

Dynamic entrepreneurship and technology-based innovation

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Abstract:

This paper seeks to distinguish between dynamic and static entrepreneurship. We define the construct of dynamic entrepreneurship in terms of Schumpeterian innovativeness and then develop a hypothesis suggesting that human capital is conducive to such action. In contrast, a paucity of human capital is more conducive to static entrepreneurship (defined in terms of organizational or ownership status). Based on a rich data set of entrepreneurs receiving research funding through the U.S. Small Business Innovation Research (SBIR) program, our empirical evidence suggests that academic-based human capital is positively correlated with dynamic behavior, whereas business-based human capital and prior business experience is not.

Keywords: dynamic entrepreneurship | static entrepreneurship | Schumpeterian innovation | human capital | Small Business Innovation Research (SBIR) program

Article:

Introduction

Scholars have been examining the meaning of what constitutes entrepreneurship and the activities which define entrepreneurship for decades (e.g., Hébert and Link 1988, 1989, 2006, 2009). One prevalent view of entrepreneurship is based on someone who starts or owns a business (Lazear 2004; Parker 2009). While the various views—which are just as common in the public discourse as they are among scholars—suggest that a person or company can be classified as being entrepreneurial based on the organizational or ownership status, which, according to Audretsch et al. (2015), is essentially a static view of entrepreneurial action.¹

¹ As Hébert and Link (2009) point out, the intellectual history of who the entrepreneur is and what he/she does is replete with static definitions of entrepreneurship. In a static world the entrepreneur is a passive element because his/her actions represent repetitions of past procedures and techniques already learned and implemented.

This static view of entrepreneurship is in sharp contrast with the view of Schumpeter, who defined the actions of the entrepreneur in dynamic terms as the person who innovates and who makes “new combinations” in production (1934, p. 78):²

[E]veryone is an entrepreneur only when he actually ‘carries out new combinations,’ and loses that character as soon as he has built up his business, when he settles down to running it as other people run their businesses.

Schumpeter thus defined innovative actions of the entrepreneur with reference to a production function (1939, p. 62):

[The production function] describes the way in which quantity of product varies if quantities of factors vary. If, instead of quantities of factors, we vary the form of the function, we have an innovation.

In this paper we try to identify characteristics about an entrepreneur acting in such a dynamic manner as Schumpeter (1939) envisioned as opposed to a static manner as discussed by Audretsch et al. (2015). In particular, we define for our empirical analysis dynamic entrepreneurship as it is related to Schumpeterian innovation, that is, in terms of one varying “the form of the production function.”

Our emphasis on this distinction between dynamic and static entrepreneurship is grounded in an understanding of entrepreneurial action as well as on the availability of a rich and unique set of data from the National Research Council’s (NRC’s) U.S. Small Business Innovation Research (SBIR) database that facilitates our measurement of these two concepts.³ Given a sample of technology-based projects funded through the SBIR program that accordingly can be classified as reflecting either dynamic or static entrepreneurship, we argue, following Lazear (2004), that the probability of observing dynamic entrepreneurial behavior can be explained in terms of the human capital of the associated entrepreneur.

Our paper proceeds in the following manner. In Section 2, we elaborate on our construct of dynamic entrepreneurship, and we develop a hypothesis linking human capital uniquely to such activity. In Section 3, we discuss human capital as a key to understanding entrepreneurial action. In Section 4, we overview the NRC’s SBIR database as well as our approach to defining research projects that reflect dynamic entrepreneurship in the sense of Schumpeter. Our empirical findings are discussed in Section 5, and we conclude the paper in Section 6 with an agenda for future research to further this important and previously neglected area of research that characterizes entrepreneurs as static or dynamic.

² The knowledge that kindles an innovation, according to Schumpeter (1928), need not be new; rather, it may be existing knowledge that has not been used before.

³ The National Research Council (NRC) is the operating arm of the U.S. National Academy of Sciences and the National Academy of Engineering. Its mission is to improve U.S. government decision making and public policy, increase public understanding, and promote the acquisition and dissemination of knowledge in matters involving science, engineering, technology, and health. See: <http://www.nationalacademies.org/nrc/>

Dynamic versus static entrepreneurship

A prevalent strand of literature views entrepreneurship as a state of being, or what is essentially a static perspective. According to this view, entrepreneurship is inferred on the basis of the organizational status of the company or the occupational status of the individual (Ruef et al. 2003). In terms of the company, this organizational status is typically characterized in terms of size (Jovanovic 1982, 1994; Lucas 1978) or age (Zucker et al. 1998; Brüderl and Preisendorfer 1998). Thus, companies below a prescribed size threshold, measured for example in terms of number of employees or dollar volume of sales, are classified as being entrepreneurial. Similarly, companies that are new or young, that is, companies that are of an age that is less than a second criterion threshold, are accordingly classified as being young or nascent (Davidsson and Honig 2003; Gicheva and Link 2015).

