A GENERAL THEORY OF EMPLOYEE ENTREPRENEURSHIP: A KNOWLEDGE-BASED VIEW

Aseem Kaul
Department of Strategic Management and Entrepreneurship
Carlson School of Management
University of Minnesota
321 19th Avenue South, RM 3-412
Minneapolis, MN 55455
E-mail: akaul@umn.edu

Martin Ganco
Department of Management and Human Resources
Wisconsin School of Business
University of Wisconsin-Madison
975 University Avenue, 4257 Grainger Hall
Madison, WI 53706
E-mail: martin.ganco@wisc.edu

Joseph Raffiee
Department of Management and Organization
Marshall School of Business
University of Southern California
701 Exposition Blvd., HOH 512
Los Angeles, CA 90089
E-mail: joe.raffiee@marshall.usc.edu

01/15/2018

ABSTRACT

We advance a knowledge-based theory of employee entrepreneurship that focuses on the nature of the employee idea. We examine how the structural uncertainty of the employee idea, firm-specificity of knowledge utilized in the idea, and dependence on the employer's complementary resources impact how the idea is commercialized and who appropriates the value from it. Using a formal model, we show that these three characteristics of the employee's invention interact in complex ways. In particular, we suggest that employees pursue spin-outs when their ideas are too uncertain to be contractible to other market participants, but sufficiently independent and non-firm specific that the employee is better off pursuing them on her own rather than commercializing them through the firm. Our model also predicts how the threshold values necessary to motivate the employee to pursue spin-outs change with the start-up costs the employee faces, the value of her idea, and the opportunity cost of the firm's internal resources. We offer an integrated and holistic theory of the commercialization of employee ideas as a function of the nature of those ideas, providing an alternate explanation for the incidence of entrepreneurial spin-outs, while linking work in this area to research on employee mobility, entrepreneurial action under uncertainty, and the knowledge-based view of the firm.

Introduction

Although small firms are often lauded as a key source of innovation and entrepreneurship (Elfenbein, Hamilton, & Zenger, 2010), a substantial number of innovative ideas are initially conceived by employees working in large and established organizations (Acs & Audretsch, 1988; Agarwal & Shah, 2014). There is considerable variation, however, with respect to how these ideas are brought to market. While some ideas are commercialized internally by the firm, others are exploited externally by employees through the creation of spin-out firms or by rivals via employee mobility (Gambardella, Ganco, & Honoré, 2014; Singh & Agrawal, 2011).[1] Scholarly interest in the formation of spin-outs, in particular, has grown considerably in recent years (e.g., Agarwal *et al.*, 2016; Campbell *et al.*, 2012b; Ganco, 2013), in part due to empirical evidence that indicates spin-outs represent a significant source of start-up activity and often outperform other types of new entrants (Muendler, Rauch, & Tocoian, 2012). For instance, Agarwal et al. (2004) find that spin-outs represent approximately 25% of start-ups in the disk drive industry and have increased chances of survival. Similarly, Klepper and Sleeper (2005) note that spin-outs represent around 40% of new entrants in the laser industry, Buenstorf and Klepper (2009) report that spin-outs account for north of 80% of start-up activity in the tire industry, and Gompers, Lerner, and Scharfstein (2005) document that nearly 50% of start-ups that received venture capital funding were founded by employees previously employed by publicly-traded organizations.

The empirical patterns in these studies point to a broader theoretical question which is central to the field of strategic management: Why are some employee ideas commercialized internally by the firm while others are exploited by employees outside the firm's boundaries – either

[1] Employee entrepreneurship or spin-out firms are defined as startups founded by individuals with prior work experience in the focal industry (Agarwal *et al.*, 2004). These startups do not have ownership ties to the parent firm which differentiates them from corporate spinoffs. However, prior literature often uses spin-out and spin-off interchangeably (e.g., Klepper & Sleeper, 2005).

through employee entrepreneurship or by a competitor via employee mobility? To answer this question, traditional economic models have focused on the strength and locus of property rights, arguing that employees launch spin-outs when inadequate property rights lead them to believe that disclosing their idea to their employer would result in expropriation (Anton & Yao, 1994, 1995; Pakes & Nitzan, 1983). While this argument is theoretically compelling, it is somewhat inconsistent with growing empirical evidence indicating that employees often disclose their ideas to their employers (e.g., Bhidé, 2003; Gambardella *et al.*, 2014) and opt to form spin-outs when the firm is uninterested in commercializing the employee's idea (Klepper, 2007; Klepper & Thompson, 2010).

Building upon the aforementioned studies, this paper develops a comprehensive theory that explains how an employee idea is likely to be commercialized *and* who captures the value created from the commercialization of that idea. Importantly, our theory differs from prior work in several ways. First, we refocus the discussion on the underlying nature of the employee idea in question. Our key argument is that some portion of the idea's true value will be structurally uncertain and therefore unverifiable until the idea is fully developed and commercialized (Foss *et al.*, 2008; Kaul, 2013; Knight, 1921). The structural uncertainty of entrepreneurial ideas means that, absent commercialization, the entrepreneur's judgment of the value of her idea is subjective and therefore non-contractible (Foss *et al.*, 2007; Klein, 2008) with other actors having different ex ante assessments regarding the idea's value (Klepper, 2007), and this will drive employees to pursue their ideas on their own, *i.e.*, through spin-out. Second, we argue that a portion of the structural uncertainty will arise from the fact that employee ideas are likely to incorporate at least some knowledge which is firm-specific. When ideas draw upon firm-specific knowledge, it increases the difficulty outside firms face in assessing the idea's value, thereby putting the focal firm at an advantage relative to rivals. By explicitly considering rival assessments of employee ideas, our model extends prior work by incorporating the notion that employees have the option to commercialize

