and prioritize external resources and stakeholder interactions (Fehder, Hochberg, and Lee 2019). Additional field experiements exploring how individual differences amongst investors and entrepreneurs may impact how they deviate from mean behavior would be of some interest.

Notably, a growing set of RCTs in mainstream and managerial economics have emphasized the possibility of influencing and improving the entrepreneurial process (Chatterji et al. 2019; Camuffo et al. 2019). Other studies suggest that entrepreneurs are harder to improve (Fairlie, Karlan, and Zinman 2015). These studies, however, utilize dramatically different study populations. Some focus on high human capital individuals primarily pursuing a mix of IDE and TBE (Camuffo et al. 2019), some focus on IDE alone (Bailey et al. 2023), while others focus on under-employed and educated individuals for whom entrepreneurship or self-employment might provide an avenue out of unemployment (Fairlie, Karlan, and Zinman 2015). Heterogeneity in the treatment effect for different populations for different types of interventions can be explored explicitly through trial design. As field experiments continue to grow in importance in the study of entrepreneurship, however, is as important that researchers explicitly recognize the differences between different types of entrepreneurship and between the different entrepreneurial populations they are studying. More careful consideration of these issues during initial trial design will then allow for deeper understanding of external validity of the results and which populations and entrepreneurship types they apply to.

Finally, we note that carefully constructed field studies offer an additional benefit in that they afford the researcher an improved opportunity to identify causal effects and magnitudes, in particular when the population and type of entrepreneur studied is carefully selected.

7.6. IDE as an Opportunity to Advance Economic Theory

Economic theory has argued that the introduction of new ideas is the engine of economic growth, and the rate of their introduction substantially determines the long run path of growth (Romer 1990; Aghion and Howitt, 1992). In these models, growth is driven by the temporary monopoly created by a valuable idea that generates significant returns to scale. Growth is also moderated by the realization that monopoly power is susceptible to disruption by the next innovation. A particular thread in the literature on endogenous growth argues that the details of how innovation effort and expenditures are allocated matter both for the rate of economic growth and for economic welfare (Jones, 2022; Acemoglu 2022). Differences in beliefs and preferences among those allocating resources toward innovation can dramatically shift the long-run equilibrium outcomes for the rate and direction of inventive activity (Acemoglu, 2022).

The sweeping macroeconomic scope of these endogenous growth models calls attention to the importance of the institutions, such as VC, which allocate resources towards innovative activity. Early-stage investors in IDE and the entrepreneurs they fund must coordinate even though they may share substantially different information and beliefs about technical change in the economy. As individuals take ever longer to reach the frontier of knowledge in any particular technical area (Jones 2010; Azoulay et al. 2020), individuals seeking to evaluate the value of ideas across multiple domains will have to rationally invest in attention to a limited set of information, forsaking others, and leading to dramatic differences in knowledge and beliefs about different projects. While the uneven distribution of information sits at the heart of early theoretical work on innovation (Hayek 1937; 1945), more recent work by economic theorists has sought to ground the development of differing information sets into rational inattention models (cf. Capillan 2022; Maćkowiak, Matějka, and Wiederholt 2023). Recent theoretical work on directed search has attempted to characterize contracts that yield optimal search among agents in an economy that have differences in both information and beliefs about the distribution of rewards across different strategic choices (cf. Wright et al. 2021; Garlappi, Giammarino, Lazrak 2022). As theorists seek to better characterize how individuals interact strategically in environments rich with hard-to-

acquire information, the IDE setting provides a fertile lab for testing key empirical applications of these theories. It also provides an opportunity to use empirical descriptive patterns to push economic theory forward.

8. Concluding Remarks

While the previous section attempted to distill the implications of the distinctiveness of IDE into a set of priorities for near-term research, we conclude with a broader reflection of the aims of this paper. We began this review by suggesting that individuals that enter entrepreneurship with the ex ante intention to innovate are conceptually distinct from other entrepreneurs, and that this conceptual difference has implications for both the generalizability of existing research findings and the prioritization of future research. For example, research into such fundamental questions as the returns to entrepreneurship may have fundamentally different answers when the question is examined for each type of entrepreneur, rather than pursued in a comingled fashion. As the risks and returns for entrepreneurship may vary between IDE, TBE, the self-employed, and subsistence entrepreneurs, we should expect the individuals entering these vastly different types of entrepreneurship to vary, as will the fundamental challenges they face. While there is growing evidence of differences between these types of entrepreneurs, further understanding these differences and sharpening their distinction in economic research will help contribute both to more insightful economic theory and better policy recommendations.

If IDE entrepreneurs face fundamentally different processes and problems than other entrepreneurs, then they serve a fundamentally different role in the economy and similarly a different role in economic theory. Broadly, economic theory has argued that the introduction of new ideas is the engine of economic growth, and the rate of their introduction determines substantially the long run path of growth (Romer 1990; Aghion and Howitt, 1992). While this provides a key motivation for studying IDE, we would argue that more attention to the processes of IDE would provide economic researchers with an exciting context to explore several active areas of economic theory including, but not limited to, directed search, rational inattention, and the role of innovation in the evolution of market power. We believe that critical engagement between theorists and entrepreneurship researchers on these and other topics are likely to enrich both sides.

Relatedly, we believe that a crisper theoretical understanding of the fundamental problems facing different stakeholders in IDE may allow economists to take a more active role in improving the institutions, policies and programs which enable IDE. A growing number of prominent scholars have suggested that a more action-oriented engagement with real-world problems improves economics and makes it more valuable (Roth 2002; Duflo 2017). The substantial changes to the landscape of IDE over the past few decades suggest that there may be a number of barriers and frictions which could be substantially relieved through the creative and careful work of economic research.

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