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Taking leaps of faith: Evaluation criteria and resource commitments for early-stage inventions

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ABSTRACT

Successfully developed academic inventions have the potential to spawn new technological domains, form the basis of thriving business ventures, and improve the well-being of society. However, evaluating whether an early-stage scientific invention truly has such potential is extremely difficult, and financially backing such inventions is highly risky. And yet, organizations and their evaluators still back some of these inventions with resources for further development. We investigate this puzzle to pinpoint how and why evaluators decide to offer resource commitments at early stages, despite the red flags raised using standard evaluation criteria. Many academic inventions need these initial resources to dispel concerns regarding their commercial feasibility, so evaluators need to take a leap of faith with their support to prematurely avoid eliminating high-potential opportunities. We tested our theory using text analysis on nearly 700 invention evaluation reports written by a university's technology transfer experts. Our results revealed that evaluators backed inventions based on their feasibility (overcoming doubt and assessing maturity) and desirability (background familiarity and scientific complexity). Using the context of the research laboratory, our study insights can be applied to many management situations in which early-stage opportunities are assessed for resource commitments under high uncertainty.

Keywords: early-stage scientific inventions, opportunity evaluation criteria, high-risk opportunities, text analysis, resource commitments, entrepreneurial action.

> Of the modes of persuasion furnished by the spoken word there are three kinds. The first kind depends on the personal character of the speaker; the second on putting the audience into a certain frame of mind; the third on the proof, or apparent proof, provided by the words of the speech itself. - Aristotle, *Rhetoric*, Book 2 [1356a]

1. Introduction

To prosper in competitive environments, organizations must regularly commit to the resource demands of new technology-based opportunities – even when their commercial outcomes are unknown. We view these resource-commitment decisions as inputs for various forms of entrepreneurial action undertaken by organizations (McMullen and Shepherd, 2006). A decision to act depends on whether the opportunity's expected value will exceed its costs and the probability of achieving the hoped-for profitable outcome (Shane and Venkataraman, 2000). While the decision to support a given proposal with clear-cut evidence is straightforward, early-stage opportunities often lack details and are based in unfamiliar domains, making decision-making riskier and more ambiguous (Ahuja and Lampert, 2001; Wood and Williams, 2014). Specifically, we investigate one type of early-stage opportunity – university-based academic inventions – and examine why evaluators would offer resource commitments to these inventions despite the red flags raised by standard criteria.

Academic inventions are high-risk, yet often appealing opportunities to act upon. Based on discoveries pioneered by academic scientists, these inventions can serve as the basis for new technologies, and their applications may even pave the way for entirely new industries (Ahuja and Lampert, 2001). Some inventions can also generate large-scale private and social benefits (Schumpeter, 1975; Venkataraman, 1997). However, foreseeing the success of such inventions in their early-stages is a daunting proposition. Evaluators must assess unfamiliar technology or market domains that greatly depart from existing solutions (Ahuja and Lampert, 2001; Shane and Khurana, 2003). Moreover, the intellectual property for these inventions may be challenging to protect and require long development times, making it difficult to calculate expected returns (Lanjouw and Schankerman, 2001, 2004). And finally, inertia, path-dependence in resource-allocation, and the self-reinforcing effects of exploitation often encourage decision-makers to shy away from highly uncertain opportunities (Bardolet et al., 2011; Gilbert, 2005; March, 1991).

Despite these unfavorable circumstances, evaluators still choose to back some early-stage academic inventions. On the one hand, this seems fraught with risk, because evaluators face considerable uncertainty when assessing an invention's potential. On the other hand, rendering a negative final judgment on early-stage inventions can result in missed opportunities, since many need time and initial resources to reveal a more accurate picture of their commercial potential. But even if early-stage innovations are backed for further development, results that affirm the decision may not become evident until much later, which runs counter to expectations for timely investment returns. Our study tackles this puzzle: what criteria are best suited for committing resources to early-stage scientific opportunities within a context of high uncertainty?

Conventional thinking is that for early-stage inventions, resource commitments are made based on the invention's track record or the inventor's experience, or the emotional appeal of a potential breakthrough, sometimes with intuition trumping analysis (Burton et al., 2002; Huang and Pearce, 2015; Zott and Huy, 2007). In the introductory quotation from Aristotle, the first two approaches reflect these conventional arguments. But the quotation also offers a third approach, which is the focus of our study. We investigate why inventions are backed when only the words themselves serve as primary evidence to justify resource commitments. While it is reasonable to expect that organizations depend on initial evidence such as test results and past performance, organizations still receive and back proposals that lack information needed for a straightforward assessment.

As hypotheses of potentially profitable opportunities, inventions take shape when evaluators recount the inventions to others in written form. When evaluators codify abstract and imaginative concepts into words on paper, these nascent ideas are no longer vague notions of a future reality. Instead, they begin to represent something more concrete that could be assessed by organizations for possible action (Davidsson, 2006; Dimov, 2007; Gartner, 1993). Narratives then serve as a proxy – a first estimation – for communicating initial details about the invention to others (Abbott, 2008; Gartner, 2007). We argue that specific attributes of the written statements, in

terms of their traceable linguistic properties, provide clues for appraising the potential of early-stage scientific inventions and whether they are worth pursuing with entrepreneurial action.

Up to now, entrepreneurship researchers have mainly studied narrative concepts from the perspective of founders – who use narratives to seek resources – or investors – who use narratives to decide whether to provide these resources (Lounsbury and Glynn, 2001; Martens et al., 2007; Navis and Glynn, 2011). We use narrative concepts to develop further theory about another entrepreneurial situation: how *organizations* use evaluation narratives – written documents recounting pertinent facts about inventions – to determine whether to back them with budgetary support. Consensus regarding resource allocation forms around ostensive principles – abstract guidelines known by all organization members – enabling members to make systematic evaluations using a common source of information (Latour and Woolgar, 1986; Stasser and Titus, 1985). Although some research exists regarding the role of narratives in funding scenarios, we argue that further theoretical development is necessary to delineate the ostensive principles guiding organizational decision makers in their evaluations of early-stage opportunities (Ocasio, 2011).

To achieve this study objective, we apply McMullen and Shepherd's (2006) framework for entrepreneurial action to encompass an evaluator's perspective: We argue that when evaluation narratives offer evidence supporting an invention's feasibility and desirability – the two pillars of their entrepreneurial-action framework – organizations are likely to back the invention. Our work defines the feasibility and desirability criteria more explicitly and links them to specific linguistic features within the narratives (Pennebaker, 2011). We develop arguments about how these linguistic features explain an organization's decision-making and its willingness to devote resources to scientific inventions, despite uncertain commercial horizons. We posit that inventions meeting certain feasibility- and desirability-evaluation criteria display written features – and argue that these features explain whether the inventions are embraced for action, whereas inventions that fall short of necessary thresholds, lacking certain linguistic features, are

dismissed. Thereby, we uncover both triggers for supporting early-stage scientific inventions, as well as red flags that lead to abandonment.

To accomplish our study, we investigated nearly 700 evaluation reports of scientific inventions handled by the oldest university technology transfer office (TTO) in the world, spanning a seven-year period (1998 to 2005) and analyzed which of these inventions received budgetary support. Using evaluation reports allowed us to examine how evaluation criteria were represented by specific linguistic properties. We employed quantitative, top-down textual analytical techniques to examine the evaluation statements for evidence of feasibility and desirability evaluation criteria and their corresponding linguistic properties (Humphreys and Wang, 2018; Tausczik and Pennebaker, 2010).

Our study's contributions are beneficial for the following reasons: Our work examines explicit criteria aligned with McMullen and Shepherd's (2006) entrepreneurial-action framework, further establishing how organizations determine the feasibility and desirability of scientific inventions for deeper consideration (Mitchell and Shepherd, 2010). Although research has established some baseline principles for evaluating opportunities for further action (Autio et al., 2013; Haynie et al., 2009), our study establishes a stronger link between organizations' early-stage opportunity assessments and their resource commitments. Our emphasis on written expressions of inventions also offers an alternative means of assessing how narratives aid organizations in dedicating resources for action (Lounsbury and Glynn, 2001; Navis and Glynn, 2011). By linking analytical techniques based on linguistic principles and theory about opportunity evaluation, we provide a framework for detecting clues embedded within opportunity assessments for entrepreneurial action (Berger and Milkman, 2012; Coussement et al., 2017; Gartner, 1993; Ireland et al., 2011)

Finally, it is important to note that while many studies examine why some *actors* are more likely to pursue an opportunity (e.g., Shane and Venkataraman, 2000), ours is different. We focus on why some *opportunities* are pursued over others – especially when a full assessment is impractical. Scientific progress requires entrepreneurs, organizations, and shareholders to

envision future possibilities that outpace present realities. We offer insights into how evaluators and their organizations assess expectations of future success and make decisions on opportunities with limited verifiable information. Despite a proclivity towards incremental and safer opportunities (March, 1991), organizations have to take leaps of faith when backing scientific inventions at an early stage, and our study demonstrates the value of uncovering written clues as determinants of entrepreneurial action.

2. Research Setting

Before we describe our theoretical arguments, we provide an overview of our research setting, which we use to develop our conceptual framework. University TTOs have theoretical and empirical advantages that make them excellent settings to study an organization phenomenon such as ours (Weick, 1979). Specifically, this setting represents a loosely coupled system that allows for the theoretical and empirical separation of knowledge production capabilities (housed with academic scientists) from organizational capabilities of identifying and enforcing intellectual property (located at the TTO) (Shane, 2000; Sine et al., 2003). Because inventions are generated separately from their evaluation, we have a suitable context to study how academic inventions are evaluated for additional resource commitments.

Established in the 1920s, our study's TTO setting has an extensive history of both working with academic inventors to protect their discoveries and partnering with businesses to commercialize the inventions. The TTO is an active organization, evaluating over 200 inventions disclosed by the University's academic community each year. Although many discoveries do not qualify for patent protection (and those that do may not translate immediately into financial successes), over the last 15 years, this TTO has at times received over $50 million annually in licensing income, amassing over $2 billion in its endowment. This historical performance reflects a record of selecting promising inventions. Moreover, the TTO's financial footing enables it to regularly take leaps-of-faith on potential breakthroughs by committing financial resources toward their development and commercialization. It is worth noting that the majority of the inventions do not yield positive returns once the cost of patenting and licensing are

accounted for; only a few commercialized inventions lift the entire portfolio of a TTO into a place of positive returns. Therefore, seeking out the most promising inventions is a primary concern of the TTO and its evaluators (Siegel et al., 2003).

To better understand the various facets of the invention disclosure and evaluation process, we visited the TTO regularly over a two-year period. We conducted extensive interviews with the organization's CEO and managers from its major functional areas – intellectual property, licensing, legal, and general administration – to understand the process of evaluating promising inventions. For our study, the intellectual property managers (IPMs) play a central role. The IPM's typically have advanced masters or PhDs in the domains they oversee and manage the supply of inventions disclosed to the TTO for evaluation.

When new inventions are disclosed, the TTO uses a routine procedure for evaluation (see Figure 1). The inventor first completes a short background form regarding their discovery and the people involved with the invention. The IPM responsible for the invention's scientific domain then interviews the inventor (or inventing team) to better understand the details of the invention and to gather preliminary ideas about the invention's commercial prospects. Next, the IPM conducts an exploratory patent search for prior art through desk research or contacting domain experts. The IPM finally prepares a three- to four-page report on the commercial potential of the invention and circulates it to all the members of the TTO.

[INSERT Figure 1 ABOUT HERE]

Although the invention-evaluation reports are fairly short documents, the information they organize about the invention is vital to the TTO's evaluation. The reports contain several sections: scientific background (description of the invention's context), current invention (summary of the discovery), intellectual property protection issues (including any perceived concerns regarding size of the claim or its enforceability), commercial applications, funding sources for the invention, and any prior public disclosures that might affect the invention's patentability (such as prior publications, presentations, or conversations by the inventors). We focused our analyses on particular sections of the document so we could better pinpoint the

substantive source of the evaluation and its bearing on resource-commitment outcomes. It is important to note that during our observational period (1997 to 2005), U.S. patent law was based on a "first to invent" principle.[1] This provision made public documentation of the invention risky if inventors wanted to preserve their options for obtaining patent protection, because any publicly disclosed inventions had to apply within one year from disclosure. Inventions disclosed to TTOs are exempt from this provision, so the evaluation reports provide an early representation of the discovery itself and preliminary assessment of its commercial potential at a time when other documents with this type and scope of information are unlikely to exist in any systematic way.

3. Conceptual Background

To revisit our research question, we focus on how and why early-stage opportunities are supported for entrepreneurial action when success is highly unlikely. To tackle this question, we begin by defining several constructs central to our arguments and relating them back to our context. We define *entrepreneurial action* as a "response to a judgmental decision under uncertainty about a possible opportunity for profit" (McMullen and Shepherd, 2006:134). As this definition conveys, the decision to act on an opportunity is rarely clear-cut, so we examine more closely the evaluators who assess these opportunities and the criteria they use for their assessments. In our context, the evaluators are the TTO's intellectual property and licensing managers, who are responsible for evaluating the commercial potential of the inventions disclosed to them. This evaluation depends on two criteria: the *feasibility* of successfully executing the opportunity (i.e., can the outcome be achieved?) and the *desirability* acting on that particular opportunity (i.e., is this anticipated outcome sufficient enough for the investment required to attain it?) (McMullen & Shepherd, 2006: 133). Since the investments for patent filings are not trivial, TTO managers must take prudent steps to identify the most feasible and desirable inventions for further action. Any opportunities, regardless of their perceived potential for success, will not be acted upon if they lack sufficient feasibility or desirability.

[1] As opposed to a "first to file" principle used in other parts of the world and subsequently adopted by the US in 2011 through the America Invents Act.

Conventional wisdom and common sense would dictate that scientific invention-based opportunities lacking feasibility (showing few confirmatory signs of achieving the desired outcome) and/or desirability (where the value of the anticipated outcomes is less than the costs required to achieve them) would not be acted upon. If these same criteria are applied to high-risk inventions with unclear intellectual property claims, it is unlikely they will pass the threshold for action based on these criteria alone.