their ideas within the context of rival organizations through employee mobility (Singh & Agrawal, 2011), thus allowing us to compare employee entrepreneurship not only to internal commercialization as prior work has typically done (e.g., Klepper, 2007), but also to employee mobility. Third, we consider the fact that some ideas will require the use of the firm's complementary resources for commercialization (e.g., Cassiman & Ueda, 2006). However, we shift our attention to the importance of understanding the firm-specificity of these assets – essentially the degree to which it is difficult and/or costly to replicate the resources outside of firm boundaries. We argue and show that when ideas *depend on* firm's complementary resources that are difficult to obtain and/or develop in factor markets, it increases the firm's bargaining power and therefore allows the firm to expropriate a portion of the value created from the idea. Interestingly, because the firm may be able to claim this value regardless of how the employee idea is brought to market, we argue that dependence of complementary resources need not always constrain employee exit; in fact, there may be situations where the firm may actually prefer that the idea is commercialized outside of the firm's boundaries.

Our approach to theoretical development is twofold. First, focusing our attention on the structural uncertainty of the idea, the firm-specificity of knowledge utilized in the idea, and the degree to which the idea relies on complementary resources controlled by the firm, we develop a set of simple baseline propositions to explain how these factors influence the means by which ideas are brought to market. Second, we formalize our arguments into a model of the commercialization choice of an employee who comes up with an innovative idea while working in an established organization. The model does not simply formalize the baseline propositions; it allows us to explore the relationships between structural uncertainty, firm-specific nature of knowledge, and dependence on complementary resources, showing that these three factors interact in complex ways, and allowing us to develop a more nuanced set of predictions regarding when our baseline propositions

will and will not hold. Moreover, the model not only explains the means by which ideas are brought to market, it also predicts *who* captures value from the commercialization of these ideas. As in prior work (e.g., Kaul, 2013; Zott, 2003), we chose this layered approach because it allows us to develop and explore our theory in a multi-method fashion while improving external validity, internal consistency, and increasing accessibility to a broader set of scholars.

Based on the model, our core theoretical argument is that spin-outs are associated with employee ideas that have high structural uncertainty. When uncertainty is low, the employee is better off contracting with an existing firm for the commercialization of her idea, with the terms of the contract being determined by the market, and the choice between her current employer and a rival firm being driven the firm-specificity of the employee's idea; in such cases, employees have little to gain from spin-outs. When uncertainty is high, however, spin-outs may be the only means for an employee to appropriate at least some part of the rents from her invention, though this may only be feasible for ideas that are relatively independent of her employer's complementary resources, and only preferable if the firm-specificity of her idea is too low for her employer to value it. Spin-outs are thus seen as the commercialization mode of last resort for the employee, one she will only pursue if a combination of high uncertainty and low firm-specificity means that better offers are not available, but that is still preferable to the case where high dependence on her employer leaves the employee unable to appropriate any value from her invention.

This paper makes several contributions to the extant literature. We contribute to the employee entrepreneurship literature by developing a model which offers a novel knowledge-based explanation for employee spin-outs, highlighting the complex effects of the idea's structural uncertainty, firm-specificity of knowledge, and dependence on firm's complementary resources. In particular, while extant work has argued that disagreements drive the creation of spin-outs (Klepper & Thompson, 2010), we show that general asymmetries in the evaluation of ideas may not be

sufficient to generate employee entrepreneurship because the degree to which the ideas relies on firm-specific complementary resources will impact the feasibility of spin-outs and the distribution of value created. In doing so, our theory provides a more holistic model of commercialization of employee ideas which focuses on value capture in addition to value creation and incorporates the possibility that ideas can be exploited in rival firms through employee mobility (cf. Cassiman & Ueda, 2006). By focusing on the characteristics of the idea itself, our model allows for the integration of prior models into a single framework which can be extended to incorporate, for example, property rights (Anton & Yao, 1995) and/or economies of scope and cannibalization (Campbell & Franco, 2013; Cassiman & Ueda, 2006), which function as moderators in our framework. Thus, we contribute by developing a first-order theory that allows for the integration of prior work into a single framework that is internally consistent. Finally, our theory contributes to knowledge-based theories of competitive advantage (Coff, Coff, & Eastvold, 2006) by explaining how firm-specific knowledge and complementary resources allow firms to profit from and prevent the leakage of employee ideas while also providing a novel explanation for the counterintuitive idea that, under certain conditions, firms can benefit from employee mobility and entrepreneurship (cf. Agarwal *et al.*, 2016; Campbell *et al.*, 2012b; Wezel, Cattani, & Pennings, 2006).