In terms of the individual, the organizational status of owning a company (Lazear 2004; Parker 2009; Carree et al. 2002), or being self-employed, is considered to constitute entrepreneurship (Parker and van Praag 2012). These classifications or depictions of what constitutes entrepreneurship are first and foremost based on a static view of the company and of the actions of the individual. It is the organizational status of the company and the ownership or occupational status of the individual—and not his/her actions—that distinguishes the static entrepreneur. As Hébert and Link (2009) observed (p. 101):

In a static world the entrepreneur is a passive element because his actions merely constitute repetitions of past procedures and techniques already learned and implemented. Only in a dynamic world does the entrepreneur become a robust figure.

By contrast, a very different strand of literature views entrepreneurship through a dynamic lens. According to these views, entrepreneurship is inferred on the basis of change, and in particular, changing products or processes through innovative activity. For example, Link and Link (2007) and Leyden and Link (2013, 2014) have proposed a dynamic theory of entrepreneurship to apply to decision making and behavior within the context of both the public and private sectors. This dynamic perspective of entrepreneurship clearly aligns with the Schumpeterian view that the entrepreneur has long been the driving force for innovation. According to Schumpeter (1942, p. 13), what distinguished the entrepreneur from other agents in the economy is his/her willingness to pursue innovative activity:

The function of entrepreneurs is to reform or revolutionize the pattern of production by exploiting an invention, or more generally, an untried technological possibility for producing a new commodity or producing an old one in a new way... To undertake such new things is difficult and constitutes a distinct economic function, first because they lie outside of the routine tasks which everybody understands, and secondly, because the environment resists in many ways.

Schumpeter offers some guidance to the antecedents of dynamic entrepreneurship, and that guidance points generally to one's experience and leadership (i.e., human capital). Schumpeter recognized that the knowledge that kindles an innovation can be new or already existing. But according to Schumpeter (1928, p. 378):

[I]t is not the [*per se*] knowledge that matters, but the successful solution of the task *sui generis* of putting an untried method into practice—there may be, and often is, no scientific novelty involved at all, and even if it be involved, this does not make any difference to the nature of the process.

In Schumpeter's theory, successful innovation requires an act of will, not of intellect. It depends, therefore, on leadership, and not on intelligence. An aptitude for leadership stems in part from the use of knowledge; people of action who perceive and react to knowledge do so in various ways and those ways are engendered from one's past experiences (i.e., human capital).⁴ According to Schumpeter (1928, p. 380), different leadership aptitudes mean that:

[S]ome are able to undertake uncertainties incident to what has not been done before; [indeed] ... to overcome these difficulties incident to change of practice is the function of the entrepreneur.

It is important to emphasize that we are using the concept of dynamic entrepreneurship in this paper to describe Schumpeterian innovativeness, and we are open to those who might prefer the latter term to ours. But, given that there is an important thread in the literature that considers the actions of an entrepreneur as being static, our terminology seems appealing. But, we do acknowledge that others have also emphasized dynamic characteristics of an entrepreneur.

To demonstrate the dynamic nature of entrepreneurship, for example, Morris et al. (2012) present an experiential approach to understanding entrepreneurship. They note that entrepreneurship has been described in various ways within the literature: as a passionate experience (Cardon et al. 2009); a gambling experience (Baumol (2001); a learning experience (Cope and Watts 2000); an adaptive experience (Stoica and Schindelhutte 1999); an evolutionary experience (Andren et al. 2003); a self-discovery experience (Gibb 1993); a peak experience (Schindelhutte et al. 2006); a social experience (Aldrich and Zimmer 1986); and even a grieving experience (Shepherd 2003).

According to Morris et al. (2012, p.11):

[A] better understanding of the ways in which events are processed and acted upon holds great promise in addressing a number of critical questions surrounding the entrepreneurial process.

In explaining the experiential approach, Morris et al., (2012, p.31) state:

Relying on experience-based concepts to create meaning, the entrepreneur filters inputs from the world to produce his or her own unique reality. ... The entrepreneur constructs and reconstructs both an identity and a venture by applying motivation, intention, and affective reactions to past and present experiences and the anticipated future.

⁴ Emphasis on past experiences influencing behavior traces to the writings of Locke (1979) and Hume (1993), both of whom argued that past experiences are the genesis of creativity.