To achieve our goal of developing a more comprehensive framework for how early-stage academic inventions are evaluated for potential action, we carefully consider the *documentation* of the evaluation itself – that is, the formal write-up of an opinion regarding the merits of an invention. In its written form, the evaluation statement offers a tangible representation of the invention's potential, visibly structured on different evaluation criteria. The words used within the statement act as scaffolding upon which the invention and its evaluation are organized and represented. More broadly, these words form narratives about the inventions and any rationale for taking action on them and communicate these details throughout an organization in a structured manner (Czarniawska-Joerges, 1997; Garud et al., 2010).

We posit that written documents can provide clues about the evaluator's inclination to act, based on their determination of whether an invention is a feasible and desirable opportunity. In general, narratives are useful for sharing details about novel concepts (Barry & Elmes, 1997; Deuten & Rip, 2000). We know from linguistics scholars that the written language contains many features for expressing complex ideas (Finegan, 2004; Lobeck, 2000; Napoli, 1996). At the most basic level of written communication, evaluators use *content* words – such as nouns, verbs, and adjectives – to describe details about the idea or invention. Besides content words, written language also includes *function words*, such as pronouns and prepositions, that indicate the relationships between the content words in sentences. Despite being generally overlooked and uninteresting to the listener, comprising only about 450 words of an average 100,000 word vocabulary, function words account for more than 50 percent of word use and are foundational to structure content (Pennebaker, 2011; Pinker, 2000). Function words are not merely necessary for

effective communication; research has shown that they provide style, support, and insight as "connective tissues" to a text's underlying meaning and intention (Tausczik and Pennebaker, 2010). As such, when properly analyzed, function words can expose additional evidence regarding how an author thinks; we analyze function words in evaluators' written statements to reveal the extent to which the authors are guided by ostensive organizational principles (Feldman and Pentland, 2003; Latour and Woolgar, 1986). Using principles from linguistics theory, we link the presence of particular word categories with the evaluation criteria of the entrepreneurial action framework.

In our framework, we argue that when actors evaluate opportunities for possible action, their assessment can be understood with the analogy of stepping toward or away from the given invention. That evaluations bear upon actors' (be they individuals or organizations) willingness to either "embrace" or "distance" themselves from a business idea is a critical component of our theoretical framework. This idea builds on McMullen and Shepherd's (2006) depiction of the differences between third-person opportunities – those that may be available for anyone to pursue – and first-person opportunities – which actors choose to pursue directly for their own potential gain. By *embrace*, we mean the evaluators find enough merit in the scientific invention to adopt it as their own (based on their consensus decision) and to develop the invention further. By *distance*, we mean the evaluators are not sufficiently convinced by the feasibility and desirability an opportunity to seriously consider it as a *first-person* opportunity. By adopting this analogy, we emphasize that early-stage opportunities have dynamic attributes as they undergo development from idea to action and evaluators deliberate over them (Dimov, 2007; Perry-Smith and Mannucci, 2017). Despite the abstract nature of early-stage scientific inventions summarized on three or four pages, our narrative lens posits that the extent to which evaluators distance or embrace them can be observed by tracking the documentation of certain evaluation dimensions and their associated criteria. In the following sections, we describe our rationale for why organizations may either distance themselves from scientific inventions or embrace them with a resource commitment.

3. Theory and Hypotheses

3.1 Feasibility evaluation dimensions

We define *feasibility* as a form of evaluating whether action on an invention could lead to a desired end state in the manner envisioned by those undertaking the effort (McMullen and Shepherd, 2006: 141). Drawing from prior research on the precursors to entrepreneurial action, we argue that feasibility evaluation depends on at least two criteria: 1) Overcoming doubts about whether the claims about the invention are valid, and 2) assessing if the invention has matured enough to enable further action on it. Positive evaluations will reassure organizational sponsors about the potential success of their efforts if actions are taken to pursue the opportunity. In the following sections, we define each criterion, detail how they may present themselves in written portrayals of inventions, and offer specific explanations about their relationships with entrepreneurial action.

Overcoming doubts: Central to early-stage inventions is the claim of novelty by their originators. By definition, such inventions are on the cutting edge of science and push the frontiers of knowledge in their respective domains. When disclosing information to others, inventors make claims concerning details about their discoveries of new technologies, methods, or other scientific advancements. These inventions might have true potential for commercial success, but it is necessary to ensure their technical claims are of merit. Organizations evaluating the feasibility of an invention seek to dispel doubts about the discovery's claims before acting on it.

We define *doubt* as having uncertainties about pursuing action on an invention successfully (McMullen and Shepherd, 2006). Theories about the role doubt plays in entrepreneurial action depend on how evaluators perceive the credibility of the invention's claims (Shepherd et al., 2012). Our emphasis on doubt advances these foundational principles by specifying one source of speculation: whether the inventions actually work in the ways claimed. When questions about the invention's claims persist, they can undermine an organization's inherent need for claims to be substantiated, and evaluators will speculate if they have enough tolerance to pursue a

potentially risky venture (McMullen and Shepherd, 2006). However, when organizations are sufficiently convinced of an invention's efficacy, they are more likely to embrace it for entrepreneurial action.

Evaluators can express doubt using discrepancy words to describe the invention's purpose or scientific objectives. When evaluators use words such as *should*, *could*, and *would*, they communicate slight differences in the current status of the invention and what eventual state it could achieve (Brett et al., 2007; Pennebaker, 2011). High discrepancy use indicates skepticism about the invention's scientific assertions and commercial promise – and accordingly, the likelihood of achieving a return that exceeds costs. Without resolving the underlying doubts about the technical merits, evaluators are unable to fully embrace the purported claims or offer a positive opinion about future action. For these reasons, we hypothesize that:

> **Hypothesis 1**: When evaluating for commercial feasibility, inventions documented with a higher frequency of discrepancy words are less likely to receive resource commitments because of doubts about their technical efficacy.

Maturity: Evaluators may assess feasibility based on an invention's maturity. We define a potential breakthrough's *maturity* as its current state within its life cycle. Inventions with merit rarely achieve such distinctions right away, but often require a period of refinement (Dimov, 2007). Regardless of any commercial implications, an invention must first prove itself to work – an achievement typically referred to as "reduction to practice." More mature inventions will show reliable operating results outside controlled, experimental conditions in a laboratory setting. With credible results from an invention in hand, evaluators can envision its commercialization prospects more clearly, and will be more likely to commit to further action in an area where success has already been proven (or is highly likely). Without a track record, an invention remains in a nascent stage; any subsequent commercial pursuit of it would likely be premature and may thus encourage evaluators to distance themselves from it.

Evaluators can convey concerns about a scientific invention's maturity by using negation words to describe whether proven results exist. When an invention has not shown sufficient

reduction to practice, evaluators are likely to use negation words such as *no*, *none*, or *never* to describe the current state of the research results. These words are "expressions of refusal, contradiction, or absence" in information being presented (Taylor and Thomas, 2008: 270). When evaluators write with a high frequency of negation words, it points to a lack of clear evidence of the invention's efficacy beyond its conceptual state. Without such evidence, evaluators will not be sufficiently persuaded about the invention's commercial feasibility to seek further action. For these reasons, we hypothesize that:

> **Hypothesis 2**: When evaluating for commercial feasibility, inventions documented with a higher frequency of negation words about their reduction to practice are less likely to be pursued for entrepreneurial action because of their lack of technical maturity.

3.2 Desirability evaluation dimensions

In the following sections, we focus on desirability – the second dimension of the entrepreneurial-action framework. We define *desirability* as a form of evaluating whether taking action on an invention is likely to fulfill the motives for which it is being sought, in light of the expected costs associated with the effort (McMullen and Shepherd, 2006: 141). Inspired by those who have worked to delineate the specific components of evaluations, we argue that desirability evaluations depend on at least two criteria: 1) Leveraging familiarity of the context associated with the invention, and 2) containing sufficient scientific complexity such that the opportunity derived from the invention is novel. The purpose of conducting desirability evaluations is to determine if the scientific invention aligns with a key reason for taking entrepreneurial action: the ambition to produce a profitable return over the investment required to develop the invention. Similar to the feasibility evaluations, confirming the desirability of an invention will further motivate organizational sponsors to pursue it, while lacking validation of commercial promise will keep sponsors at a distance.

Background familiarity**:** We define *familiarity* as having sufficient knowledge about the context associated with the invention being evaluated. This concept has roots in a broader emphasis on the role of knowledge in formulating, developing, and exploiting entrepreneurial

opportunities (Dimov, 2010; Shane, 2000; Venkataraman, 1997). In this prior work, the emphasis on familiarity has been on the individuals undertaking the efforts: founders launching new ventures (Gruber et al., 2008; Mitchell and Shepherd, 2010). In our study, we apply this concept to organizations, and reason that those who sponsor inventions for action are similarly confronted with the issue of whether their organization is sufficiently knowledgeable about the invention's context. When organizations are familiar with an invention's context, they have the capabilities to sense and seize technological opportunities and operate effectively in that domain (Teece et al., 1997) – even for an early-stage invention. These capabilities are formed from relevant experience and shared throughout an organization as the knowledge becomes routinized (March, 1991; Nelson and Winter, 1982). Having a deep understanding of the science behind a technology-based opportunity provides a stronger basis on which to evaluate the desirability of undertaking entrepreneurial action. Organizations with sufficient familiarity will confidently navigate the pathways required to convert an invention into a viable commercial opportunity, and fulfill their objectives of pursuing profitable ventures.

Evaluators can display their familiarity about an invention's scientific background by using indefinite pronouns to describe these details. Indefinite pronouns are employed when a level of shared understanding exists among readers of the text (Colomb and Williams, 2012; Pennebaker, 2011). Pronouns reduce the burden of language processing by providing a linguistic shortcut to information already known by the audience (Fromkin et al., 2009; Gordon and Hendrick, 1998). Thus, high indefinite-pronoun use represents discourse occurring in a known context and referencing salient information already familiar to readers (Almor et al., 2007; Gundel et al., 1993). When the scientific context is well known to the evaluators, they are more likely to use such pronouns because there is a common understanding about its technical aspects. By displaying a level of comfort with the technical aspects of an early-stage invention, evaluators are likely to have a greater interest in embracing it. For these reasons, we hypothesize that:

Hypothesis 3: When evaluating for commercial desirability, inventions documented with a higher frequency of indefinite pronouns are more likely to receive resource commitments because of the organization's greater familiarity of their scientific contexts.

Scientific complexity: We define *complexity* as the extent to which an invention is based on intricate and elaborate technical foundations. When evaluating an early-stage invention derived from a scientific discovery, organizational sponsors can use its complexity to help determine how appealing the opportunity is for action. Complexity's influence on action can be understood in the following ways. When inventions are based on simple technical foundations, they (often) lack two important features related to its desirability for action: novelty and proprietary elements (Haynie et al., 2009). Simple inventions from known science will likely face more difficult competition from those who already market similar products, or will be prone to having their concepts imitated by better positioned competitors or even new entrants. Both shortcomings diminish the ability to generate and sustain profitable returns, lowering the desirability for action.

By contrast, the expression of inventions based on complex technical foundations requires greater precision to accurately convey intricate details. Such precision involves providing additional information about the scientific context and background. Given their uniqueness, inventions with novel technologies – and potentially higher commercial desirability – require more effort to contextualize. The results of such expressions enable evaluators to conduct more specific evaluations about their merits and assess the desirability with greater confidence. Scientific inventions based on complex foundations can also spark creative possibilities among organizational sponsors (Shane, 2000); the depth and intricacy of an invention's scientific foundations helps sponsors to envision its unique applications in ways that those based on known science would limit. As a result, an evaluation revealing more complex technical foundations highlights more unique features and prospects of more lasting competitive advantage, relative to existing offerings available in the current marketplace. This feature is especially desirable to organizational sponsors who seek out inventions with significant commercial promise.

Evaluators can document their understanding of an invention's scientific complexity by using preposition words. Prepositions indicate several features relevant for our theoretical purposes.

They are important markers for detailed explanations and enable more precise exposition, especially in scientific contexts (Kemper et al., 1989; Lobeck and Morenberg, 2000:190). Prepositions are also necessary for writers to convey intricate information and concepts based on complex inventions (Francis et al., 2002; Rohdenburg, 1996:151). They provide spatial, symbolic, and relational information reflecting specific claims about a particular subject, as in the inventions in our study (Taylor, 1993; Tyler and Evans, 2003). Because evaluators are concerned that an invention's commercial desirability depends in part on having sufficient scientific complexity, the use of preposition words provides a window into this assessment. When a scientific invention is sufficiently complex and evaluators appreciate its finer details, documenting its evaluation for commercial desirability will involve a higher use of prepositions. Greater preposition use in evaluation documents conveys more complexity about the underlying science – a criteria employed by evaluators to embrace an invention for future action. For these reasons, we hypothesize that:

> **Hypothesis 4**: When evaluating for commercial desirability, inventions documented with a greater number of preposition words are more likely to receive resource commitments because of their complex technical foundations.

4. Methods

4.1 Research Setting

To test our hypotheses, we used original data from the oldest technology transfer organization (TTO) serving a large public research university in the United States. The TTO has been the context for other published research, including an analysis of changing organizational capabilities due to technology acquisition (George, 2005), case studies on legitimacy among scientists (George and Bock, 2009; Jain et al., 2009), the influence of the depth of the inventors' domain experience on commercialization (Kotha et al., 2013), and signaling properties of licensing contract payment structures (Kotha et al., 2018). However, our research examines new aspects of this study context: evaluation reports and the variables coded from the reports not associated with any published results.