The commercialization of employee ideas

Employee ideas are brought to market in various ways. The idea may be commercialized internally by the employee's employer (Cassiman & Ueda, 2006), exploited by the employee via employee entrepreneurship, (Agarwal *et al.*, 2004), or exploited by rival firms through inbound employee mobility (Rao & Drazin, 2002).[2] Understanding why some ideas are commercialized by firms

[2] Employees can also sell or license their ideas in technology markets (Gans & Stern, 2003). However, we focus on ideas in which the employee and idea are inseparable, *i.e.*, that the employee's tacit understanding of the idea and its mechanics

whereas others are exploited by employees outside firm boundaries has become a key question in the strategy literature. This is particularly so because employee ideas conceived within but exploited outside of firm boundaries tend to be successful (Chatterji, 2009), may deplete the firm's existing knowledge base (Agarwal, Ganco, & Ziedonis, 2009), and can have negative implications for parent firm performance (Campbell *et al.*, 2012b). Indeed, if employee ideas are in fact viable, then what explains why these ideas are not exploited by the firm itself? To answer this question, a number of theorists have sought to explain the mode by which employee ideas are brought to market, typically focusing on the distinction between internal commercialization and employee entrepreneurship (e.g., Anton & Yao, 1994, 1995; Cassiman & Ueda, 2006; Hellmann, 2007; Klepper, 2007). Our theory complements this work by shifting the focus to the nature of the employee idea itself and develop a comprehensive framework which allows us to explain how ideas are commercialization and who captures value from these ideas. To do so, we focus on three key constructs: 1) the structural uncertainty of entrepreneurial ideas, 2) firm-specific nature of knowledge used in the idea, and 3) the dependence on the firm's complementary resources to commercialize the idea. We introduce these constructs in the following sections and develop theoretical propositions regarding their baseline relationship with commercialization mode. We then formalize these baseline predictions into a simple model where we examine the interactive effects as well as the distribution of value appropriation.

Structural uncertainty of employee ideas

There is extensive work in the entrepreneurship literature which focuses on the subjective nature of entrepreneurial ideas (Foss *et al.*, 2008; Kaul, 2013; Klein, 2008; Knight, 1921).[3] A key

are needed to effectively bring the idea to market (Coff *et al.*, 2006). This means that employees will face significant frictions selling their idea in technology markets, and so the market option becomes employee mobility.

[3] The notion of subjectivity of entrepreneurial judgement is related to entrepreneurial over-optimism (e.g., Busenitz & Barney, 1997; Camerer & Lovallo, 1999; Forbes, 2005; Wu & Knott, 2006). From the perspective of the observed outcome (e.g., mobility vs. entrepreneurship), a biased belief about own entrepreneurial idea will have the same effect as an unbiased one. The differences between the biased and unbiased beliefs will emerge in the ex post value realized by

feature of entrepreneurial ideas is that they involve structural uncertainty – ex ante the distribution of potential outcomes and therefore value of the idea is unknown and cannot be statistically or analytically determined (Knight, 1921; LeRoy & Singell Jr, 1987). As a result, the value of the idea is not fully contractible ex ante (Grossman and Hart, 1986; Hart and Moore, 1990), and its value can only be resolved through entrepreneurial action which fully develops and commercializes the idea (Kaul, 2013), or, as Klein (2008: 181) notes, "opportunities for entrepreneurial gain are, thus, inherently subjective – they do not exist until profits are realized". This structural uncertainty associated with entrepreneurial ideas means that the employee's judgement about her idea is inherently subjective (Foss *et al.*, 2008) and may diverge from the beliefs of the firm (Gambardella *et al.*, 2014; Klepper & Thompson, 2010) as well as from the beliefs of other firms (Ganco, Ziedonis, & Agarwal, 2014; Kim & Marschke, 2005).

The degree to which structural uncertainty leads to potential disagreements, however, will depend on *how* uncertain the idea is. As researchers have argued, the subjectivity is a critical element of entrepreneurial judgement under "uninsurable" uncertainty (Foss, Foss, & Klein, 2007a; Foss *et al.*, 2008). That is, in some cases, employees will develop ideas that will tend to be less uncertain, will utilize building blocks that are readily available on the market or have less complex design and therefore are less subjective than others. When uncertainty is low, the ex ante value of the idea is less uncertain and therefore various actors will be more likely to converge on an estimated value (McMullen & Shepherd, 2006). Conversely, ideas which are more uncertain—e.g., ideas which push the technology frontier forward—will be subject to greater variance in ex ante assessments and therefore greater potential for disagreement between employees and firms (both the focal firm and rival organizations). Disagreement between rivals and the employee should decrease the

different parties. We remain agnostic about whether the entrepreneur's belief is biased or not in our theoretical development but we will return to this issue in our model and in the discussion section below.

attractiveness of employee mobility and disagreement between the employee and firm should decrease the chances that the firm is interested in commercializing the idea. As a result, these are the precise situations where opportunities for profit tend to be greatest, as profit is the reward of "anticipating the uncertain future more accurately than other "(Klein, 2008 : 180). Therefore, we propose:

> *Baseline proposition 1: The likelihood an employee idea is commercialized through employee entrepreneurship rather than through internal commercialization or employee mobility increases with the structural uncertainty associated with the idea.*