Thus, their approach is a more recent illustration of how the dynamic nature of entrepreneurship is defined through the actions of the entrepreneur.

In other studies, entrepreneurship is conceptualized as a process involving multiple stages over time (Shane and Khurana 2003); yet, research has tended to be more static examining the entrepreneur's strategy, network, perceptions, skills, resource slack, and a host of other variables at a particular moment in time ignoring the value of an entrepreneur's experiences.

Teece, and his colleagues, have set forth the idea that company's achieve and maintain a competitive advantage through their dynamic capabilities. As Teece et al. (1997, p. 515) point out in their seminal paper on the topic:

The term 'dynamic' refers to the capacity to renew competences so as to achieve congruence with the changing business environment. ... The term 'capabilities' emphasizes the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment.

Teece elaborated on the concept of dynamic capabilities in subsequent writings. In particular (2007, p. 1344), he emphasized that continuous effort is needed—"entrepreneurial management"—to maintain the capabilities needed to remain competitive (p. 1322):

To identify and shape opportunities, enterprises must constantly scan, search, and explore across technologies and markets, both 'local' and 'distant'

Finally, Teece (2012, p. 1396) articulated the dynamic nature of entrepreneurial management necessary to maintain critical capabilities:

Dynamic capabilities can usefully be thought of as falling into three clusters of activities and adjustments: (1) identification and assessment of an opportunity (*sensing*); (2) mobilization of resources to address an opportunity and to capture value from doing so (*seizing*); and (3) continued renewal (*transforming*). These activities must be performed expertly if the firm is to sustain itself as markets and technologies change, although some firms will be stronger than others in performing some or all of these tasks.

Our construct of dynamic entrepreneurship (or Schumpeterian innovativeness) is narrower than Teece's construct in the sense that it is explicit as to how resources are mobilized or used, namely through a new production function. That said, our construct has the advantage of being operationalized for empirical purposes as we discuss below.

Relatedly, there is a rich literature, arguably popularized in the literature by March (1991) and Levinthal and March (1993) and ably reviewed by Lavie et al. (2010), that dichotomizes entrepreneurial activity as having the characteristic of exploration versus exploitation of ideas. As defined by Levinthal and March (1993, p. 105):

[E]xploitation [is] the pursuit of new knowledge, of things that might come to be known.
... [E]xploitation [*sic!*] [is] the use and development of things already known.

Certainly, these two concepts have a dynamic nature. In fact, Lavie et al. (2010, p. 114) argue that exploration-exploitation is “a continuum.” Organizations transition between these activities over time. But, these concepts are similar—not identical—to our notion of dynamic entrepreneurship, but there is a subtle and important difference.⁵ In a dynamic sense, entrepreneurship involves perception and action. Exploration-exploitation involves, at any moment, the choice of a strategy for perceiving new opportunities. Dynamic entrepreneurship, as we are using the term, refers to the action taken given that a strategically-determined opportunity has been perceived. The action being undertaken is conditional upon a decision that has already been made to exploit an opportunity. The question for us in this paper, however, distinguishes between action which involves dynamic entrepreneurship and action involving static entrepreneurship. While the decision to act upon an opportunity has already been made, the differences lies in the nature of that action—static or dynamic.

One might reasonably ask about the distinction between our construct of dynamic entrepreneurship and that of knowledge-intensive entrepreneurship (KIE). According to Malerba (2010, p. 4):

Knowledge-intensive entrepreneurship concerns new ventures that introduce innovations in the economic systems and that intensively use knowledge.

And according to Hirsch-Kreinsen and Schwinge (2014, p. 2):

KIE is considered an activity dealing with the uncertainties of discovering and exploiting new opportunities, often driven by individuals but also by established organizations.

While these two definitions of KIE differ they do have a common element, namely they both deal with action. However, neither is specific about how that action occurs. Albeit narrow, our construct of dynamic entrepreneurship, which of course follows from Schumpeter, is specific about the type of action that the entrepreneur undertakes, namely action that involves changing the production function; or in terms of the data we analyze herein, action that involves an “untried technological possibility” (Schumpeter 1942, p. 13).

Human capital and entrepreneurship

The distinction between dynamic and static entrepreneurship is innovation, and in particular, how the innovation comes about. Scholars of innovation have generally identified knowledge as the driving force underlying innovative activity (Koskinen and Vanharanta 2002). While investments in research and development (R&D) have long been the focal input to innovative activity for companies, human capital is the link between innovative activity and individual entrepreneurs. According to the World Economic Forum (2013: p.3):

⁵ We thank anonymous reviewers for encouraging us to relate our construct of dynamic entrepreneurship to the exploration-exploitation literature, and to the knowledge-intensive entrepreneurship concept.