4.2 Sample

Our sample consists of 686 invention evaluation reports available from our observation period (1998 to 2005), the TTO convened monthly meetings to discuss whether to support the commercialization of the invention disclosures. All IPMs, licensing managers, legal staff, and senior management attended the meetings, which were open to all TTO employees. The IPM who wrote the report served as the invention's sponsor during these monthly evaluation meetings. At the meetings, the IPM briefly summarized the main points of the invention and answered questions from the group regarding the merits of the invention. The group then deliberated the invention in great detail; despite being a heterogeneous group, they almost always arrived at a consensus regarding whether or not to support the pursuit of these technology-based opportunities. In less than one percent of cases, one member of the group felt strongly about the invention's merits when the others did not. In these situations, that individual was appointed as a champion to furnish additional information in support of the invention to present at the next meeting. (Analyzing these cases separately did not change our results.) Rather than follow predetermined management strategies, the IPMs' evaluation reports were central to building a consensus for or against resource allocation. This support, if granted, would come in the form of exploring patent filing assistance, future enforcement, and marketing for future licensing partners, all of which require significant upfront investments. Also, the TTO evaluators do not personally benefit from their resource-allocation decisions. The IPMs are bound by strict ethical standards; their compensation is not contingent on any invention's commercialization success.

4.3 Dependent Variable

Our dichotomous outcome variable – *budgetary support* – was constructed based on information provided by the TTO regarding the results of the monthly disclosure meetings when the invention disclosures and their evaluation reports were deliberated. We used this outcome to determine if entrepreneurial action was pursued for a given scientific invention. Approved disclosures (1=yes) indicated the invention was allocated a budget to support further actions. Possible next steps included starting the patent application process and soliciting interest among

industry partners and entrepreneurs for potential licensing opportunities. Some inventions were licensed to start-ups formed specifically to commercialize the invention. These actions required the TTO to devote both internal staff resources and incur upfront costs associated with the patent application process. Given the uncertain timeframe for receiving patent approvals (over five years in some cases) and the generally small likelihood of finding licensing partners for patented technologies, the time horizons for recouping the initial costs and generating income on these investments were far into the future. Thus, budgetary support of an invention indicated the TTO's willingness to place an educated bet on the technology's future profitability. In our sample, about 63 percent of disclosures received budgetary support for further commercialization. This is in line with data from other TTOs (Owen-Smith and Powell, 2001). For example, Shane (2002) reported 60 percent of all invention disclosures at MIT were patented and nearly 52 percent of patented inventions were licensed.

4.4 Dictionary-based text analysis

To test our hypotheses, we needed a method that allowed us to operationalize our feasibility- and desirability-evaluation constructs into independent variables. Since our theory depends on operationalizing these constructs from the documentation itself, we relied on automated text analysis for this step. Recognizing the different analytical options available to us, we determined that a "top-down" dictionary-based method was the most appropriate one for our research objectives (Grimmer and Stewart, 2013; Loughran and McDonald, 2016). This decision was consistent with guidance offered by automated text analysis experts who surveyed the various options and mapped them to their corresponding research objectives (Humphreys and Wang, 2018). We offer the following rationale for this decision.

First, top-down methods are ideal for operationalizing variables and defined concepts drawn from the published literature. Although unsupervised "bottom-up" topic modeling approaches like Latent Dirichlet Allocation (LDA) are appropriate for generating *new* constructs, our analytical approach enabled us to operationalize our *existing* concepts into *independent* variables. Second, the top-down method relies on dictionaries, which contain validated measures for

classifying text into pre-defined categories. Dictionary-based classifications provide the advantage of allowing us to systematically operationalize our study constructs with validated measures. Third, we used the Linguistic Inquiry Word Count (LIWC) program – a widely adopted dictionary software tool featured in automated text analysis management studies. LIWC is commonly employed to operationalize theoretical constructs from text by mapping them onto pre-defined linguistic variables in entrepreneurship (Kim et al., 2016; Obschonka et al., 2017), management (Antioco and Coussement, 2018; Coussement et al., 2017), psychology (Pennebaker et al., 1997), marketing (Berger and Milkman, 2012; Ludwig et al., 2013), operations management (Debaere et al., 2018), and information systems (McHaney et al., 2018).

Fourth, a key benefit of the LIWC program is that its validity and reliability have been previously confirmed, including evidence for a reliable convergence between the extracted linguistic LIWC variables and separate ratings by human coders (e.g., Ireland et al., 2011; Ludwig et al., 2014; Tausczik and Pennebaker, 2010). The dictionary is pre-defined, so no additional training or learning is needed on the study sample to use the variables in the dictionary. LIWC is easy to implement and comprehend without extensive programming or computational linguistics knowledge. The software is also objective and eliminates human judgment bias, since one always gets identical results when repeating the analysis on the same corpus. Finally, linguists and social psychologists have consistently studied language as a credible way of understanding people's internal thinking. As an application of these principles, we use LIWC as a method to measure the inventions' underlying potential as evaluated by the IPMs for their TTO colleagues (Pennebaker, 2011; Pinker, 2000). For more information about the development of the LIWC word dictionary and the construct validity of the word categories, please see http://www.liwc.net/.

4.5 Independent Variables

Our independent variables are based on output from the LIWC program of the study sample. The LIWC program outputs the percentage frequencies for a particular word category (i.e., frequency of category words present divided by the total words in a given evaluation report)

contained in the text corpus. This output is independent of the number of words in the report and the size of the corpus.

Specifically, for our analysis, we calculated the word frequencies for feasibility and desirability constructs in specific sections of the evaluation report to form the independent variables in our study. For the feasibility evaluation criteria, we constructed two measures. We measured *doubt* based on the percentage of discrepancy words (e.g., should, could, would) in the invention's description section. We measured *maturity* based on the percentage of negation words (e.g., no, not, never) in the description of the invention's results as reduction to practice. For the desirability evaluation criteria, we constructed two measures. *Background familiarity* was based on the percentage of impersonal pronouns (e.g., it, that, this) appearing in the section of the IPM report's describing the invention and its scientific background. *Scientific complexity* was based on the percentage of prepositions (e.g., to, with, above) used to describe the invention's scientific background. Our use of the LIWC-generated measures is consistent with other entrepreneurship research that has employed this method to analyze published texts (Kim et al., 2016; Pfarrer et al., 2010; Wolfe and Shepherd, 2015). To help demonstrate the presence of these words, we provide sample texts from the evaluation reports with the explanatory variables identified in the Appendix.

4.6 Validity checks

We conducted a validity check to confirm that our LIWC-based independent variables were measured and operationalized as expected. We followed guidance offered by text analysis experts: relying on human experts to evaluate the extent of agreement between the computer- and human-coded reports (e.g., Humphreys and Wang, 2018). We randomly identified a subsample of 100 report sections (50 low and 50 high word frequency) per explanatory variable (for a total of 400 report sections). Then two human experts (a professor of biomedical engineering and one of the authors) separately reviewed each report section and classified the LIWC operationalization and the explanatory variables' interpretation. The experts classified the words in the sections into their independent variable high/low categories (e.g., high vs. low doubt).

Then we calculated the level of agreement between the LIWC software and human coding in two ways (See Table I for results). The hit rate represents the percent of accurately coded categories and the Krippendorf's alpha reflects agreement between the human and computer coders. The hit rate or the number of reports that are correctly classified by the human experts should be at least 80 percent (Wade et al. 1997; Weber 2005). The Krippendorff's alpha, or the agreement between computer- and human coding should be greater than 0.70 (Krippendorff, 2007, 2010). In our validity checks, the hit rates ranged from 89 to 91%, while the Krippendorff's alphas ranged from 0.85 to 0.88 for all the LIWC-based independent variables. This validation check assured us of high agreement between the computer and human expert coding.

[INSERT Table I ABOUT HERE]

4.7 Control Variables

We included several additional inventor, invention, and IPM evaluator variables to address null and alternate explanations for our budgetary support outcome variable. We constructed these variables from both the LIWC program and from the hand-collected data on inventor, invention, and IPM background characteristics. To distinguish between third-person and first-person opportunities, we controlled for *inventor reference* pronouns when discussing the scientific background (the percentage of third-person pronouns *they*, *she*, and *he*) and *TTO reference* pronouns when discussing the TTO's opinion of pursuing patent protection on the invention (the percentage of first-person pronoun *we*) (McMullen and Shepherd, 2006). To account for explanations driven by inventor background and qualities, we controlled for star scientists with the inventor's *publication record* as the natural logarithm of the total number of published scientific articles for the inventing team; *scientific distance* to account for the extent to which members of the inventor team work in the same scientific domain (0=complete overlap, 1=no overlap); and *scientific distance*^{2}, based on a non-linear relationship between scientific distance and technology licensing reported in Kotha et al., (2013). To control for other invention characteristics, we used a *patent claims concern* variable based on tentative words used discussing the strength of the invention's patent claims and the TTO's ability to secure

intellectual property protection for them (the percentage of words such as *maybe, perhaps, guess*). We also used a *commercial skepticism* variable, based on the percentage of negation words used to describe the invention's proposed commercial applications (Pennebaker, 2011); an *external vetting* variable, based on descriptions of whether the inventors' research received any external funding (0=not funded; 1=funded); and a *window of opportunity* variable, based on whether the inventors intended to disclose their invention details in a scientific publication or conference (1=yes). We also controlled for *total words*, to account for longer documents providing additional pertinent information. To account for the possibility of IPM influence on the outcome, we controlled for *IPM experience* (the number of prior disclosure evaluation reports written for the TTO, time varying by year). Finally, we included measures for *IPM enthusiasm* based on the percentage of positive emotion words present in the disclosure report (Pfarrer et al., 2010; Wolfe and Shepherd, 2015).

4.8 Estimation Strategy

We used binary logistic regression models with fixed effects for evaluator, scientific domain, and year to test our hypotheses. We chose this strategy for the following reasons: it is possible that budgetary approvals may have resulted from certain stylistic preferences of the IPM author of the invention evaluation reports, such that for the same invention, IPMs may individually write their reports differently. If unaccounted for, these socially constructed differences may confound the estimation of our core theoretical relationships. To rule out these alternate explanations and to focus on invention-level variance, our strategy was to examine variation in approval outcomes controlling for the IPM evaluator and scientific domain and year. In so doing, the resulting variation can be attributed to the underlying commercial potential of the invention. Specifically, we included fixed-effects variables to further differentiate among the six IPMs involved in the preparation of the evaluation reports, among the 62 scientific domains from which the technologies were developed (based on Klevorick et al.'s 1995 scheme), and across

the nine years (1997-2005) of our sample.[2] By controlling for all these characteristics, we estimate whether linguistic dimensions of these invention evaluation reports matter for taking entrepreneurial action over and above alternate explanations rooted in the inventor, IPM, and scientific domain characteristics and account for other random heterogeneity from these qualities.

[INSERT Tables II - IV ABOUT HERE]

5. Results

In Tables II and III, we show descriptive information about our analytic sample. In Table IV, we report logistic regression results on the likelihood of a scientific invention receiving budgetary support. Before we report our main results, it is useful to highlight several control variable results related to the null expectations (Model 1). In terms of inventor and invention characteristics, publication record was positively related to receiving budgetary support, while scientific distance has a U-shaped curvilinear relationship. Inventions from those with strong publication academic records were more likely to receive support; this is consistent with studies showing that academic reputation has spillover effects into commercial evaluations of their discoveries (Zucker and Darby, 1996). Longer reports provide more information, revealing the IPM's effort in searching for relevant information about the invention. Since search costs are non-trivial when consulting patent attorneys and potential licensing firms, a more exhaustive report indicates an invention's commercial promise. When the distance between inventor scientific domains is negative, this indicates an invention combined principles from less-connected scientific areas; research has shown these discoveries are harder to evaluate for their commercial potential (Kotha et al., 2013). As the distance moves into the positive region, so too does its commercial potential, which is consistent with our finding. We also found evidence of negative inventor reference (third-person) and positive TTO reference (first-person) relationships

[2] To address other possible IPM influences, we tested separate models with the dyadic history between the IPM and the inventor to account for any relationship effects (see online Appendix Table 5). Of the six IPMs, one IPM was disproportionately associated with positive budgetary support for the inventions the IPM oversaw. Thus, we also tested our models without this IPM's invention reports (see online Appendix Table 6). In both situations, our results remained consistent for our theory variables.

with budgetary support, providing initial confirmation of McMullen and Shepherd's (2006) distinction for evaluating opportunities. Invention perceived as having breakthrough potential were also more likely to receive budgetary support.

In terms of other TTO characteristics, IPM experience did not have any relationship with the outcome. Our models also contained fixed effects for the individual IPM and scientific domains, which accounts for any additional differences in how individuals write the actual evaluations. IPM enthusiasm (measured by positive emotion words) on its own, however, did not have any relationship with organizational action. This is reasonable, given that in formal situations such as our TTO context, dispassionate analysis may be favored over emotional appeals.

In terms of invention and report characteristics, tentatively evaluated patent claims and inventions without clear commercial applications were less likely to be considered for budgetary support. Externally vetted inventions, short windows of opportunity, and evaluation-report length (total words) were positively related to receiving budgetary support. Taken together, these control variable results remain consistent across all models and provide a strong foundation for our analyses.

We now turn to discussing our theory variable results. In Models 2 and 3, we introduce our theory variables; Model 4 represents our full model from which we report our findings. We begin with results for the feasibility evaluation criteria. We hypothesized that doubt (Hypothesis 1) and lack of maturity (Hypothesis 2) would be negatively associated with budgetary support. We found supportive evidence: (doubt: b=-0.26, maturity: b=-0.12). To provide substantive interpretations of these results, we calculated probabilities for each independent variable (while holding all other variables at their mean values). As doubt (discrepancy words) and lack of maturity (negation words) increased from one standard deviation (SD) below to one SD above their mean values, the probability of receiving budgetary support dropped for both variables (doubt: from 0.68 to 0.61 – nearly a 10 percent decline; lack of maturity: from 0.68 to 0.58 – nearly a 15 percent decline).