Firm-Specificity of Knowledge

Thus far, we have said nothing about the source of the structural uncertainty surrounding the entrepreneurial idea; consistent with the existing literature (Foss *et al.*, 2007; Klein, 2008; Kaul, 2012), we have simply assumed that some level of structural uncertainty exists. One reason entrepreneurial inventions may be hard to objectively value, however, is that they are the product of the idiosyncratic mind of the inventor, *i.e.*, they draw on knowledge and experiences that are unique to the inventor, making it difficult for others, who do not share the same perspective, to judge them in the same way (until they are commercialized and observed in action). This, in turn, has important implications for the case where the inventor is also the employee of an established firm. To the extent that employee ideas are a result of a recombinant process (Fleming, 2001; Schumpeter, 1934), then ideas conceived within the context of an established firm are likely to draw upon, recombine, and utilize at least some knowledge which is internal to the firm and therefore firm-specific (Jaffe, Trajtenberg, & Henderson, 1993). When employee ideas utilize firm-specific knowledge it puts rival firms at a disadvantage relative to the focal firm in terms of evaluating the merits of the idea. This is simply because the rival firms will, by definition, be less familiar with firm-specific knowledge (Coff *et al.*, 2006), and so their ability to accurately estimate the future value of the idea will be inferior to

the focal firm which has presumably accumulated firm-specific knowledge that rival firms cannot access (Foss *et al.*, 2008). Indeed, as work in the knowledge-based tradition has long argued, knowledge is a key strategic resource (Grant, 1996) precisely because the difficulty of transferring and communicating knowledge across firm boundaries (Kogut & Zander, 1992) leads to knowledge asymmetries between the firm and its rivals (Coff *et al.*, 2006; Dierickx & Cool, 1989). Thus, when employee ideas build on firm-specfic knowledge, it should result in tighter coupling of idea valuation between the employee and employer relative to the employee and rival firms.

That said, although greater firm-specificity of knowledge should make the firm closer in its assessment of an idea to the employee relative to the assessments of competitiors, the evaluation gap between the employee and the firm may remain (Coff & Raffiee, 2015; Raffiee & Coff, 2016). This is because the subjective nature of entrepeneurial judgement can still lead to differences in idea valuation between the employee and firm; even if an idea draws on firm-specific knowledge, there may still be within-firm knowledge asymmetries (Coff, 2010). Accordingly, while the firm should have an advantage in assessing the value of the employee's idea relative to rivals, there may still be (substantial) disagreement between the employee and firm (Klepper, 2007). Nevertheless, the firm-specificity of knowledge should play a key role in determining how employee ideas are brought to market. As firm-specificity of knowledge rises, the firm will be more likely to see the value of the employee's idea and therefore be interested in potential internal commercialization. In contrast, when firm-specificity of knowledge is low, the firm has no inherent advantage in assessing the idea relative to rival firms in the market. This makes mobility a more credible option. At the same time, the lack of firm-specific knowledge also means that the probability of disagreement between the employee and firm regarding the idea value rises, which, in turn, can make employee entrepreneurship a more attractive option (Klepper, 2007). Thus, we propose the following:

Baseline proposition 2: The likelihood that an employee idea is commercialized internally by the firm rather than through employee entrepreneurship or employee mobility increases when the idea draws upon knowledge which is firm-specific.

Dependence on Firm's Complementary Resources

For the very same reasons that ideas birthed in the context of established organizations are likely to draw on knowledge which is firm-specific, these ideas are also likely to utilize complementary resources possessed by the firm for commercialization (Kaul, 2013). In some situations, the complementary resources will be widely available or relatively easily attainable in factor markets (e.g. capital requirements, office space, etc.). In other situations, however, employee ideas may require, or be more valuable when combined with, complementary resources that are firm-specific in the sense that they are controlled by a single firm (Coff *et al.*, 2006) or would be costly and/or difficult to purchase and/or replicate in factor markets (Campbell *et al.*, 2012b). For example, an employee idea may be most valuable when combined with a firm's unique distribution system (Campbell, Coff, & Kryscynski, 2012a), supplier networks (Dyer & Hatch, 2006), or an efficient "activity system" comprised of many interdependent activities (Siggelkow & Levinthal, 2003) to create value[4]. The greater the need for firm-specific complementary resources, the greater the firm's ability to capture value from the idea, since such resources may be difficult for others (including entrepreneurial start-ups) to develop or imitate (Barney, 1991). In fact, if the employee's idea is highly reliant on the firm's complementary resources then the employee may find it challenging (or impossible) to commercialize her idea without the cooperation of the firm (Kaul, 2013). As a result, a greater dependence on firm's complementary resources puts the firm in the driver's seat in terms of determining how the idea

[4] Again, note that dependence on firm's complementary resources does not necessarily imply that the resources cannot be acquired or developed at all. It just implies that it may be prohibitively costly or time intensive to acquire such complementary resources (Barney, 1986; Dierickx & Cool, 1989). The parameter of dependence on firm's complementary resources that we incorporate into our theoretical model may be thought of as a proxy of these costs.

ultimately comes to market. If the firm sees value in the employee's idea then they have the complementary resources required to commercialize it. If the firm does not see value in the idea, they still control the assets required to commercialize it which means they can expropriate the employee if she launches a start-up or a rival firm if the employee moves to one (Kaul, 2013). In contrast, if the idea does not require firm's complementary resources, then the employee has no inherent need for firm cooperation and external options may become more feasible and attractive. Together, this discussion leads to the following prediction:

Baseline proposition 3: The likelihood that an employee idea is commercialized internally by the firm rather than through employee entrepreneurship or employee mobility increases when the idea depends on parent firm's complementary resources.

The Model

The discussion above allowed us to develop basic propositions that suggest that the means by which employee ideas are commercialized and brought to market will be influenced by the structural uncertainty embedded within the idea, firm-specificity of knowledge utilized in the idea and the degree to which the commercialization of the idea depends on firm's complementary resources. Having articulated these general relationships, we now proceed to develop a simple model of the commercialization choice of an employee who comes up with an innovative idea while working in an established organization. The model formalizes the logic developed above and allows us to examine the interactive effects of our key constructs, thereby adding refinement to our baseline propositions and revealing a number of additional insights.