[A] nation's human capital endowment—the skills and capacities that reside in people and that are put to productive use—can be a more important determinant of its long term economic success than virtually any other resource. This resource must be invested in and leveraged efficiently in order for it to generate returns, for the individuals involved as well as an economy as a whole. Traditionally, human capital has been viewed as a function of education and experience, the latter reflecting both training and learning by doing. But in recent years, health (including physical capacities, cognitive function and mental health) has come to be seen as a fundamental component of human capital.

Educational attainment and gained experience are the most recognized forms of human capital. Relatedly, Maclup (1980) argued that formal education is only one form of knowledge. Knowledge, and hence human capital, is also gained experientially at different rates by different people depending on their abilities (1980, p. 179):

Some alert and quick-minded persons, by keeping their eyes and ears open for new facts and theories, discoveries and opportunities, perceive what normal people of lesser alertness and perceptiveness, would fail to notice. Hence new knowledge is available at little or no cost to those who are on the lookout, full of curiosity, and bright enough not to miss their changes.

Gained experience has been expressed by entrepreneurship scholars in at least five distinct ways: the outcome of involvement in previous entrepreneurial activities (Baron and Ensley 2006); experientially acquired knowledge and skills that result in entrepreneurial know-how and practical wisdom (Corbett 2007); the sum total of things that have happened to a founder/owner over their career (Shane and Khurana 2003); the collective set of events that constitute the entrepreneurial process (Bhave 1994); and direct observation of or active participation in activities associated with an entrepreneurial context (Cope and Watts 2000). Of these, the most common usage is to describe prior knowledge and skills gained either in business or when creating ventures. Approached as an antecedent condition, researchers have emphasized the role of prior experience as: a factor in explaining self-efficacy (Baron and Ensley 2006); entrepreneurial intentions (Krueger 2007); information processing (Cooper and Folta 1995); business practices (Cliff et al. 2006; Link and Ruhm 2013); learning from failure (Shepherd 2003); habitual entrepreneurship (Westhead et al. 2005); and metacognition in decision-making (Haynie et al. 2010).

Much of the academic literature has been devoted to prior experiences in corporate management, venture creation, and each of which has been associated with venture performance within particular industries (Gimeno et al. 1997). In this regard, prior entrepreneurial experience enhances both the ability to recognize viable opportunities and to overcome the liability of new challenges as a venture is created (Politis 2005). In the recent studies of metacognition (Haynie et al. 2010), for example, prior experience can be expected to play a role in both in determining which events are processed and the manner in which they are processed.

Thus, greater knowledge, greater experience, and greater education, all lead to a greater capacity of human capital. It is that sum of human capital that can accelerate true innovation. As Lazear (2004) suggests, those entrepreneurs with a greater endowment of human capital have access to

the particular knowledge resources that are requisite for fueling innovation. This argument leads us to hypothesize that an endowment of human capital is relatively more conducive to dynamic entrepreneurship than to static entrepreneurship. By contrast, a paucity of human capital is relatively more conducive to static entrepreneurship than to dynamic entrepreneurship.

National Research Council database

The Small Business Innovation Development Act of 1982 established the Small Business Innovation Research (SBIR) program. The Act required all government agencies with, at that time, extramural research budgets in excess of \$100 million to establish a set-aside program to stimulate technological innovation in small companies with no more than 500 employees. As discussed in detail Link and Scott (2012) and in Leyden and Link (2015), and in references therein, the Act was reauthorized periodically and the amount of the set-aside was accordingly increased to the current level of 2.5 % of each agencies extramural research budget.

A critical element of the Small Business Reauthorization Act of 2000, the National Research Council (NRC) was charged with the responsibility of conducting an evaluation of the SBIR program. As part of that evaluation, the NRC conducted an extensive and balanced survey in 2005 of a population of 11,214 research projects funded over the period 1992 through 2001. As shown in Table 1, the NRC's efforts resulted in the collection of data for a random sample of 1878 funded projects.

Table 1. Description of the National Research Council's SBIR database

Agency ^a	Population of phase II projects ^b	Sample size	Respondents	Response rate	Random sample ^c
Department of Defense (DoD)	5650	3055	920	30	891
National Institutes of Health (NIH)	2497	1678	496	30	485
National Aeronautics and Space Administration (NASA)	1488	779	181	23	177
Department of Energy (DOE)	808	439	157	36	154
National Science Foundation (NSF)	771	457	162	35	161
All Agencies	11,214	6408	1916	30	1878

^aThese five agencies accounted for nearly 97 % of the SBIR program's awards in 2005

^b"The objective of Phase I is to determine the scientific or technical feasibility and commercial merit of the proposed research or R&D efforts and the quality of performance of the small business concern, prior to providing further Federal support in Phase II." See, <http://grants.nih.gov/grants/funding/SBIRContract/PHS2008-1.pdf>, page 1. "The objective of Phase II is to continue the research or R&D efforts initiated in Phase I. Funding shall be based on the results of Phase I and the scientific and technical merit and commercial potential of the Phase II proposal."