We now turn to our desirability criteria. We hypothesized background familiarity

(Hypothesis 3) and scientific complexity (Hypothesis 4) would positively impact action. Again, we found support: background familiarity (b=0.09) and scientific complexity (b=0.07). As familiarity (indefinite pronouns) and scientific complexity (prepositions) increased from one SD below to one SD above their mean values, the probability of receiving budgetary support increased for both variables (familiarity: from 0.61 to 0.69 – approximately a 13 percent improvement; scientific complexity: from 0.62 to 0.68 – nearly a ten percent improvement). These results reveal the specific evaluation criteria employed to determine whether to embrace inventions with action.

5.1 Robustness Checks

We conducted several robustness checks for our independent, control, and dependent variables and our modeling strategy to reaffirm the validity of our findings. Please see the online Appendix (OA) for these results. First, we explored if IPMs' perceptions of the invention's impact mattered for their resource commitment evaluations. For this check, we created a *perceived breakthrough potential* variable to capture the extent to which the TTO evaluators perceived the breakthrough potential for the invention. Breakthrough inventions are discoveries that serve as the foundation for future technologies, products, or services, and have the potential to create entirely new industries or classes of technologies since they have no technological antecedents (Ahuja and Lampert, 2001). A research assistant read the invention evaluation reports and coded for breakthrough potential on a scale of 0 (none) to 7 (high) and recorded the text used for this coding. Reports containing no text related to breakthrough potential were coded as 0. To validate this coding, a 2nd research assistant coded a random sample of about 100 reports. The overlap in the coding was nearly 79 percent, reassuring us about the objectivity and validity of the coding schema. These excerpts reveal the vastness of high-potential inventions in terms of the scope and degree of their scientific advancement, the importance of the problems they address in society, the intricacy of the inventions, and the long-time horizons they require to fully develop. We reran our models with this variable. We found that having perceived breakthrough potential is positively associated with budgetary support. Results for our theory

variables remained generally consistent (OA Table 1).

Second, we tested an alternate to our binary dependent variable by creating a more fine-grained ordered categorical variable. Based on our interviews with the IPMs, lawyers, and licensing managers at the TTO, we learned that the degree of support among accepted inventions could vary. For example, some of the inventions received only a preliminary approval, conditional on additional information or support for copyright and trademark protection, which require a substantially smaller initial investment than inventions requiring full patent protection. Thus, we constructed an ordered seven-category variable, ranging from outright rejections to several intermediate forms of partial support to full patent applications. Unfortunately, we were unable to run a robustness test using actual budgeted investment data for each of the approved inventions, because we had this information in only a very small number of cases. But for the cases we did have actual budget information, we found a positive association between it and the ordered categorical variable. We used this ordered categorical variable as a robustness test of the binary outcome variable. We found that the two variables were highly correlated (0.92). We estimated an OLS regression on the degree of support that an invention report received. As these results show, the direction and statistical significance are consistent with our main findings. We also used an ordered logit model with this alternate dependent variable and observed nearly similar results (OA Table 2).

Third, we substituted variables as alternative evaluation criteria. For doubt, we used future words of the current invention's description, implying the invention was still more conceptual and speculative. For window of opportunity, we used past publication disclosures, indicating the scientific details had already been made public. Our results remained consistent (OA Table 3).

Fourth, we further investigated whether inventor and IPM characteristics solely determined our evaluation-criteria variables. To rule out this mediation process, we estimated models using the four evaluation-criteria variables as dependent variables and used the inventor and IPM characteristics as explanatory variables. As these results reveal, the inventor and IPM characteristics do not systematically explain the evaluation-criteria variables. This implies that

after accounting for the inventor and IPM characteristics, our main findings captured the relationship between the commercial potential of the invention and the likelihood of its budgetary support (OA Table 4).[3]

It is important to reiterate our study focused on systematic variation in word frequencies associated with the ostensive principles guiding the evaluation of the invention, and not idiosyncratic variation produced by individual evaluators. Although evaluators could write different reports about the same invention, we took appropriate analytical steps (i.e., including variables for IPM, scientific domain, and year fixed effects; IPM experience; IPM-inventor dyadic relationships; and omitting one IPM with the highest percentage of supported inventions) to rule out such differences in our results (OA Tables 5 & 6). We also studied evaluation criteria that would minimize ambiguously written evaluations (e.g., whether an invention achieved reduction to practice), which links our word-frequency measures more closely with our evaluation-criteria concepts. We also note there is little room for IPMs to employ certain word categories strategically to embellish or misrepresent an invention's prospects. Given the group members' collective expertise, consensus-seeking methods, and the lack of any direct reward structure for IPMs to favor certain inventions, we avoid any complications arising from these alternate explanations. As a result, we offer new pathways for understanding the mechanisms by which organizations identify promising new opportunities and make decisions to support these opportunities under extreme uncertainty (Gruber et al., 2008).

6. Discussion

[3] We conducted three additional robustness tests recommended by one of our anonymous reviewers. The first analysis examined if the word count effect was non-linear. We introduced the squared term for the word count as an additional control variable and re-estimated Model 4 in Table IV used to test the hypotheses. Results for the theory variables are all significant and similar. However, the word count main effect is no longer significant and neither is the word count squared. Therefore, we choose not to include the squared term of word count as an additional control variable. Second and related to the word count analysis, we split the sample into two sub-samples (above and below median word count) and retested the theory variables. Since the sample sizes were halved, we just focused on the theory variables. We found that doubt and maturity are negative and statistically significant in both sub-samples as in the main analysis. Background familiarity and scientific complexity are positive but not significant in both sub-samples. Since none of the theory variables changed signs, this implies word count does not moderate the direct relationships. Third, we repeated a similar analysis using two sub-samples split by two time periods. Again, the theory variables did not changed signs. However, the statistical significance of some theory variables dropped, thus, some caution is warranted in the sample sizes needed to detect the effect of the theory variables.

Academic inventions begin to take shape when expressed in written form, especially by independent parties who evaluate the merits of these opportunities. The people and organizations evaluating very early-stage opportunities must take several factors into account when considering whether or not to act upon a potential opportunity. By their very nature, science and technological inventions require entrepreneurs, organizations, and other stakeholders to envision future possibilities that outpace present realities – otherwise these inventions are unlikely to get a chance to materialize (Ahuja and Lampert, 2001; Slater et al., 2014). However, evaluating such opportunities is challenging, and doing so on the basis of standard criteria will likely lead to holding back support (McMullen and Shepherd, 2006; Perry-Smith and Mannucci, 2017; Wood and Williams, 2014). Using the context of the laboratory (Kotha et al., 2013), we refine existing theories of opportunity evaluation to accommodate scenarios for pursuing action on early-stage academic inventions and overcoming the doubt associated with them (Shepherd et al., 2007).

We portrayed the evaluation process as an analogy of either distancing or embracing inventions for further action. Our study focused on the question of how an organization determines the feasibility and desirability of very early-stage scientific inventions for entrepreneurial action. To accomplish this objective, we assembled a set of evaluation criteria for both dimensions and used them to develop arguments for why these specific criteria are linked to a determination for action.

6.1 Contributions to Entrepreneurial Action Research

We expand the theoretical scope of the evaluation-action framework by detailing the criteria by which early-stage academic inventions are evaluated for their feasibility and desirability. Although there is the potential to employ these criteria independently and meaningfully, we chose to assemble them within the evaluation-action framework to provide a comprehensive way of discerning how actors (be they individuals or organizations) assess the merits of technology-based opportunities. We report direct results anticipated in conceptual arguments about how evaluators determine whether to embrace a third-person opportunity as a first-person opportunity to pursue (Haynie et al., 2009; McMullen and Shepherd, 2006). Our work is valuable because we

show more precisely how the third-person to first-person transition occurs, as evaluators – who are entirely distinct from the inventors behind the ideas – express their assessments about their feasibility and desirability for action. Embracing an idea as a first-person opportunity requires favorable expectations about its future value; we offer specific evidence for the particular criteria by which these expectations are based.

More broadly, our study strengthens the general connection argued by entrepreneurship scholars about why feasibility and desirability attributes influence opportunity identification, development, and exploitation (Davidsson, 2006; Dimov, 2007; Shane, 2000). We deepen the conceptual moorings for how opportunities are evaluated in terms of their implementation feasibility and whether they meet the desirability thresholds necessary to vigorously pursue them (Stevenson and Jarillo, 1990). This emphasis enables us to move beyond foundational arguments about the nature of opportunities toward a more comprehensive depiction of how individuals and organizations determine if their ideas appear promising enough for further action (Alvarez et al., 2012; Eckhardt and Shane, 2003). Our findings provide empirical validation for why certain criteria are linked to embracing inventions for action. By directing the conceptual spotlight on evaluation criteria, we promote an additional complementary reason for why certain opportunities are pursued over others. Prior work has emphasized the role of experience as a leading indicator of whether opportunities can be successfully exploited (Shane and Venkataraman, 2000). Experience provides greater perspective when selecting promising opportunities (Baron and Ensley, 2006; Gruber et al., 2012). Our work improves our understanding of how organizations screen risky ideas based on their familiarity of their context, a capability many organizations employ when assessing potentially promising but complex inventions to pursue. Our study enriches these arguments with these particular evaluation criteria, while still preserving the importance of experience in discerning whether to act.

Our interdisciplinary approach of using automated text analysis on written reports of early-stage scientific inventions opens up new ways for entrepreneurship scholars to support arguments about feasibility and desirability criteria in organizations. Prior research has used a

variety of empirical techniques to gather information about the ways in which opportunities are assessed by individuals: some are indirectly measured based on the human capital of entrepreneurs (Davidsson and Honig, 2003; Gruber et al., 2012; Kim and Longest, 2014; Kotha and George, 2012). Others have used descriptions of potential opportunities in quasi-experimental settings to study how decision makers (e.g., experienced entrepreneur and MBA students) process information and identify potential opportunities (Read et al., 2009). Taking inspiration from field studies on actual invention commercialization (Shane, 2000), others have focused on the structural and superficial similarities between hypothetical opportunities that influence some individuals to act (Grégoire and Shepherd, 2012). However, we know of no study to date that examines the criteria used by organizations to pursue entrepreneurial action on uncertain opportunities. Because routines and capabilities guide the decisions and actions of organizational members, it is possible to anticipate what action an organization may undertake based on the attention its members allot to certain factors (Ocasio, 2011). Our work develops theory for specific criteria used by an organization in their consideration of early-stage inventions for commercialization.

6.2 Contributions to Entrepreneurial Narratives Research

A key contribution we make to entrepreneurial narratives research is the emphasis on language choice and word frequency. This emphasis is beneficial for two reasons. First, prior work on entrepreneurial narratives has covered broad literary techniques, such as employment (Downing, 2005), voice and collective memory (Garud et al., 2010), perspective (Deuten and Rip, 2000), and identity (Ibarra and Barbulescu, 2010; Phillips et al., 2012). We distinguish our work from these studies in terms of word choices and their frequencies in our theory and analysis. These elements provide clues about the feasibility and desirability of pursuing an invention with financial support.

Second, our focus on word frequency allows for a more standardized, quantitative approach to studying narrative patterns and their associations with organizational outcomes. The results from our approach complement the qualitative studies previously conducted on the use of

narratives in organizational decision-making (Czarniawska-Joerges, 1997; Feldman and Skoldberg, 2002; Garud et al., 2010) and empirically investigate conceptual arguments previously untested (Lounsbury and Glynn, 2001; Navis and Glynn, 2011). Our results reveal that variations in language choice and word frequency, as anticipated by linguistic theory, have substantial influence on how organizations determine whether to back early-stage inventions. Although the sensitivity of these associations can be easily overlooked, a closer look reveals how certain word categories can offer insight into the ostensive principles guiding organizational actions regarding the pursuit of invention-based business ideas (Feldman and Pentland, 2003; Latour and Woolgar, 1986). Our findings complement existing tenets of organizational narratives developed through prior qualitative studies. Our quantitative study design adds to the limited research using such methodologies in this domain (Martens et al., 2007), while making effective use of textual-analysis methodology currently being used by entrepreneurship researchers (Obschonka et al., 2017; Wolfe and Shepherd, 2015).

Given the uncertainties associated with evaluating novel concepts for their commercial potential, narratives provide credibility to key stakeholders (Barry and Elmes, 1997; Deuten and Rip, 2000). Knowing that entrepreneurial narratives are useful for securing resources (Baker and Nelson, 2005; Lounsbury and Glynn, 2001; Martens et al., 2007) and that language usage can influence how novel concepts are understood (Cornelissen and Clarke, 2010; Rindova et al., 2009), our work systematically highlights how the construction of narratives influences organizational audiences to act on matters involving resource allocations (Vissa, 2011). Given the shroud of uncertainty surrounding the evaluation of scientific inventions, our framework and results are revealing in their demonstration that even the most overlooked linguistic features can enable audiences to envision future potential and back new initiatives, even without complete information (Gartner, 2007).

6.3 Limitations and Avenues for Future Research

Although we approached our study with care and diligence, we discuss opportunities for refinement in future research. Our study is based on analysis of a limited set of evaluations of

scientific inventions for a particular timeframe derived from a specific source: inventions arising from one university organization. Future work could compare multiple organizations and the consistency of their evaluation criteria. Our approach can be expanded to include other evaluation criteria relevant in other organizations. We tested a conceptual model that assumes each evaluation criteria influences whether action is pursued on a particular technology-based opportunity. Future investigations could explore a more comprehensive framework for how these criteria may complement or substitute for each other in an assessment.

As automated text analysis scholars have discussed, these methods offer both advantages and shortcomings to those who employ these techniques (Grimmer and Stewart, 2013; Humphreys and Wang, 2018; Loughran and McDonald, 2016). While our top-down, dictionary-based method conforms to recommendations from automated text analysis experts, future research has opportunities to extend our study. Given the versatility of the LIWC software and its dictionary of pre-classified word categories, it may be possible to develop composite variables to reflect the feasibility and desirability constructs. Dictionary methods rely on the popular "bag-of-words" model, which depends on word frequency and assumes the words are drawn randomly from a bag. Thus, this approach cannot account for word order and the same words taking on different meaning. Nevertheless, previous research confirms that when a dictionary-based approach is used, tests are conservative (Humphreys and Wang, 2018). In short, by employing a predetermined dictionary, the researcher may not pick up all cases of one wants to measure, but if useful patterns arise, the researcher can still argue that there is an effect.