Basic assumptions

Consider an employee who has an idea for a Schumpeterian invention, *i.e.*, a recombination of existing resources in a way that generates value in excess of the value of those resources in their

current use (Schumpeter, 1934). The employee's assessment of the value of the invention—the net present value of the cash flows it is expected to generate—is V and the value of the resources being recombined to create the invention in their (best) current use is C. Thus, the employee believes her invention has the potential to generate economic rents equal to $V - C \equiv \tau V$ where $\tau = \frac{V-C}{V}$ is a measure of the value added by the invention. Clearly, the invention is only worth pursuing if $\tau > 0$. Unlike prior work that has focused on weak property rights in explaining spin-outs (Anton & Yao, 1994, 1995, 2002; Franco & Filson, 2006; Pakes & Nitzan, 1983), we assume that the employee's property rights in her invention are secure, *i.e.*, she has full rights over her idea to start with, and can choose to either sell them to someone else or retain them for her own use.

While the employee believes her invention will generate cash flows equal to V, this belief may not be shared by all. In particular, we assume that only some fraction $1 - \mu$ of this value can be convincingly demonstrated either analytically or statistically ex ante, *i.e.*, before the invention is commercialized (Kaul, 2013; LeRoy & Singell Jr, 1987), where $1 \geq \mu \geq 0$ is thus a parameter reflecting the structural uncertainty associated with the employee's idea (Dequech, 2006; Knight, 1921; Langlois, 1992). The value V thus reflects the subjective judgment of the employee (Foss *et al.*, 2007b; Foss *et al.*, 2008), and only the portion of this value that is not uncertain in that it can be objectively verified (Knight, 1921; LeRoy & Singell Jr, 1987), *i.e.*, $V(1 - \mu)$ can be contracted for ex ante (Kaul, 2013; Klein, 2008). We can thus divide the potential rents from the invention into two parts: a Kirznerian rent that reflects the value of the invention as instantly evident to others (Kirzner, 1985) and can be immediately claimed through market contracts, equal to $V(1 - \mu) - C$; and a Knightian rent, equal to μV, that remains uncertain till the invention is commercialized[5]

[5] In our main analysis below, we assume that the employee's judgment of the value of her idea is accurate, though we discuss the implications of relaxing this assumption. Note that in so far as the employee's decisions are driven by her beliefs, the outcomes of the model with respect to how the idea will be commercialized are unchanged even if we

(Knight, 1921), and must therefore be claimed as the residual value by whomever commercializes the invention (Kaul, 2013; Klein, 2008). Clearly, if $V(1-\mu)-C \leq 0 \Rightarrow \mu \geq \tau$ then the objective ex ante assessment of the employee's idea is negative, and all potential rents are Knightian.

Given the uncertainty around her idea, and the resulting incompleteness of ex ante contracts, one option for the employee is to commercialize the idea on her own[6], retaining the property rights in the idea (Foss & Foss, 2005; Grossman & Hart, 1986; Hart & Moore, 1990), and hoping to capture the full value of the rents generated as the residual claimant (Kaul, 2013; Klein, 2008). Doing so, however, would require the employee to incur additional start-up costs of establishing her own firm $S \geq 0$. These start-up costs may include the administrative and regulatory costs of establishing a new enterprise (Djankov *et al.*, 2002), the higher cost of capital faced by the entrepreneur (Evans & Leighton, 1989; Jacobides & Winter, 2007), or the organizational costs of forming a new business[7] (Kaul, 2013). Whatever their source, these costs limit the employee's ability to capture the Knightian rents associated with her invention through entrepreneurship, *i.e.*, by retaining the property rights to her invention and commercializing it herself in order to claim residual value (Klein, 2008; Sautet, 2002). In the absence of such costs, the employee would always choose the entrepreneurship option (Kaul, 2013); conversely, if the costs are high enough, entrepreneurship may be infeasible, and the employee's best option may be to contract for the Kirznerian rent from her invention, leaving the remaining value to be appropriated by others.

Thus far, we have focused on value of the employee's invention, and its uncertain nature, without paying much attention to the firm in which she is employed; in other words, we have been

assume that the employee's belief is incorrect; all that changes with incorrect beliefs is the distribution of value among the various parties involved.

[6] Note that the contract incompleteness associated with uncertainty also rule out the possibility of the employee putting up a bond to incentivize her employer to commercialize the invention (Anton & Yao, 1994); an employee who did so would be exposed to potential hold-up by an opportunistic employer.

[7] Note that if the employee receives some private benefit from starting a business, e.g., if she derives positive utility from being her own boss, this would tend to reduce S, though for our purposes we assume that S is strictly non-negative.

thinking of her as just another inventor, without considering the implications of her being an employee. The employee's current employer (henceforward, the firm) has a special relationship with her in at least three ways. First, as discussed above, some part of the value of the employee's invention may depend upon the use of the firm's complementary resources; in particular, we assume that the value of the employee's invention is reduced by a fraction $1-\beta$ if the invention is commercialized without the use of the firm's complementary resources, where $1 \geq \beta \geq 0$ is thus a parameter measuring the level of independence of the employee's invention from the complementary resources of her employer, with the invention being entirely independent where $\beta = 1$ and entirely dependent where $\beta = 0$. It follows that the firm will always claim a fraction $1-\beta$ of the total rents generated by the invention, irrespective of how it is commercialized; even if the invention is commercialized outside the firm, the firm may always contract out for the use of its complementary resources (for simplicity, we assume that there are no transaction costs of doing so) in a way that allows it to claim that fraction of the invention's value[8]. Alternatively, given sufficient modularity, the commercialization of the invention could simply raise the value of the firm's resources as a result of complementarities (Arora & Nandkumar, 2012).