See, <http://grants.nih.gov/grants/funding/SBIRContract/PHS2008-1.pdf>, page 1

^cThe NRC surveyed a number of non-randomly selected projects. Some of these projects were survey at the request of funded companies and others were surveyed to capture extraordinary accomplishments to be included in the NRC final report to Congress. These non-random projects were deleted to create the random sample

The NRC database, arguably the most complete U.S. database of public-supported innovative activity in small companies (Link 2013), contains project information as well as information on the company to which the SBIR award was made. Of particular relevance for this paper, each SBIR-funded project respondent was asked as part of the NRC survey about his/her previous SBIR awards. Specifically: "How many SBIR awards has your company received *that are*

related to the project/technology [emphasis added] supported by this Phase II award?”⁶ We posit that those companies that responded to this survey question with “none” are in fact pursuing in their current SBIR-funded project with an entirely new technology that does not mirror previous technology-based endeavors but rather follows, in a Schumpeterian sense, a new production function and thus is a research endeavor that might be characterized as the actions of a dynamic entrepreneurial company.

Empirical findings

As we noted in the Section 1, this paper is grounded on historical economic thought about who the entrepreneur is and what he/she does, as well as on the availability of a rich and unique set of data from the NRC’s database that facilitates our measurement of relevant constructs. To our advantage, there are data in the NRC database that correspond directly to our construct of dynamic entrepreneurship.

Our discussion in Section 3 of the extant literature on human capital led us to hypothesize that an endowment of human capital is relatively more conducive to dynamic entrepreneurship than to static entrepreneurship. Thus, our empirical model focuses on human capital as the key variable to explain cross-SBIR project differences in dynamic entrepreneurship. We hypothesize that the propensity toward dynamic entrepreneurship as reflected through the focus of an SBIR project (*i*) is related to the human capital embodied in the entrepreneur of the company conducting the project research:

$$DynamicEntrepreneurialProject_i = F(\mathbf{X}_i + u_i) \quad (1)$$

where a funded research project is defined to capture the Schumpeterian elements of dynamic entrepreneurship if it is new and is not merely an extension of the company’s on-going technology-based research, \mathbf{X} a vector of human capital characteristics and other controls, and u_i is an error term that incorporates both unobserved individual characteristics and other determinants of entrepreneurial behavior. If $F(\cdot)$ is the cumulative normal distribution function and the $u_i \sim N(0,1)$, the probability of observing a dynamic entrepreneurial project being undertaken can be estimated as a probit model specified by:

$$DynamicEntrepreneurialProject_i = F(\mathbf{X}_i + u_i > 0) \quad (2)$$

Equation (2) was estimated using the data in the NRC database. Each project in the database was competed for agency funding and received it. Each year a federal agency that is involved in the SBIR program makes public a list of research projects that it is willing to fund. Companies respond to the notice, and they describe in their proposal, among other things, the methodology they plan to use to develop the proposed technology. A dimension of their methodology is reflected through the survey question that we use to quantify the variable *DynamicEntrepreneurialProject*.

The variables used to estimate Eq. (2) are defined in Table 2 and descriptive statistics on the relevant variables are provided in Table 3. The dependent variable is a binary measure, taking on

⁶ Phase I and Phase II SBIR awards are described in the note to Table 1.

the value of 1 if the research project represents a new technology that does not mirror previous technology-based endeavors by the company but rather follows, in a Schumpeterian sense, a new production function; and 0 otherwise.