Although the "top-down" LIWC dictionary-based approach is perfectly suited as a theory-testing method, future research could focus on "bottom-up" text analyses tools that will shed a different light on the report corpus. First, *unsupervised* topic discovery models like LDA could be used to explore whether and why a report is similar to another report, and to specify the words that underlie the unobserved, latent topics of the report corpus (Blei et al., 2003). Compared to the LIWC approach, implementing LDA requires a large sample of reports to find meaningful topics, and the meaning of the LDA topics is subject to the interpretation of the researcher and

therefore subjective (Croidieu and Kim, 2018). Also, the LDA method often leads to ambiguous constructs that are hard to link to existing theoretical constructs in a conceptual framework. Second, a *supervised* classification approach could be applied to *predict* based on the textual reports whether or not an application will receive budgetary support. The outcome of this binary classification analysis, which is a probability of acceptance for each report in the corpus, could guide decision makers based on the analysis of which reports previously had the highest probability of getting accepted. Predictive modeling is a popular research approach in this big data era with various applications like finance (Lessmann et al., 2015), accounting (Huang et al., 2014; Li, 2010), fraud detection (Van Vlasselaer et al., 2017), or new product development (Hoornaert et al., 2017). The researcher has the choice between a statistical (e.g. logistic regression, linear or quadratic discriminant analysis, etc.) or machine-learning (e.g. support vector machines, random forests, adaboost, etc.) algorithm as a predictive model, while various methods exist that convert text into numeric explanatory variables, i.e. a vector-space (Coussement et al., 2015), deep learning (Collobert et al., 2011), or dictionary-based (Debaere et al., 2018) approaches. Various text mining toolkits for unsupervised topic modeling and supervised classification are available like the tm and tidytext packages in R or the NLTK package in Python. Inventors and evaluators alike can benefit from text analyses to gain a deeper understanding of what makes opportunity pursuit more likely.

6.4 Broader Implications

Our work focuses on a particular class of entrepreneurial opportunities – those based on scientific inventions and originating from research in academic settings. Given the potential commercial and social value of science and technology development from universities, academic entrepreneurship remains an area of considerable interest among scholars, practitioners, and policy makers (e.g., Colyvas, 2007). Existing work on academic research has examined a variety of factors such as the reputation and attributes of the TTO (Sine et al., 2003), social context of scientists (Stuart and Ding, 2006), team formation (Forbes et al., 2006), and IP regimes (Shane, 2001). Commercializing academic research occurs within the context of considerable

uncertainty, as many early-stage inventions require long cycles of testing, validation, and regulatory approvals (from a technical standpoint), while not fully knowing their appeal among potential users/customers. Only few inventions lead to the formation of large, successful technology firms. Hence, commercial promise is unlikely and hard to determine. Our work provides a window into how evaluators discern the potential of academic inventions in ways prior research on academic entrepreneurship has not. We provide a glimpse into which criteria may enable systematic decision-making when information is scarcest. We advance the literature on academic entrepreneurship by revealing how TTO evaluators take leaps of faith on scientific discoveries, despite insufficient information.

Besides our primary focus on the linguistic properties of evaluation reports, our work has broader implications for scenarios involving resource commitments based on early-stage ideas. For example, business unit directors write proposals and lobby management to provide financial support for new product ideas and their development. As such, opportunity recognition and assessment capabilities are key components of organizations and the management teams' ability to adapt (Arndt et al., 2018) Also, lead venture capital investors present potential investment opportunities for consideration to their entire partnership. Crowdfunding platforms provide a means for the general public to appraise the promise of business, artistic, or social campaigns. Similarly, film studios evaluate movie scripts submitted by producers for financing and distribution and may only uncover the next blockbuster by making a leap of faith. Non-profit organizations also face budgetary decisions, such as when program officers shepherd innovative funding proposals for consideration by a foundation's executive committee. In such scenarios, our distance and embrace motif (and the associated evaluation criteria) help pinpoint why some proposals are viewed more favorably than others. Clues in written evaluations can illuminate more specifically how feasibility and desirability are assessed and can be used to anticipate whether inventions or projects will receive the resource commitments they require.

7. Conclusion

Our study addresses how written evaluation statements provide structure for an organization's collective evaluation of inventions for entrepreneurial action. Particularly in the case of science-based inventions, organizations often take a leap of faith in determining whether or not to commit a significant amount of resources to its development. A crucial step for inventors, entrepreneurs, and innovators alike is the ability to express early-stage opportunities in written form and to have them represented by third parties for further evaluation. This in turn can form the basis of routines for evaluating opportunities with uncertain outcomes and incomplete information. Our work demonstrates how and why particular language choices may make a difference in these evaluations.

8. References

Abbott HP (2008) *The Cambridge Introduction to Narrative*. Cambridge introductions to literature, Cambridge, UK: Cambridge University Press.

Ahuja G and Lampert CM (2001) Entrepreneurship in the Large Corporation: A Longitudinal Study of How Established Firms Create Breakthrough Inventions. *Strategic Management Journal*, John Wiley & Sons 22(6/7): 521–543.

Almor A, Smith D V, Bonilha L, et al. (2007) What is in a name? Spatial brain circuits are used to track discourse references. *Neuroreport*, LWW 18(12): 1215–1219.

Alvarez SA, Barney JB and Anderson P (2012) Forming and Exploiting Opportunities: The Implications of Discovery and Creation Processes for Entrepreneurial and Organizational Research. *Organization Science* 24(1): 301–317. Available from: http://orgsci.journal.informs.org/cgi/doi/10.1287/orsc.1110.0727.

Antioco M and Coussement K (2018) Misreading of consumer dissatisfaction in online product reviews: Writing style as a cause for bias. *International Journal of Information Management*, Elsevier 38(1): 301–310. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0268401217307922.

Arndt F, Fourné SPL and MacInerney-May K (2018) The merits of playing it by the book: routine versus deliberate learning and the development of dynamic capabilities. *Industrial and Corporate Change* 27(4): 723–743. Available from: https://academic.oup.com/icc/article/27/4/723/5001766.

Autio E, Dahlander L and Frederiksen L (2013) Information exposure, opportunity evaluation and entrepreneurial action: An empirical investigation of an online user community. *Academy of Management Journal* 56(5): 1348–1371. Available from: http://amj.aom.org/cgi/doi/10.5465/amj.2010.0328.

Baker T and Nelson RE (2005) Creating Something from Nothing: Resource Construction through Entrepreneurial Bricolage. *Administrative Science Quarterly* 50(3): 329–366. Available from: http://asq.sagepub.com/lookup/doi/10.2189/asqu.2005.50.3.329.

Bardolet D, Fox C and Lovallo D (2011) Corporate capital allocation: a behavioral perspective. *Strategic Management Journal* 1483(32): 1465–1483. Available from: http://onlinelibrary.wiley.com/doi/10.1002/smj.966/full.

Baron RA and Ensley MD (2006) Opportunity Recognition as the Detection of Meaningful Patterns: Evidence from Comparisons of Novice and Experienced Entrepreneurs. *Management Science* 52(9): 1331–1344. Available from: http://mansci.journal.informs.org/cgi/doi/10.1287/mnsc.1060.0538.

Barry D and Elmes M (1997) Strategy Retold: Toward a Narrative View of Strategic Discourse. *Academy of Management Review* 22(2): 429–452. Available from: http://www.jstor.org/stable/259329?origin=crossref.

Berger J and Milkman KL (2012) What Makes Online Content Viral? *Journal of Marketing Research* 49(2): 192–205. Available from: http://journals.ama.org/doi/abs/10.1509/jmr.10.0353.

Blei DM, Ng AY and Jordan MI (2003) Latent dirichlet allocation. *Journal of machine learning research*, JMLR. org 3: 993–1022.

Brett JM, Olekalns M, Friedman R, et al. (2007) Sticks and stones: Language, face, and online dispute resolution. *Academy of Management Journal* 50(1): 85–99. Available from: http://amj.aom.org/cgi/doi/10.5465/AMJ.2007.24161853.

Collobert R, Weston J, Leon B, et al. (2011) Natural language processing (almost) from scratch. *Journal of machine learning research*, MIT Press 12(Aug): 2493–2537.

Colomb GG and Williams JM (2012) *Style: the basics of clarity and grace*. Boston: Longman.

Colyvas JA (2007) From divergent meanings to common practices: The early institutionalization of technology transfer in the life sciences at Stanford University. *Research Policy* 36(4): 456–476. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0048733307000509.

Cornelissen JP and Clarke JS (2010) Imagining and rationalizing opportunities: Inductive reasoning and the creation and justification of new ventures. *Academy of Management Review* 35(4): 539–557. Available from:

http://connection.ebscohost.com/an/53502700.

Coussement K, Benoit DF and Antioco M (2015) A Bayesian approach for incorporating expert opinions into decision support systems: A case study of online consumer-satisfaction detection. *Decision Support Systems* 79: 24–32. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0167923615001384.

Coussement K, Debaere S and De Ruyck T (2017) Inferior Member Participation Identification in Innovation Communities: The Signaling Role of Linguistic Style Use. *Journal of Product Innovation Management*, Blackwell Publishing 34(5): 565–579. Available from: http://doi.wiley.com/10.1111/jpim.12401.

Croidieu G and Kim PH (2018) Labor of Love: Amateurs and Lay-expertise Legitimation in the Early U.S. Radio Field. *Administrative Science Quarterly* 63(1): 1–42. Available from: http://journals.sagepub.com/doi/10.1177/0001839216686531.

Cyert RM and March JG (1963) *A behavioral theory of the firm*. Englewood Cliffs, NJ,: Prentice-Hall.

Czarniawska-Joerges B (1997) *Narrating the organization: dramas of institutional identity*. Chicago: University of Chicago Press.

Davidsson P (2006) Nascent Entrepreneurship: Empirical Studies and Developments. *Foundations and Trends in Entrepreneurship* 2(1): 1–76.

Davidsson P and Honig B (2003) The role of social and human capital among nascent entrepreneurs. *Journal of Business Venturing* 18(3): 301–330.

Debaere S, Coussement K and De Ruyck T (2018) Multi-label classification of member participation in online innovation communities. *European Journal of Operational Research*, Elsevier 270(2): 761–774. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0377221718302686.

Deuten JJ and Rip A (2000) Narrative Infrastructure in Product Creation Processes. *Organization* 7(1): 69–93. Available from: http://org.sagepub.com/cgi/content/abstract/7/1/69.

Dimov D (2007) Beyond the single-person, single-insight attribution in understanding entrepreneurial opportunities. *Entrepreneurship Theory and Practice* (860): 713–731. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.1540-6520.2007.00196.x/full.

Dimov D (2010) Nascent Entrepreneurs and Venture Emergence: Opportunity Confidence, Human Capital, and Early Planning. *Journal of Management Studies* 47(6): 1123–1153. Available from: http://doi.wiley.com/10.1111/j.1467-6486.2009.00874.x.

Downing S (2005) The social construction of entrepreneurship: Narrative and dramatic processes in the coproduction of organizations and identities. *Entrepreneurship Theory and Practice* 29(2): 185–204. Available from: http://onlinelibrary.wiley.com/doi/10.1111/j.1540-6520.2005.00076.x/full.

Eckhardt J and Shane S (2003) Opportunities and entrepreneurship. *Journal of management* 29(3): 333–349. Available from: http://jom.sagepub.com/content/29/3/333.short.

Feldman MS and Pentland BT (2003) Reconceptualizing Organizational Routines as a Source of Flexibility and Change. *Administrative Science Quarterly* 48(1): 94. Available from: http://www.jstor.org/stable/3556620?origin=crossref.

Feldman MS and Skoldberg K (2002) Stories and the rhetoric of contrariety: subtexts of organizing (change). *Culture and Organization* 8(4): 275–292. Available from: http://www.tandfonline.com/doi/abs/10.1080/14759550215614.

Finegan E (2004) *Language: Its structure and use*. Boston, MA: Thomson Wadsworth.

Forbes DP, Borchert PS, Zellmer-Bruhn ME, et al. (2006) Entrepreneurial Team Formation: An Exploration of New Member Addition. *Entrepreneurship: Theory & Practice*, Blackwell Publishing Limited 30(2): 225–248.

Francis WS, Romo LF and Gelman R (2002) Syntactic Structure, Grammatical Accuracy, and Content in Second-Language Writing: An Analysis of Skill Learning and On-line Processing. In: Heredia RR and Altarriba J (eds), *Bilingual Sentence Processing*, Amsterdam: Elsevier B.V., pp. 317–337.

Fromkin V, Rodman R and Hyams NM (2009) *An introduction to language*. Cengage Learning.

Gartner WB (1993) Words lead to deeds: Towards an organizational emergence vocabulary. *Journal of Business*

Venturing 8(3): 231–239. Available from: http://linkinghub.elsevier.com/retrieve/pii/0883902693900295.

Gartner WB (2007) Entrepreneurial narrative and a science of the imagination. *Journal of Business Venturing* 22(5): 613–627. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0883902606000681.

Garud R, Dunbar RLM and Bartel C a. (2010) Dealing with Unusual Experiences: A Narrative Perspective on Organizational Learning. *Organization Science* 22(3): 587–601. Available from: http://orgsci.journal.informs.org/cgi/doi/10.1287/orsc.1100.0536.

George G (2005) Learning to be capable: patenting and licensing at the Wisconsin Alumni Research Foundation 1925-2002. *Industrial and Corporate Change* 14(1): 119–151. Available from: http://icc.oxfordjournals.org/cgi/content/abstract/14/1/119.

George G and Bock AJ (2009) *Inventing entrepreneurs: technology innovators and their entrepreneurial journey*. Upper Saddle River, NJ: Pearson Prentice Hall.

Gilbert C (2005) Unbundling the Structure of Inertia: Resource versus Routine Rigidity. *Academy of Management Journal*, Academy of Management 48(5): 741–763. Available from: http://search.epnet.com/login.aspx?direct=true&db=bsh&an=18803920.