Second, the firm may share some part of the employee's judgment about the value of the invention; specifically, we assume that the firm believes the invention will generate cash flows worth $V(1-\mu(1-\rho))$, where $1 \geq \rho \geq 0$ is a parameter reflecting the extent to which the knowledge used to generate the invention is firm-specific. As discussed above, the intuition behind this assumption is that part of the uncertainty surrounding an invention derives from the idiosyncratic nature of the inventor's knowledge base, which causes her to have a unique judgment of the

[8] In that sense, we can think of β more generally as the bargaining power of the employee relative to her employer. While we focus on the role of complementary resources in driving this bargaining power, our base model could be extended to include the effect of weak property rights (Anton & Yao, 1995; Luo, 2014), as a factor driving down β.

invention's value. For inventors who are also employees, some part of the knowledge base they draw on will be specific to the firm at which they are employed, with the result that the firm may share some part of the employee's perspective on her invention, and therefore her judgment of its value. In particular, the more that the invention draws on knowledge that is specific to the firm, the greater the convergence between the employee's belief about its value, and the judgment of the firm. In the extreme, if $\rho = 1$, then the firm's valuation of the idea is identical to that of the employee's[9]. Conversely, if $\rho = 0$, then the firm has no special understanding of the employee's idea and shares the general assessment of its value. We assume that ρ is strictly non-negative, however, meaning that the firm is never at a disadvantage in evaluating the inventions of its employees.

Third, we account for the possibility that the opportunity cost of resources within the firm may be higher than those of resources available through the market. The intuition for this assumption goes back to the well-established idea that internal resources—specifically resources that may be general enough to serve many purposes but are constrained in terms of total capacity—determine the limits to firm growth (Levinthal & Wu, 2010; Penrose, 1959). Given a limited supply of internal managerial and financial resources in the short-run, the firm must evaluate its investments more carefully, since investments in commercializing one invention may come at the cost of other potentially valuable investments in the future (Cassiman & Ueda, 2006). Thus, the hurdle rate that the firm must apply to its internal projects may need to be higher than that applied by the market, given the high opportunity costs of using internal resources that are specialized to the firm, though not specialized to the invention itself. This is simply a numbers game: the focal firm may be subject to some constraints, which, probability suggests, at least some rivals will not. We model this by assuming that the opportunity cost of resources if commercialization is undertaken

[9] Again, while we focus on firm-specificity as the driver of the difference between the firm's valuation and that of its employee, our model is easily extended to incorporate other factors that might drive a wedge between employee and firm valuations (e.g., Klepper & Thompson, 2010), with greater differences in valuation being captured by lower ρ.

internally is $C(1+r)$, where $r \geq 0$ is a parameter reflecting the higher opportunity cost[10] associated with internal commercialization (Cassiman & Ueda, 2006). We would expect r to be higher, the stronger the firm's capabilities, and therefore the more valuable the other investment opportunities the firm was considering, as well as for firms with limited slack managerial or financial resources to invest in new areas (Kaul, 2012; Levinthal & Wu, 2010).

Model set-up

Given the assumptions outlined above, we can model the employee's choice regarding how to commercialize her invention. Specifically, we consider that the employee has three alternatives—establish her own start-up (the 'spin-out' option), contract[11] with her existing employer to commercialize the invention internally (the 'firm' option), or move to her employer's next best rival[12], taking the invention with her in exchange for a contract from her new employer (the 'rival' option)—and will choose the one that offers her the highest value[13]. We model a three-stage process through which the employee arrives at her decision.

In the first stage, the employee reveals her idea to the rival[14], and asks the rival to make her an offer for the rights to commercialize it. The rival, faced with potential competition from other firms (including the employee's current employer) makes the maximum offer it can make given its (objective) assessment of the invention's value, as well as the share of that value it can hope to

[10] As an extension to the main model, we consider the case where the employee's invention potentially cannibalizes the firm's sales as the case where $0 > r \geq -1$, reflecting the fact that in such cases the firm's existing resources may be worth less if the invention is commercialized by someone else, making it more valuable to the firm.
[11] This may take the form of a separate contract for the development of the invention within the firm (as a kind of internal venture), or it may simply be an enhanced wage contract with the incremental increase in the employee's wage reflecting the additional value created by her invention.
[12] As discussed above, we assume that the partially tacit nature of the invention makes it inseparable from the inventor, so that the inventor cannot simply sell her invention to a third party through the market for ideas (Gans, Hsu, & Stern, 2002; Gans & Stern, 2000, 2003). Relaxing this assumption would in no way change our results, except to replace employee mobility with sale to the market.
[13] We assume that other things being equal, the employee will always prefer to stay in current employment, *i.e.*, she will only move if she has more to gain from the rival or spin-out than from the firm.
[14] In practice, this may involve revealing her idea to the entire market, since the identity of the relevant rival may not be known ex ante.

appropriate given its dependence on the current employer's current assets. Thus, it makes an offer $\psi_r = \max(0, \beta(V(1-\mu) - C))$. Clearly, if $\mu \geq \tau$ the rival will see no value in the invention and will therefore not make an offer.