Table 2. Definition of variables

Variable	Definition
<i>DynamicEntrepreneurialProject</i>	=1 if the research project represents a new technology, that is if the research project does not build on existing technologies within the company; 0 otherwise
<i>BusinessExp</i>	=1 if at least one of the founders of the company has a business background; 0 otherwise
<i>AcademicExp</i>	=1 if at least one of the founders of the company has an academic background; 0 otherwise
<i>NoCompany</i>	Number of other companies started by one of the founders in any industry or sector
<i>CompanyExp</i>	=1 if the founders of the company had previously started at least one other company in any industry or sector; 0 otherwise (constructed from <i>NoCompany</i>)
<i>Age</i>	Age of the company defined at the time of the Phase II award
<i>Employ</i>	Number of employees in the company at the time of the Phase II award
<i>Univ</i>	=1 if a university was involved in the research project; 0 otherwise
<i>Female</i>	=1 if the company is owned by a female; =0 if the company is owned by a male
<i>DoD</i>	=1 if the Phase II award came from the Department of Defense; 0 otherwise
<i>NIH</i>	=1 if the Phase II award came from the National Institutes of Health; 0 otherwise
<i>NASA</i>	=1 if the Phase II award came from the National Aeronautics and Space Administration; 0 otherwise
<i>DOE</i>	=1 if the Phase II award came from the Department of Energy; 0 otherwise
<i>NSF</i>	=1 if the Phase II award came from the National Science Foundation; 0 otherwise

Table 3. Descriptive statistics on the variables ($n = 1557$)

Variable	Mean	Standard deviation	Range
<i>DynamicEntrepreneurialProject</i>	0.4708	0.4993	0/1
<i>BusinessExp</i>	0.4419	0.4968	0/1
<i>AcademicExp</i>	0.6570	0.4749	0/1
<i>NoCompany</i>	1.8259	2.0923	1–18
<i>CompanyExp</i>	0.2980	0.4575	0/1
<i>Age</i>	12.0816	10.7105	1–101
<i>Employ</i>	30.5196	57.2734	1–450
<i>Univ</i>	0.3616	0.4806	0/1
<i>Female</i>	0.1002	0.3004	0/1
<i>DoD</i>	0.4798	0.4998	0/1
<i>NIH</i>	0.0880	0.2834	0/1
<i>NASA</i>	0.0983	0.2978	0/1
<i>DOE</i>	0.2473	0.4316	0/1
<i>NSF</i>	0.0867	0.2815	0/1

The human capital of entrepreneurs is limited by the availability of data in the NRC database. Available data allow us to quantify three dimensions of the human capital embodied in the company. One dimension of human capital is measured as 1 if at least one of the founders of the company has an academic background, and 0 otherwise. By contrast, a second dimension of human capital is measured as 1 if at least one of the founders of the company has a business experience, and 0 otherwise. And third, a measure, entrepreneurial experience, is also included in the model in terms of the number of other companies started by at least one of the founders.

Control variables included in the model are the age, founders' experience, and employment size of the company at the time of the SBIR Phase II award, the involvement of a university in the SBIR-funded research project, and the gender of the owner. Age and employment size are included to control for, respectfully, possible internal experience as well as the capabilities to achieve economies of scale and scope. Older (i.e., experienced) and larger companies, as so measured, might have the internal resources to pursue new research projects in a Schumpeterian manner, whereas less experienced and smaller companies might not be able to allocate resources accordingly.

Involvement of a university in the funded project controls for possible externally created economies of scale and scope. Thus, we predict the estimated effects of these three variables on observed dynamic entrepreneurship to be positive.

The gender variable should be considered to be an exploratory variable; it is included because an explicit goal of the SBIR program is "to provide for enhanced outreach efforts to increase the participation of ... small businesses that are 51 % owned and controlled by women."⁷

In addition, the agency providing the SBIR funding is also reflected as fixed effects through agency-specific dummy variables. These variables are intended to control for any agency-specific technology focus that might influence dynamic entrepreneurship.

A correlation matrix of the variables is in Table 4. Note in the matrix that projects in companies with founders who have academic experience are more dynamic in nature; experienced and larger companies are more likely to be pursuing their funded research project in a dynamic manner, although that is not the case for projects that involve a university. The gender variable is not correlated with the funded research project being dynamic in nature.

Table 4. Correlation matrix of variables

<i>Dynamic</i>	1.00								
<i>BusinessExp</i>	-0.008	1.00							
<i>AcademicExp</i>	0.055*	-0.065*	1.00						
<i>NoCompany</i>	0.025	0.059*	0.107*	1.00					
<i>CompanyExp</i>	0.002	0.141*	0.063*	0.606*	1.00				
<i>Age</i>	0.070*	0.014	-0.025	0.080*	0.0002	1.00			
<i>Employ</i>	0.128*	0.010	0.069*	0.097*	0.014	0.474*	1.00		
<i>Univ</i>	-0.040	-0.002	0.113*	0.080*	0.077*	0.089*	0.084*	1.00	
<i>Female</i>	0.002	-0.004	0.038	-0.045	-0.026	0.087*	0.081*	-0.029	1.00

*Significant at .05-level or better

The empirical results from alternative specifications of Eq. (2) are presented in Table 5. Consider the results in column (1). *Ceteris paribus*, there is compelling empirical evidence that suggests that founders with academic-based human capital tend to have a greater likelihood of being dynamic entrepreneurs in that their companies are more innovative as we have measured that

⁷ The 1992 reauthorization of the SBIR program, legislated through the Small Business Research and Development Enactment Act (Public Law 102–564), added this statement.

phenomenon. The estimated probit coefficient on *AcademicExp* is positive and significant. In contrast, those companies with a founder with a business background, *BusinessExp*, do not exhibit Schumpeterian innovativeness in their SBIR research project. The other human capital dimension in column (1) is a dichotomous variable quantifying if any of the founders had previously started another company. That variable, *CompanyExp* is not significant.