Gordon P and Hendrick R (1998) The Representation and Processing of Coreference in Discourse. *Cognitive Science* 22(4): 389–424. Available from: http://www.sciencedirect.com/science/article/pii/S0364021399800457.

Grégoire DA and Shepherd DA (2012) Technology-Market Combinations and the Identification of Entrepreneurial Opportunities: an Investigation of the Opportunity-Individual Nexus. *Academy of Management Journal* 55(4): 753–785. Available from: http://amj.aom.org/cgi/doi/10.5465/amj.2011.0126.

Grimmer J and Stewart BM (2013) Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts. *Political Analysis* 21(03): 267–297. Available from: https://www.cambridge.org/core/product/identifier/S1047198700013401/type/journal_article.

Gruber M, MacMillan IC and Thompson JD (2008) Look Before You Leap: Market Opportunity Identification in Emerging Technology Firms. *Management Science* 54(9): 1652–1665. Available from: http://mansci.journal.informs.org/cgi/doi/10.1287/mnsc.1080.0877.

Gruber M, MacMillan IC and Thompson JD (2012) Escaping the Prior Knowledge Corridor: What Shapes the Number and Variety of Market Opportunities Identified Before Market Entry of Technology Start-ups? *Organization Science* 24(1): 280–300. Available from: http://orgsci.journal.informs.org/cgi/doi/10.1287/orsc.1110.0721.

Gundel J, Hedberg N and Zacharski R (1993) Cognitive Status and the Form of Referring Expressions in Discourse. *Language* 69(2): 274–307. Available from: http://www.jstor.org/stable/10.2307/416535.

Haynie JM, Shepherd DA and McMullen JS (2009) An Opportunity for Me? The Role of Resources in Opportunity Evaluation Decisions. *Journal of Management Studies* 46(3): 337–361. Available from: http://doi.wiley.com/10.1111/j.1467-6486.2009.00824.x.

Hoornaert S, Ballings M, Malthouse EC, et al. (2017) Identifying New Product Ideas: Waiting for the Wisdom of the Crowd or Screening Ideas in Real Time. *Journal of Product Innovation Management* 34(5): 580–597. Available from: http://doi.wiley.com/10.1111/jpim.12396.

Huang AH, Zang AY and Zheng R (2014) Evidence on the Information Content of Text in Analyst Reports. *The Accounting Review*, American Accounting Association 89(6): 2151–2180. Available from: http://aaajournals.org/doi/10.2308/accr-50833.

Humphreys A and Wang RJH (2018) Automated text analysis for consumer research. *Journal of Consumer Research* 44(6): 1274–1306.

Ibarra H and Barbulescu R (2010) Identity as Narrative: Prevalence, Effectiveness, and Consequences of Narrative Identity Work in Macro Work Role Transitions. *Academy of Management Review* 35(1): 135–154.

Ireland ME, Slatcher RB, Eastwick PW, et al. (2011) Language Style Matching Predicts Relationship Initiation and Stability. *Psychological Science*, SAGE Publications Inc 22(1): 39–44. Available from: https://doi.org/10.1177/0956797610392928.

Jain S and George G (2007) Technology transfer offices as institutional entrepreneurs: the case of Wisconsin Alumni Research Foundation and human embryonic stem cells. *Industrial and Corporate Change* 16(4): 535–567. Available from: http://icc.oxfordjournals.org/cgi/content/abstract/16/4/535.

Jain S, George G and Maltarich M (2009) Academics or entrepreneurs? Investigating role identity modification of university scientists involved in commercialization activity. *Research Policy* 38(6): 922–935. Available from: http://linkinghub.elsevier.com/retrieve/pii/S004873330900050X.

Kemper S, Kynette D, Rash S, et al. (1989) Life-span changes to adults' language: Effects of memory and genre. *Applied Psycholinguistics* 10(01): 49–66.

Kim PH and Longest KC (2014) You can't leave your work behind: Employment experience and founding collaborations. *Journal of Business Venturing* 29(6): 785–806. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0883902613001043.

Kim PH, Buffart M and Croidieu G (2016) TMI: Signaling Credible Claims in Crowdfunding Campaign Narratives. *Group & Organization Management* 41(6): 717–750. Available from: http://gom.sagepub.com/cgi/doi/10.1177/1059601116651181.

Klevorick AK, Levin RC, Nelson RR, et al. (1995) On the sources and significance of interindustry differences in technological opportunities. *Research Policy* 24(2): 185–205. Available from: http://linkinghub.elsevier.com/retrieve/pii/004873339300762I.

Kotha R and George G (2012) Friends, family, or fools: Entrepreneur experience and its implications for equity distribution and resource mobilization. *Journal of Business Venturing* 27(5): 525–543. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0883902612000365.

Kotha R, George G and Srikanth K (2013) Bridging the Mutual Knowledge Gap: Coordination and the Commercialization of University Science. *Academy of Management Journal* 56(2): 498–524. Available from: http://amj.aom.org/cgi/doi/10.5465/amj.2010.0948.

Kotha R, Crama P and Kim PH (2018) Experience and Signaling Value in Technology Licensing Contract Payment Structures. *Academy of Management Journal* 61(4): 1307–1342. Available from: http://amj.aom.org/lookup/doi/10.5465/amj.2015.1233.

Krippendorff K (2007) *Computing Krippendorff's Alpha Reliability*. Philadelphia, PA.

Krippendorff K (2010) *On communicating: Otherness, meaning, and information*. Routledge.

Lanjouw JO and Schankerman M (2001) Characteristics of patent litigation: a window on competition. *RAND journal of economics*, JSTOR: 129–151.

Lanjouw JO and Schankerman M (2004) Protecting intellectual property rights: are small firms handicapped? *The journal of law and economics*, The University of Chicago Press 47(1): 45–74.

Latour B and Woolgar S (1986) *Laboratory life : the construction of scientific facts*. Princeton, NJ: Princeton University Press.

Lessmann S, Baesens B, Seow H-V, et al. (2015) Benchmarking state-of-the-art classification algorithms for credit scoring: An update of research. *European Journal of Operational Research*, Elsevier 247(1): 124–136. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0377221715004208.

Li F (2010) The Information Content of Forward-Looking Statements in Corporate Filings-A Naïve Bayesian Machine Learning Approach. *Journal of Accounting Research*, Wiley Online Library 48(5): 1049–1102. Available from: http://doi.wiley.com/10.1111/j.1475-679X.2010.00382.x.

Lobeck AC (2000) *Discovering grammar: an introduction to English sentence structure*. Boston, MA: Oxford University Press.

Lobeck AC and Morenberg M (2000) *Cognitive complexity and increased grammatical explicitness in English*. New York: Oxford University Press.

Loughran T and McDonald B (2016) Textual Analysis in Accounting and Finance: A Survey. *Journal of Accounting Research* 54(4): 1187–1230. Available from: http://doi.wiley.com/10.1111/1475-679X.12123.

Lounsbury M and Glynn MA (2001) Cultural entrepreneurship: Stories, legitimacy, and the acquisitions of resources. *Strategic Management Journal* 22(6/7): 545–564. Available from:

http://proquest.umi.com/pqdweb?did=74615424&Fmt=7&clientId=15094&RQT=309&VName=PQD.

Ludwig S, de Ruyter K, Friedman M, et al. (2013) More Than Words: The Influence of Affective Content and Linguistic Style Matches in Online Reviews on Conversion Rates. *Journal of Marketing*, American Marketing Association 77(1): 87–103. Available from: http://journals.ama.org/doi/abs/10.1509/jm.11.0560.

Ludwig S, de Ruyter K, Mahr D, et al. (2014) Take Their Word for It: The Symbolic Role of Linguistic Style Matches in User Communities. *MIS Quarterly*, Society for Management Information Systems 38(4): 1201–1217. Available from: https://misq.org/take-their-word-for-it-the-symbolic-role-of-linguistic-style-matches-in-user-communities.html.

March JG (1991) Exploration and Exploitation in Organizational Learning. *Organization Science* 2(1): 71–87. Available from: http://orgsci.journal.informs.org/content/2/1/71.short.

Martens ML, Jennings JE and Jennings PD (2007) Do the stories they tell get them the money they need? The role of entrepreneurial narratives in resource acquisition. *Academy of Management Journal* 50(5): 1107–1132.

McHaney R, Tako A and Robinson S (2018) Using LIWC to choose simulation approaches: A feasibility study. *Decision Support Systems*, Elsevier 111: 1–12. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0167923618300691.

McMullen JS and Shepherd DA (2006) Entrepreneurial Action And The Role Of Uncertainty In The Theory Of The Entrepreneur. *Academy of Management Review* 31(1): 132–152. Available from: http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=19379628&loginpage=Login.asp&site=ehost-live DP - EBSCOhost DB - buh.

Mitchell JR and Shepherd DA (2010) To thine own self be true: Images of self, images of opportunity, and entrepreneurial action. *Journal of Business Venturing*, Elsevier Inc. 25(1): 138–154. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0883902608001006.

Napoli DJ (1996) *Discovering grammar: an introduction to English sentence structure*. New York: Oxford University Press.

Navis C and Glynn MA (2011) Legitimate Distinctiveness and the Entrepreneurial Identity: Influence on Investor Judgments of New Venture Plausibility. *Academy of Management Review* 36(3): 479–499.

Nelson RR and Winter SG (1982) *An evolutionary theory of economic change*. Cambridge, MA.: Belknap Press of Harvard University Press.

Obschonka M, Fisch C and Boyd R (2017) Using digital footprints in entrepreneurship research: A Twitter-based personality analysis of superstar entrepreneurs and managers. *Journal of Business Venturing Insights* 8: 13–23. Available from: http://www.sciencedirect.com/science/article/pii/S2352673417300239.

Ocasio W (2011) Attention to Attention. *Organization Science* 22(5): 1286–1296. Available from: http://orgsci.journal.informs.org/cgi/doi/10.1287/orsc.1100.0602.

Owen-Smith J and Powell WW (2001) To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer. *Journal of Technology Transfer* 26(1–2): 99–114. Available from: http://www.springerlink.com/index/M1457J1J1HP57503.pdf.

Pennebaker JW (2011) *The secret life of pronouns: what our words say about us*. New York: Bloomsbury Press.

Pennebaker JW, Mayne TJ and Francis ME (1997) Linguistic predictors of adaptive bereavement. *Journal of Personality and Social Psychology*, Blackwell Publishing 72(4): 863–871. Available from: http://doi.apa.org/getdoi.cfm?doi=10.1037/0022-3514.72.4.863.

Perry-Smith JE and Mannucci PV (2017) From creativity to innovation: The social network drivers of the four phases of the idea journey. *Academy of Management Review* 42(1): 53–79.

Pfarrer MD, Pollock TG and Rindova VP (2010) A tale of two assets: The effects of firm reputation and celebrity on earnings surprises and investors' reactions. *Academy of Managemen Journal* 53(5): 1131–1152. Available from: http://amj.aom.org/content/53/5/1131.short.

Phillips N, Tracey P and Karra N (2012) Building entrepreneurial tie portfolios through strategic homophily: The role of narrative identity work in venture creation and early growth. *Journal of Business Venturing*. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0883902612000043.

Pinker S (2000) *The language instinct: how the mind creates language*. New York: Perennial Classics. Available from: http://forward.library.wisconsin.edu/catalog/ocm45992871.

Read S, Dew N, Sarasvathy SD, et al. (2009) Marketing Under Uncertainty: The Logic of an Effectual Approach. *Journal of Marketing* 73(3): 1–18.

Rindova VP, Barry D and Ketchen DJ (2009) Entrepreneuring as Emancipation. *Academy of Management Review* 34(3): 477–491. Available from: http://amr.aom.org/content/34/3/477.short.

Rohdenburg G (1996) Cognitive complexity and increased grammatical explicitness in English. *Cognitive linguistics*, MOUTON DE GRUYTER 7: 149–182.

Schumpeter JA (1975) *Capitalism, Socialism and Democracy*. New York: Harper & Row.

Shane S (2000) Prior Knowledge and the Discovery of Entrepreneurial Opportunities. *Organization Science* 11(4): 448–469. Available from: http://links.jstor.org/sici?sici=1047-7039(200007/08)11:4%3C448:PKATDO%3E2.0.CO;2-7.

Shane S (2001) Technology Regimes and New Firm Formation. *Management Science* 47(9): 1173–1190.

Shane S (2002) Selling University Technology: Patterns from MIT. *Management Science* 48(1): 122–137. Available from: http://mansci.journal.informs.org/cgi/doi/10.1287/mnsc.48.1.122.14281.

Shane S and Khurana R (2003) Bringing individuals back in: the effects of career experience on new firm founding. *Industrial and Corporate Change*, Oxford Univ Press 12(3): 519–543.

Shane S and Venkataraman S (2000) The Promise of Entrepreneurship As a Field of Research. *Academy of Management Review* 25(1): 217–226.

Shepherd DA, McMullen JS and Jennings PD (2007) The formation of opportunity beliefs: overcoming ignorance and reducing doubt. *Strategic Entrepreneurship Journal* 1(1–2): 75–95. Available from: http://doi.wiley.com/10.1002/sej.3.

Shepherd DA, Haynie JM and McMullen JS (2012) Confirmatory search as a useful heuristic? Testing the veracity of entrepreneurial conjectures. *Journal of Business Venturing*, Elsevier Inc. 27(6): 637–651. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0883902611000589.

Siegel DS, Waldman D and Link A (2003) Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. *Research policy*, Elsevier 32(1): 27–48.

Sine WD, Shane S and Di Gregorio D (2003) The Halo Effect and Technology Licensing: The Influence of Institutional Prestige on the Licensing of University Inventions. *Management Science* 49(4): 478–496.

Slater SF, Mohr JJ and Sengupta S (2014) Radical product innovation capability: Literature review, synthesis, and illustrative research propositions. *Journal of Product Innovation Management*, Wiley Online Library 31(3): 552–566.