In the second stage, the employee then takes the offer (if any) she receives from the rival and asks the firm to make her an offer. The firm then evaluates two things. First, it considers whether, based on its assessment of the invention's value, the employee's best outside option is the rival's offer or a spin-out, *i.e.*, it evaluates whether $\beta\big(V\big(1-\mu(1-\rho)\big) - C\big) - S \geq \psi_r$. Next, it determines its own best offer in light of what it considers to be the employee's best outside option. Specifically, if it thinks the employee will prefer the rival's offer to the spin-out option, it evaluates whether it is better off matching the rival's offer and commercializing the invention internally, resulting in an expected net gain to it of $V\big(1-\mu(1-\rho)\big) - C(1+r) - \psi_r$, or simply letting the rival commercialize the invention and appropriating the value that accrues to its complementary resources, which it expects to be equal to $(1-\beta)(V\big(1-\mu(1-\rho)\big) - C)$, and chooses the option that gives it the greater return. Conversely, if it believes that the employee's best outside option is a spin-out, then it tries to motivate the employee to stay by making her the best offer it can without incurring a net loss to itself, *i.e.*, it makes an offer $\psi_f = V\big(1-\mu(1-\rho)\big) - C(1+r) - (1-\beta)\big(V\big(1-\mu(1-\rho)\big) - C\big) = \beta\big(V\big(1-\mu(1-\rho)\big) - C\big) - Cr$. Note that in this case the firm offers the employee more than what it believes the employee's best outside option to be, *i.e.*, $\beta\big(V\big(1-\mu(1-\rho)\big) - C\big) - S$, because it knows from experience that employees tend to value their inventions higher than it does, so that offering the employee what it believes to be the value of

her spin-out option will invariably result in her leaving, and the firm would rather have an employee stay rather than leave so long as it is no worse off as a result[15].

Finally, the employee compares her employment options with her assessment of the value of the spin-out option, which is given by $\psi_s = \beta(V - C) - S$. If $\psi_s \leq \psi_r$, then she accepts an employment offer from the rival if only the rival offers ψ_r, or enters into a contract worth ψ_r for internal commercialization with her current employer if the firm matches the rival offer. If $\psi_r < \psi_s \leq \psi_f$, she accepts her current employer's offer of ψ_f (provided the firm makes such an offer) to commercialize the invention internally. And if ψ_s is greater than the firm's best offer (either ψ_r or ψ_f, depending on the case), then she chooses to pursue the entrepreneurial option of spinning-out to starting her own firm.

Commercialization mode choice

Given the basic assumptions and decision rules laid out above, we can now derive a set of results regarding the employee's choice of commercialization mode. We begin by considering the case where $\psi_s > 0$, *i.e.*, spin-outs are feasible in that the employee expects to earn at least some profit by pursuing the entrepreneurial option. Intuitively, this will be the case where the employee's invention is independent enough of the firm, so that she can appropriate enough value from the invention ex post to cover the start-up costs associated with establishing her own business. More specifically, we can define $\bar{\beta} = \frac{S}{\tau V}$ as the minimum level of independence for spin-outs to be feasible such that $\beta > \bar{\beta} \Rightarrow \psi_s > 0$. In this case, the employee evaluates her employment options (either with the rival or the firm) keeping in mind that she always has the alternative of starting her own

[15] Admittedly, this is a somewhat generous assumption, but the model could easily be modified to incorporate a more equitable sharing of what the firm believes to be the excess value from internal commercialization between itself and the employee without materially changing the basic pattern of our results.

firm. Figure 1a shows her choice of commercialization mode as a function of structural uncertainty (μ) and firm specificity (ρ) in this case.

Insert Figure 1a about here

To begin with, take the case where uncertainty is low. Given low uncertainty, the employee will prefer moving to a rival to starting a spin-out, because in doing so she will not incur additional start-up costs, and will still be able to appropriate a substantial portion of the value of her invention, given the relative completeness of the contract. Specifically, we can define $\bar{\mu} = \frac{S}{\beta V}$ as the minimum threshold of uncertainty for entrepreneurship, such that $\mu \leq \bar{\mu} \Rightarrow \psi_s \leq \psi_r$. When uncertainty is below this threshold, the employee has no incentive to pursue entrepreneurship and will either choose to accept an offer from her current employer if it makes one, or move to a rival if her employer is not interested. The employer's interest in turn depends on the firm-specificity of the idea and its resulting assessment of the invention's value—if that assessment is high enough relative to the rival's offer to offset the greater opportunity costs of internal commercialization, the firm will match the rival's offer, else it will allow the employee to move to the rival and wait for the value of its complementary resources to increase. Specifically, we can define $\bar{\rho} = \frac{Cr}{\mu\beta V}$ as the minimum level of firm-specificity for the firm to match the rival's offer. Thus, given low dependence on complementary resources and low uncertainty, the employee will move to a rival if $\rho < \bar{\rho}$ (Case Ia in Figure 1a), and prefer internal commercialization if $\rho \geq \bar{\rho}$ (Case IIa). Note that in either case, the employee accepts an offer equal to ψ_r. Note also that for extremely low values of uncertainty—where $\mu < \frac{Cr}{\beta V}$—the firm never chooses to match the rival's offer and employee mobility is always the result. In other words, with low enough uncertainty, market outcomes are always preferred.