Table 5. Probit results (robust standard errors in parentheses, calculated marginal coefficients in brackets; $n = 1557$)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>BusinessExp</i>	-0.013 (0.065) [-0.0049]	-0.0088 (0.065) [-0.0035]	-0.0067 (-0.065) [-0.0026]	-0.015 (0.065) [-0.0058]	-0.015 (0.065) [-0.0058]	-0.015 (0.065) [-0.0059]	-0.0087 (0.065) [-0.0034]	-0.020 (0.065) [-0.0079]
	0.163**** (0.068) [0.064]	0.164**** (0.068) [0.065]	0.134**** (0.068) [0.053]	0.155**** (0.068) [0.060]	0.158**** (0.068) [0.062]	0.158**** (0.068) [0.062]	0.131*** (0.069) [0.052]	0.152**** (0.068) [0.059]
	<i>NoCompany</i>	-	-	-	0.010 (0.016) [0.0041]	-	0.0070 (0.016) [0.0027]	-
<i>lnNoCompany</i>	-	-	-	-	-	0.047 (0.054) [0.018]	-	0.015 (0.055) [0.0061]
	<i>CompanyExp</i>	0.0046 (0.071) [0.0018]	0.0032 (0.071) [0.0013]	-0.00026 (0.071) [-0.0001]	-0.026 (0.071) [-0.010]	-	-	-
	<i>Age</i>	0.0080***** (0.003) [0.0032]	-	-	0.0078**** (0.0031) [0.0031]	-	-	-
<i>lnAge</i>	-	0.113***** (0.041) [0.044]	-	-	-	0.110***** (0.041) [0.044]	-	-
	<i>Employ</i>	-	-	0.0028***** (0.0006) [0.0011]	-	-	0.0027***** (0.0006) [0.0011]	-
	<i>lnEmploy</i>	-	-	-	0.1004***** (0.022) [0.039]	-	-	0.099***** (0.022) [0.039]
<i>Univ</i>	-0.108** (0.067) [-0.043]	-0.102** (0.068) [-0.040]	-0.093* (0.068) [-0.037]	-0.083 (0.068) [-0.033]	-0.111*** (0.067) [-0.044]	-0.106** (0.068) [-0.042]	-0.096* (0.068) [-0.031]	-0.087* (0.068) [-0.034]
	<i>Female</i>	0.020 (0.107) [0.0079]	0.014 (0.107) [0.0055]	0.038 (0.107) [0.015]	0.027 (0.107) [0.011]	0.023 (0.107) [0.009]	0.017 (0.107) [0.0066]	0.040 (0.107) [0.016]
Agency dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	-0.236***** (0.079)	-0.390***** (0.117)	-0.212***** (0.0698)	-0.363***** (0.085)	-0.247***** (0.079)	-0.392***** (0.116)	-0.220***** (0.071)	-0.366***** (0.085)
Likelihood ratio	15.326****	15.701****	31.193****	29.393****	15.774****	16.489****	31.385****	29.344****
Wald ratio χ^2	15.058****	15.603****	28.946****	28.986****	15.514***	16.329****	29.263****	28.952****

Agency dummies were not significant. Marginal coefficients are calculated at the mean of each variable

****significant at .01 level, ***significant at .05 level, **significant at .10 level, *significant at .15 level,

*significant at .20 level

Older companies are more likely to exhibit dynamic entrepreneurship; the probit coefficient on *Age* is positive and significant. Company size, measured in terms of number of employees at the time of the Phase II award, *Employ*, is not included in the specification in column (1). *Age* and *Employ* are highly correlated as was shown in Table 4.

Those projects for which a university was included as a research partner, *Univ*, are less likely to exhibit dynamic entrepreneurship than those without a university. The probit coefficient on *Univ* is negative and significant contrary to our initial expectations.⁸ Perhaps companies attempt to rely on university research expertise as a substitute for internal research capabilities, but that strategy does not seem relevant for explaining whether the project is undertaken in a dynamic entrepreneurial manner.