Stasser G and Titus W (1985) Pooling of Unshared Information in Group Decision Making: Biased Information Sampling During Discussion. *Journal of Personality and Social Psychology* 48(6): 1467–1478. Available from: http://doi.apa.org/getdoi.cfm?doi=10.1037/0022-3514.48.6.1467.

Stevenson HH and Jarillo JC (1990) A Paradigm of Entrepreneurship: Entrepreneurial Management. *Strategic Management Journal*, Springer 11(5): 17–27. Available from: http://www.jstor.org/stable/2486667.

Stuart TE and Ding WW (2006) When Do Scientists Become Entrepreneurs ? The Social Structural Antecedents of. *American Journal of Sociology* 112(1): 97–144.

Tausczik YR and Pennebaker JW (2010) The Psychological Meaning of Words: LIWC and Computerized Text Analysis Methods. *Journal of Language and Social Psychology* 29(1): 24–54. Available from: http://jls.sagepub.com/cgi/doi/10.1177/0261927X09351676.

Taylor JR (1993) Prepositions: Patterns of polysemization and strategies of disambiguation. In: Zelinsky-Wibbelt C (ed.), *The Semantics of Prepositions: From Mental Processing to Natural Language Processing*, Berlin: Mouton de Gruyter, pp. 151–178.

Taylor PJ and Thomas S (2008) Linguistic Style Matching and Negotiation Outcome. *Negotiation and Conflict*

Management Research 1(3): 263–281. Available from: http://doi.wiley.com/10.1111/j.1750-4716.2008.00016.x.

Teece DJ, Pisano G and Shuen A (1997) Dynamic capabilities and strategic management. *Strategic Management Journal* 18(7): 509–533. Available from: http://doi.wiley.com/10.1002/%28SICI%291097-0266%28199708%2918%3A7%3C509%3A%3AAID-SMJ882%3E3.0.CO%3B2-Z.

Tyler A and Evans V (2003) *The semantics of English prepositions: spatial scenes, embodied meaning, and cognition*. Cambridge: Cambridge University Press.

Van Vlasselaer V, Eliassi-Rad T, Akoglu L, et al. (2017) GOTCHA! Network-Based Fraud Detection for Social Security Fraud. *Management Science* 63(9): 3090–3110. Available from: http://pubsonline.informs.org/doi/10.1287/mnsc.2016.2489.

Venkataraman S (1997) The distinctive domain of entrepreneurship research. In: Katz J and Brockhaus RH (eds), *Advances in Entrepreneurship, Firm Emergence and Growth*, Greenwich, CT: JAI Press, pp. 119–138.

Vissa B (2011) A Matching Theory of Entrepreneurs' Tie Formation Intentions and Initiation of Economic Exchange. *Academy of Management Journal* 54(1): 137–158. Available from: http://connection.ebscohost.com/an/59215084.

Weick KE (1979) *The social psychology of organizing*. 2d ed. Reading, MA: Addison-Wesley.

Wolfe MT and Shepherd DA (2015) What Do You Have to Say About That? Performance Events and Narratives' Positive and Negative Emotional Content. *Entrepreneurship Theory and Practice* 39(4): 895–925. Available from: http://doi.wiley.com/10.1111/etap.12080.

Wood MS and Williams DW (2014) Opportunity Evaluation as Rule-Based Decision Making. *Journal of Management Studies* 51(4): 573–602. Available from: http://doi.wiley.com/10.1111/joms.12018.

Zucker LG and Darby MR (1996) Star scientists and institutional transformation: patterns of invention and innovation in the formation of the biotechnology industry. *Proceedings of the National Academy of Sciences of the United States of America* 93(23): 12709–16. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=34126&tool=pmcentrez&rendertype=abstract.

FIGURE 1:
TTO Procedure for Evaluating Invention Disclosures for Commercialization Budgetary Support

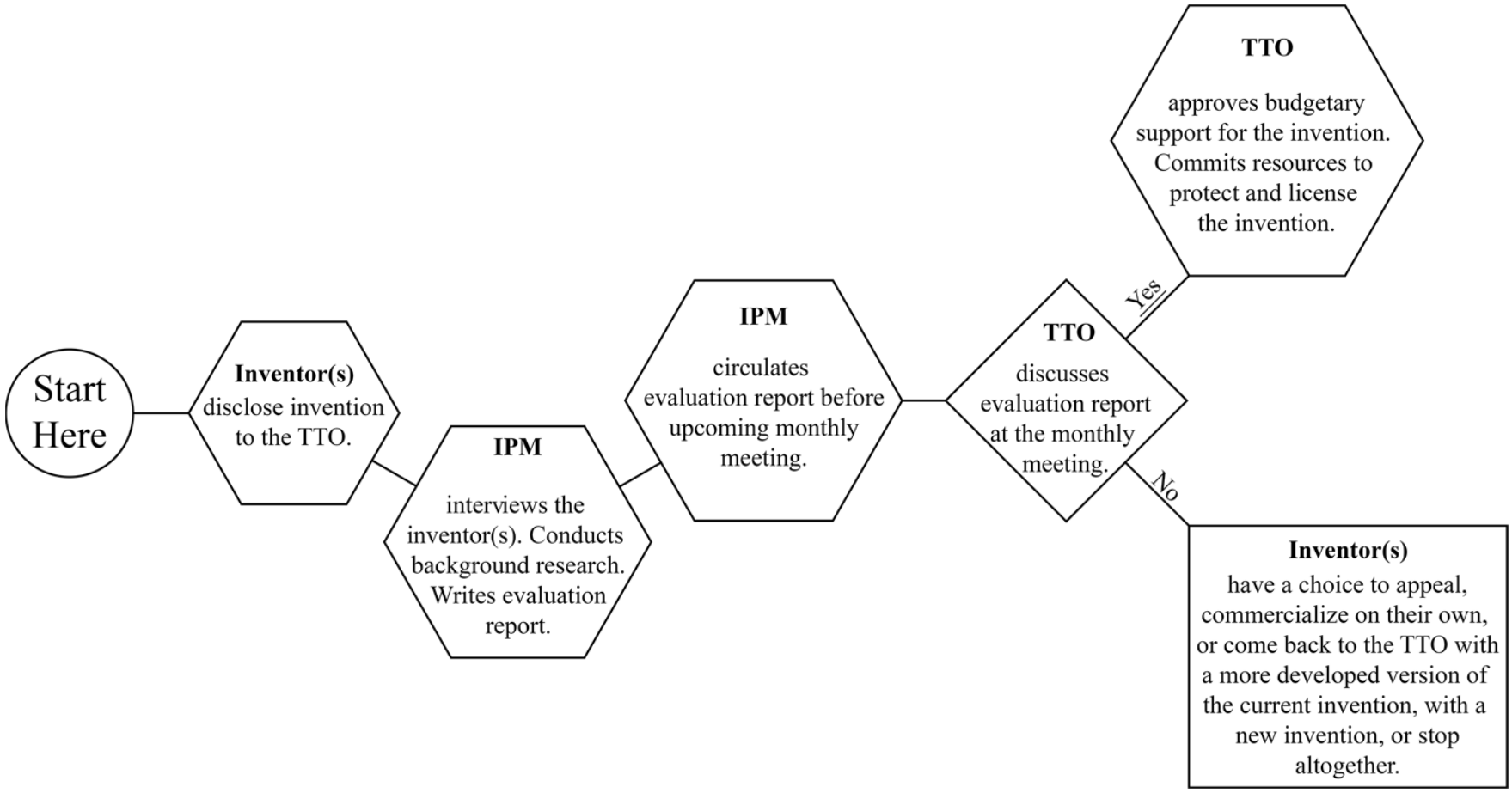

TABLE I:
Post-Measurement Validation Statistics

	Independent Variables			
Evaluation Metric	**Doubt**	**Maturity**	**Background Familiarity**	**Scientific Complexity**
Hit rates	91%	89%	90%	91%
Krippendorff's alpha	0.88	0.85	0.87	0.88

TABLE II:
Descriptive Statistics and Correlations

	Variable	Mean	Median	Std. Dev.	Min	Max
1	Budgetary support	0.64	1	0.48	0	1
2	Doubt	0.67	0.41	0.94	0	6.31
3	Maturity	1.49	0	3.82	0	20
4	Background familiarity	6.52	6.25	3.04	0	16.76
5	Scientific complexity	14.75	14.73	2.88	0	23.53
6	Inventor reference	0.25	0	0.67	0	6.67
7	TTO reference	0.98	0	1.59	0	11.11
8	Publication record	6.06	6.42	1.85	0	9.89
9	Scientific distance	0.18	0	0.33	0	1
10	Patent claims concern	2.54	2.03	2.58	0	20
11	Commercial skepticism	0.50	0	0.90	0	5
12	External vetting	0.79	1	0.41	0	1
13	Window of opportunity	0.37	0	0.56	0	3
14	Total words	684.61	648	250.77	301	1902
15	IPM experience	623.31	504	411.56	6	1686
16	IPM enthusiasm	1.54	1.44	0.63	0.27	4.40

N=686

TABLE III: Correlations

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Budgetary support	1														
2	Doubt	-0.174*	1													
3	Maturity	-0.160*	0.172*	1												
4	External vetting	0.226*	-0.186*	-0.125*	1											
5	Background familiarity	0.053	0.160*	-0.006	-0.032	1										
6	Scientific complexity	0.071	-0.112*	0.029	0.045	0.003	1									
7	Window of opportunity	0.152*	-0.043	-0.062	0.138*	0.178*	0.011	1								
8	Publication record	0.119*	-0.050	-0.055	0.154*	0.042	0.030	0.007	1							
9	Scientific distance	-0.094*	-0.052	-0.075	-0.008	0.050	0.041	-0.037	0.073*	1						
10	IPM experience	-0.070	0.164*	-0.080*	-0.053	0.038	-0.101*	-0.018	0.111*	-0.014	1					
11	IPM enthusiam	0.057	-0.055	-0.100*	0.056	-0.105*	0.027	-0.056	0.059	-0.035	0.059	1				
12	Patent claims concern	-0.117*	-0.026	-0.036	-0.002	-0.055	0.066	-0.018	-0.035	0.016	-0.019	0.035	1			
13	Commercial skepticism	-0.072	-0.076*	0.033	0.002	0.038	-0.006	0.017	0.006	-0.005	-0.050	0.010	-0.016	1		
14	Inventor reference	-0.124*	0.079*	-0.023	-0.176*	0.114*	0.057	-0.050	-0.160*	-0.039	0.129*	-0.014	0.015	-0.037	1	
15	TTO reference	0.143*	0.002	0.009	0.011	0.026	-0.003	-0.048	0.049	0.005	0.195*	-0.002	-0.057	-0.114*	-0.007	1
16	Total words	0.126*	0.026	-0.030	-0.016	0.332*	0.081*	0.255*	0.111*	0.088*	0.042	-0.090*	-0.032	0.083*	-0.003	-0.064

Notes: N=686. All correlations above |0.056| are significant at $p<0.05$.

TABLE IV:
Logit and OLS Estimations of Invention Budgetary Support

	(1) Budgetary support (1/0)		(2) Budgetary support (1/0)		(3) Budgetary support (1/0)		(4) Budgetary support (1/0) Dy/dx		(5) Degree of support (1-7)	
Constant	-5.41***	(2.07)	-4.31**	(2.10)	-6.51***	(2.15)	-5.57**	-	(2.18)	-0.92	(1.62)
Publication record	0.16***	(0.06)	0.15**	(0.06)	0.15**	(0.06)	0.14**	0.02	(0.06)	0.12**	(0.05)
Scientific distance	-3.41**	(1.36)	-3.27**	(1.37)	-3.50**	(1.37)	-3.42**	-0.53	(1.39)	-1.81	(1.17)
Scientific distance^2	2.73*	(1.40)	2.40*	(1.41)	2.80**	(1.41)	2.52*	0.39	(1.43)	1.12	(1.22)
IPM experience	0.0040	(0.00)	0.0034	(0.00)	0.0039	(0.00)	0.0034	0.001	(0.00)	0.0014	(0.00)
IPM enthusiasm	0.19	(0.16)	0.15	(0.17)	0.19	(0.16)	0.15	0.02	(0.17)	0.13	(0.15)
Patent claims concern	-0.11***	(0.04)	-0.13***	(0.04)	-0.11***	(0.04)	-0.13***	-0.02	(0.04)	-0.13***	(0.03)
Commercial scepticism	-0.32***	(0.11)	-0.33***	(0.12)	-0.32***	(0.11)	-0.33***	-0.05	(0.12)	-0.25**	(0.10)
Inventor reference	-0.33**	(0.17)	-0.37**	(0.17)	-0.41**	(0.17)	-0.45**	-0.07	(0.18)	-0.42***	(0.14)
TTO reference	0.37***	(0.08)	0.37***	(0.08)	0.37***	(0.08)	0.37***	0.06	(0.08)	0.27***	(0.06)
External vetting	1.17***	(0.26)	1.00***	(0.26)	1.14***	(0.26)	0.96***	0.15	(0.27)	0.95***	(0.24)
Window of opportunity	0.55***	(0.20)	0.49**	(0.20)	0.54***	(0.20)	0.49**	0.08	(0.21)	0.42**	(0.17)
Total words	0.0019***	(0.00)	0.0019***	(0.00)	0.0017***	(0.00)	0.0017***	0.000	(0.00)	0.0017***	(0.00)
Doubt (H1)			-0.24*	(0.13)			-0.26**	-0.04	(0.13)	-0.20*	(0.10)
Maturity (H2)			-0.12***	(0.03)			-0.12***	-0.02	(0.03)	-0.068***	(0.02)
Background familiarity (H3)					0.074*	(0.04)	0.088**	0.013	(0.04)	0.066*	(0.04)
Scientific complexity (H4)					0.062*	(0.04)	0.069*	0.011	(0.04)	0.066**	(0.03)
62 domain fixed effects	Yes		Yes		Yes		Yes			Yes	
6 Evaluator fixed effects	Yes		Yes		Yes		Yes			Yes	
10 Year fixed effects	Yes		Yes		Yes		Yes			Yes	
Pseudo R2/R2	0.24		0.27		0.25		0.27			0.34	
Log likelihood/Adj. R2	-323.31		-312.19		-320.21		-308.38			0.25	

Notes: Models 1-4: Logit, Model 5: OLS. N=686, 27 observations dropped in the logit models due to lack of variation for the fixed effects. Standard errors in parentheses;
* p<0.10, ** p<0.05, *** p<0.01 (two-tailed test).