Finally, female-owned companies are not more likely to exhibit dynamic entrepreneurship in their approach to their SBIR project.

The results in column (2) show that *Age* enters logarithmically more strongly than in a linear fashion. When a quadratic specification for company age was tried, the probit coefficient on *Age*² was not significant.⁹

The probit results in columns (3) and (4) show that the employment size of the company, *Employ*, is positively and significantly related to the presence of dynamic entrepreneurship as was *Age*. And, *Employ* more strongly enters logarithmically.

The results in columns (5) and (6)—which parallel the specifications underlying the results in columns (1) and (2)—consider the experience of the founders in terms of the number of previous companies started. *NoCompany* and *InNoCompany* do not enter significantly. The results in columns (7) and (8)—which parallel the specifications underlying the results in columns (3) and (4)—are also similar.

Overall, all of the specifications are significant as evidenced by the likelihood ratio and Wald ratio.

To examine the robustness of the regression results in Table 5, we re-estimated each specification to account for possible outliers on *Age* and *Employ* having an effect. We deleted the largest 1 % of the observations on *Age* and deleting the largest 1 and 5 % of the observations on *Employ*. These deletions brought the range on *Age* to 1–46 and the range on *Employ* to 1–325 and 1–150. The pattern of results in Table 5 remained with these deletions.^{10,11}

⁸ We are treating *Univ* as an exogenous variable. Companies identify their university research partners at the time they apply for both a Phase I and Phase II award.

⁹ These results are available from the authors on request.

¹⁰ These results are available from the authors on request.

¹¹ We thank an anonymous reviewer for pointing out that there is a literature that shows that the innovative activity in small and young companies is influenced by the prior professional, entrepreneurial, R&D, and industry experience of its founders. On the suggestion of this reviewer, we split our sample of research projects into those below the mean age of companies (12 years) and those at or about the mean age. On re-estimation of the models in Table 5, academic experience still dominates in both sub-samples. There are perhaps two reasons why our findings

Concluding remarks

In this paper we introduced the construct of dynamic/static entrepreneurship. Our method for determining this dichotomy draws on the history of economic thought about who the entrepreneurs is and what he/she does as well as on the availability of a unique data set from which we could measure Schumpeterian innovativeness. Other scholars have followed Schumpeter in distinguishing what we call herein dynamic entrepreneurship from static entrepreneurship. For example, Kuratko (2014, p. 5) summarizes entrepreneurship as:

[Entrepreneurship is] a dynamic process of vision, change, and creation. It requires an application of energy and passion toward the creation and implementation of new ideas and creative solutions.

This definition underscores the dynamic nature of entrepreneurship that is being examined herein.

However, in the past measurement constraints have made it difficult to analyze how dynamic entrepreneurs might differ from their static counterparts. Herein, we are fortunate to be able to draw on the NRC database of SBIR-funded research project to overcome this measurement constraint.

From an empirical perspective, we offer the hypothesis that since dynamic entrepreneurship involves innovative activity, knowledge generated by human capital is an important requisite distinguishing dynamic from static entrepreneurs. Our empirical findings generally supports this hypothesis, namely that while prior business and entrepreneurial experience may foster static entrepreneurship academic-based human capital is more important to generate dynamic entrepreneurship.

Still, our findings should be interpreted cautiously because there are likely few other databases with detained survey information that is directly related to what we call dynamic entrepreneurship. That said, the NRC database is limited in other respects. For example, conspicuously absent for the specifications in Table 5 are measures of regional characteristics (Stuetzer et al. 2014), motivations for founding the company that received the SBIR award (Goethner et al. 2012; Obschonka et al. 2012), or detailed personal characteristics of the researcher on the SBIR project or on the founders of the company (Stuetzer et al. 2012)

More research on this conceptually interesting and academically important topic is warranted. In particular, researchers should investigate alternative constructs related to dynamic entrepreneurship and alternative areas of application. One possible area of study where the concept of dynamic entrepreneurship might apply relates to academic entrepreneurship, namely to the type of institutional support given to the commercialization of faculty innovations. One

do not conform to this literature. One reason is that the NRC database's measure of prior business experience might be too general (see Table 2) to capture differences, and a second reason is that the SBIR-funded research project might be more or less important to the company's overall research portfolio that prior business experience alone cannot pick up that distinction. These results are available from the authors on request.

might ask: Can innovative institutional practices toward increasing the commercialization efforts and outcomes of faculty be developed, and if so what form might those practices take? The development of a portfolio of such concepts, applications, and evidence of covariates with such dimensions of behavior might also influence the direction of future public policies that support the birth and growth of entrepreneurial companies.

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