Appendix A: Evaluation Criteria Variable Definitions and Examples

Construct	Definition	Variable	Text example
Feasibility	*A form of evaluating whether action on a business idea could lead to a desired end state in the manner envisioned by those undertaking the effort* (McMullen and Shepherd, 2006: 141)		
Doubt	Having uncertainties that undertaking action on an invention can be pursued successfully.	Percent of discrepancy words used to describe the invention. (LIWC variable: discrep)	Professor believes that krypton has been overlooked because it is not as radio opaque as xenon. However, he believes krypton combined with CT **could** give the type of striking images people are obtaining only by using much more complicated hyperpolarized gas systems and MRI. Professor hasn't worked out the respiratory gating that **needs** to be implemented to practice a CT scan with radio opaque noble gases. During our disclosure, we discussed with him some of the unknowns we **would need** to satisfy in order to file a meaningful patent application. For example, we **would need** to know the time of CT exposure as well as the KVp settings and the concentration of the gas to be inhaled by the patient.
Maturity	Current state within an invention's life cycle.	Percent of negation words to describe the invention's reduction to practice. (LIWC variable: negate)	The inventors have identified the conditions necessary for solubility of the sunscreens in an alcohol base. They have **not** added fragrance, or formulated a finished product, **nor** have they done any formalized skin testing.

Appendix A: Evaluation Criteria Variable Definitions and Examples (continued)

Construct	Definition	Variable	Text example
Desirability	*A form of evaluating whether taking action on a business idea is likely to fulfill the motives for which it is being sought, in light of the expected costs associated with the effort.* (McMullen and Shepherd, 2006: 141)		
Familiarity	Having sufficient knowledge about the context associated with the invention being evaluated.	Percent of impersonal pronouns used to describe the invention and its scientific background. (LIWC variable: ipron)	Our inventors have developed a device, **which** provides an accurate, objective non-invasive method to evaluate cranial and caudal knee translation in the dog model. **This** device incorporates a spring force meter, **which** can be used to repeatedly apply a force **which** is then recorded radiographically. With the leg in the same position without the force, another radiograph is taken and the radiographs are superimposed over each **other** to measure the total translation of the knee joint. The device **itself** holds the radiographic film cassette so **that** there is no variation between positioning of the films.
Complexity	The extent to which an invention is based on intricate and elaborate technical foundations.	Percent of prepositions used to describe the invention's scientific background. (LIWC variable: preps)	One form **of** superconducting material known **as** YBCO is often applied **as** a thin film **on** top **of** a thick substrate such **as** nickel. Figure 1 shows the general layout **of** a YBCO tape. The nickel substrate is a roughly 20 μm **in** thickness and the thin film **of** YBCO is **about** 1 μm **in** thickness. Slits are cut **in** the thin film **in** order **to** allow **for** the long tape-like structure **to** be twisted **into** a round wire.

Online Appendix Table 1:
Robustness Check with Perceived Breakthrough Potential Variable

	Table IV: Models 4 & 5 (Main results)				Table IV: Models 4 & 5 with Perceived breakthrough potential variable			
	(1) Budgetary support (1/0)		(2) Degree of support (1-7)		(3) Budgetary support (1/0)		(4) Degree of support (1-7)	
Theory Variables								
Doubt (H1)	**-0.26****	**(0.13)**	**-0.20***	**(0.10)**	**-0.24***	**(0.13)**	**-0.19***	**(0.10)**
Maturity (H2)	**-0.12*****	**(0.03)**	**-0.068*****	**(0.02)**	**-0.12*****	**(0.03)**	**-0.071*****	**(0.02)**
Background familiarity (H3)	**0.088****	**(0.04)**	**0.066***	**(0.04)**	**0.089****	**(0.04)**	**0.069****	**(0.03)**
Scientific complexity (H4)	**0.069***	**(0.04)**	**0.066****	**(0.03)**	**0.063†**	**(0.04)**	**0.064****	**(0.03)**
Controls Variables								
Publication record	0.14**	(0.06)	0.12**	(0.05)	0.15**	(0.06)	0.12**	(0.05)
Scientific distance	-3.42**	(1.39)	-1.81	(1.17)	-3.39**	(1.41)	-1.80	(1.17)
Scientific distance^2	2.52*	(1.43)	1.12	(1.22)	2.44*	(1.44)	1.07	(1.22)
IPM experience	0.0034	(0.00)	0.0014	(0.00)	0.0036	(0.00)	0.0014	(0.00)
IPM enthusiasm	0.15	(0.17)	0.13	(0.15)	0.17	(0.17)	0.14	(0.15)
Patent claims concern	-0.13***	(0.04)	-0.13***	(0.03)	-0.13***	(0.04)	-0.12***	(0.03)
Commercial skepticism	-0.33***	(0.12)	-0.25**	(0.10)	-0.32***	(0.12)	-0.24**	(0.10)
Inventor reference	-0.45**	(0.18)	-0.42***	(0.14)	-0.45**	(0.18)	-0.41***	(0.14)
TTO reference	0.37***	(0.08)	0.27***	(0.06)	0.38***	(0.08)	0.27***	(0.06)
External vetting	0.96***	(0.27)	0.95***	(0.24)	0.97***	(0.27)	0.95***	(0.23)
Window of opportunity	0.49**	(0.21)	0.42**	(0.17)	0.47**	(0.21)	0.40**	(0.17)
Total words	0.0017***	(0.00)	0.0017***	(0.00)	0.0016***	(0.00)	0.0016***	(0.00)
Perceived breakthrough potential					**0.23****	**(0.09)**	**0.21*****	**(0.08)**
Constant	-5.57**	(2.18)	-0.92	(1.62)	-6.30***	(2.21)	-1.44	(1.62)
Pseudo R^2/R^2	0.27		0.34		0.28		0.35	
Log likelihood/Adj. R^2	-308.38		0.25		-305.31		0.26	

Notes: All models have IPM, year, and domain fixed effects. Models 1 & 3: Logit, Models 2 & 4: OLS. N=686, 27 observations dropped in Logit due to fixed effects. Standard errors in parentheses. †p=.107 * p<.10, ** p<.05, *** p<.01 (two-tailed test).

Online Appendix Table 2:
Robustness Check with Alternative DV
Degree of Support OLS and Ordered Logit Estimations

	(1) Degree of support		(2) Degree of support	
Theory Variables				
Doubt (H1)	**-0.20***	**(-0.10)**	**-0.18***	**(-0.1)**
Maturity (H2)	**-0.068*****	**(-0.02)**	**-0.053****	**(-0.02)**
Background familiarity (H3)	**0.066***	**(-0.04)**	**0.036**	**(-0.03)**
Scientific complexity (H4)	**0.066****	**(-0.03)**	**0.087*****	**(-0.03)**
Control Variables				
Publication record	0.12**	(-0.05)	0.088*	(-0.05)
Scientific distance	-1.81	(-1.17)	-1.72*	(-1.01)
Scientific distance^2	1.12	(-1.22)	1.11	(-1.06)
IPM experience	0.0014	(0.00)	0.0021	(0.00)
IPM enthusiasm	0.13	(-0.15)	0.15	(-0.13)
Patent claims concern	-0.13***	(-0.03)	-0.12***	(-0.03)
Commercial skepticism	-0.25**	(-0.1)	-0.19**	(-0.09)
Inventor reference	-0.42***	(-0.14)	-0.45***	(-0.14)
TTO reference	0.27***	(-0.06)	0.29***	(-0.06)
External vetting	0.95***	(-0.24)	0.86***	(-0.21)
Window of opportunity	0.42**	(-0.17)	0.35**	(-0.15)
Total words	0.0017***	(0.00)	0.0018***	(0.00)
cut1			3.46**	(-1.48)
cut2			3.76**	(-1.48)
cut3			4.12***	(-1.49)
cut4			4.19***	(-1.49)
cut5			4.40***	(-1.49)
cut6			5.62***	(-1.49)
Constant	-0.92	(-1.62)		
Pseudo R^2/R^2	0.34		0.13	
Log likelihood/Adj. R^2	0.25		-907.06	

Notes: All models have IPM, year, and domain fixed effects. Model 1: OLS, Model 2: Ologit. N=686. Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01 (two-tailed test).

Online Appendix Table 3:
Robustness Check with Alternative Operationalization of Doubt and Window of Opportunity

	(1) Test of hypotheses (Main results)		(2) Alternate Operationalized IVs	
Doubt (1) / Future (2)	-0.26**	(0.13)	-0.20*	(0.12)
Maturity	-0.12***	(0.03)	-0.13***	(0.03)
Background familiarity	0.088**	(0.04)	0.095**	(0.04)
Scientific complexity	0.069*	(0.04)	0.071*	(0.04)
Window of opportunity (1) / Past publication disclosure (2)	0.49**	(0.21)	-1.34***	(0.31)
Other controls	Yes		Yes	
62 domain fixed effects	Yes		Yes	
Evaluator fixed effects	Yes		Yes	
10 Year fixed effects	Yes		Yes	

Notes: N=659 for estimation, not including 27 observations dropped in Logit due to fixed effects. Past publication disclosure (negative coefficient predicted). Standard errors in parentheses; †p=.107 * p<.10, ** p<.05, *** p<.01 (two-tailed test).

Online Appendix Table 4:
Robustness Check for Possible Mediation

	(1) Background familiarity		(2) Doubt		(3) Maturity		(4) Scientific complexity		(5) Window of opportunity	
IPM experience	0.0038	(0.00)	-0.00052	(0.00)	-0.0007	(0.00)	0.0038	(0.00)	-0.00039	(0.00)
IPP inventor dyad exp.	0.00072	(-0.01)	0.0068*	(0.00)	0.0093	(-0.02)	-0.017	(-0.01)	-0.0013	(0.00)
Publication record	-0.061	(-0.06)	-0.041*	(-0.02)	-0.024	(-0.09)	0.12*	(-0.07)	-0.011	(-0.01)
Scientific distance	0.87	(-1.37)	0.57	(-0.48)	0.16	(-1.98)	-1.90	(-1.53)	-0.17	(-0.29)
Scientific distance^2	-0.65	(-1.43)	-0.82*	(-0.5)	-1.79	(-2.07)	1.90	(-1.59)	0.11	(-0.3)
IPM enthusiasm	-0.20	(-0.17)	-0.04	(-0.06)	-0.38	(-0.25)	0.23	(-0.19)	-0.04	(-0.04)
Patent claims concern	-0.031	(-0.04)	0.00066	(-0.01)	-0.08	(-0.06)	0.063	(-0.04)	-0.0015	(-0.01)
Inventor reference	0.53***	(-0.16)	0.018	(-0.06)	-0.3	(-0.23)	0.32*	(-0.18)	-0.015	(-0.03)
TTO reference	0.022	(-0.07)	-0.024	(-0.02)	0.054	(-0.10)	0.038	(-0.08)	-0.013	(-0.01)
External vetting	0.25	(-0.27)	-0.36***	(-0.09)	-1.07***	(-0.39)	0.38	(-0.30)	0.25***	(-0.06)
Total words	0.00074	(0.00)	-0.000021	(0.00)	0.0002	(0.00)	0.0015***	(0.00)	0.00041***	(0.00)
Constant	3.17*	(-1.83)	1.47**	(-0.64)	3.91	(-2.65)	9.59***	(-2.04)	0.39	(-0.38)
Pseudo R^2/R^2	0.38		0.21		0.17		0.13		0.20	
Log likelihood/Adj. R^2	0.3		0.11		0.07		0.02		0.10	

Notes: All models have IPM, year, and domain fixed effects. Models 1-5: OLS. N=686. Standard errors in parentheses.
* p<0.10, ** p<0.05, *** p<0.01 (two-tailed test).

Online Appendix Table 5:
Robustness Check without IPM with the highest supported percentage

	(1) Table IV Model 4 (Main results)		(2) Without obs. from IPM with highest support percentage	
Theory variables				
Doubt	-0.26**	(0.13)	-0.24*	(0.13)
Maturity	-0.12***	(0.03)	-0.12***	(0.03)
Background familiarity	0.088**	(0.04)	0.091**	(0.04)
Scientific complexity	0.069*	(0.04)	0.080**	(0.04)
IPM experience	0.0034	(0.00)	0.0059*	(0.00)
Other controls	Yes		Yes	
62 domain fixed effects	Yes		Yes	
Evaluator fixed effects	Yes (6)		Yes (5)	
10 Year fixed effects	Yes		Yes	

Notes: N=659 for estimation for Model 1, not including 27 observations dropped in Logit due to fixed effects and N=610 for Model 2 without observations from the IPM with the highest budget support percentage.
Standard errors in parentheses; p<.10, ** p<.05, *** p<.01 (two-tailed test).

Online Appendix Table 6:
Robustness Check with Additional Inventor-IPM Dyad as Control Variable

	(1) Model 4 Table IV to test hypotheses		(2) Additional Control for IPM Inventor Dyads	
Theory variables				
Doubt	-0.26**	(0.13)	-0.33**	(0.14)
Maturity	-0.12***	(0.03)	-0.12***	(0.03)
Background familiarity	0.088**	(0.04)	0.085*	(0.04)
Scientific complexity	0.069*	(0.04)	0.076*	(0.04)
IPM-Inventor Dyad			0.040**	(0.02)
Other controls	Yes		Yes	
62 domain fixed effects	Yes		Yes	
Evaluator fixed effects	Yes (6)		Yes (6)	
10 Year fixed effects	Yes		Yes	

Notes: N=659 for estimation, not including 27 observations dropped in Logit due to fixed effects. Standard errors in parentheses;
* p<.10, ** p<.05, *** p<.01 (two-tailed test).