Next, consider the case where $\mu > \bar{\mu} \Rightarrow \psi_s > \psi_r$, *i.e.*, the employee prefers the spin-out option to the rival's offer. In this case, the employee compares the value of the spin-out option to

the firm's offer, and chooses to start her own firm if the firm's offer falls short. This can happen for one of two reasons. On the one hand, it may be that the firm (incorrectly) believes that the employee's best outside option is the rival's offer, and therefore continues to try and match that offer (*i.e.*, it offers ψ_r), prompting the employee to leave. This would be the case so long as $\rho < \dot{\rho}$, where $\dot{\rho} = \frac{\bar{\mu}}{\mu}$ is the level of firm-specificity below which the firm incorrectly assesses the employee's best outside option. On the other hand, it may be that the firm (correctly) realizes that the employee's best outside option is a spin-out, and accordingly offers the employee ψ_f, but this offer proves too low for the employee. This would be the case where $\rho < \hat{\rho}$, where $\hat{\rho} = 1 - \frac{(S-rc)}{\mu\beta V} = 1 - \dot{\rho} + \bar{\rho}$ is the minimum level of firm-specificity required for the firm to value the idea enough to offer the employee more to stay than she could make by setting up her own firm. Note that $S < rC \Rightarrow \hat{\rho} > 1$, meaning that if the opportunity cost of using the firm's internal resources is greater than start-up costs of the entrepreneur, the firm will never outbid the spin-out option; the intuition being that in such cases a spin-out is fundamentally more efficient than internal commercialization. Taken together, these conditions imply that, given low dependence on complementary resources and high uncertainty, the employee prefers spin-out so long as $\rho < \max(\dot{\rho}, \hat{\rho})$—Case III in Figure 1a—and internal commercialization in response to an offer equal to ψ_f by the firm otherwise (Case IV in Figure 1a). Note that the U-shape of the line dividing Case III and Case IV in the figure is a reflection of the two different processes driving spin-out. So long as spin-outs are chosen because the firm does not realize that the rival's offer is too low, the threshold for spin-outs is defined by $\dot{\rho}$, which is decreasing in μ—as uncertainty increases, the level of firm-specificity required for the firm to undervalue the employee's spin-out option falls. Once $\hat{\rho}$ comes to dominate $\dot{\rho}$, however, the problem is not that the firm thinks the value of the spin-out to the employee is too low, bur rather that it thinks the value of internal commercialization to itself is too low. In this case, the threshold

for spin-outs is defined by $\hat{\rho}$, which is increasing in μ—as uncertainty increases, the level of firm-specificity required for the firm to believe in the value of commercializing the invention internally rises.

Next, let us consider the case where $\beta \leq \bar{\beta}$, *i.e.*, where the invention relies too heavily on the complementary resources of the firm for the employee to viably pursue commercialization on her own. This case in shown in Figure 1b, which again plots the commercialization outcomes as a function of structural uncertainty (μ) and firm-specificity (ρ), just as in Figure 1a.

For low levels of uncertainty, Figure 1b looks largely similar to Figure 1a. This is because, as before, with low uncertainty the rival's offer dominates the spin-out option. In this case, however, because the spin-out option is not feasible, any offer the rival makes is the best outside option available to the employee, and the relevant uncertainty threshold is thus the one above which the rival no longer sees any value in the invention (and therefore no longer makes an offer). This threshold occurs when $\mu = \tau$, the simple intuition being that the rival no longer sees any value in the invention once the value it creates is less than the uncertainty associated with it. For values of uncertainty below this threshold, we see the familiar outcome, with the employee choosing to move to the rival if it is the only one to make her an offer (Case Ib), which is the case so long as $\rho < \bar{\rho}$; and opting for internal commercialization if the firm matches the rival's offer (Case IIb), which occurs if $\rho \geq \bar{\rho}$.

Once uncertainty rises above the point where the rival sees value in the invention (*i.e.*, where $\mu \geq \tau$), the employee has essentially no viable outside option, and therefore no viable way to appropriate any rents from her invention. Whether the invention is commercialized at all depends, in this case, on whether it is firm-specific enough for the firm to see value in it. If this is the case, specifically if $\rho \geq \underline{\rho}$ where $\underline{\rho} = 1 - \frac{\tau}{\mu}$ is the minimum level of firm-specificity required for the firm

to see value in the employee's invention, then the firm will commercialize the invention, though the employee may appropriate no value from this commercialization, with the firm capturing all the value (Case VI in Figure 1b). Where even the firm does not see the value in the employee's invention, the idea will be abandoned entirely, with the employee having no way to bring the invention to market (Case V in Figure 1b). Note that the line dividing Case V and Case VI in Figure 1b is strictly rising in μ—the greater the uncertainty regarding the idea, the greater the level of firm-specificity required to offset that uncertainty to allow the firm to recognize any value in the idea.

Insert Figure 1b and Table 1 about here

Value creation and value appropriation

The various cases described above are summarized in Table 1, which shows how the way in which the employee's invention is commercialized varies with levels of independence from firm's complementary assets (β), structural uncertainty (μ), and firm-specificity of knowledge utilized in the idea (ρ). In addition to defining the mode of commercialization, the model also allows us to specify the overall value created by the idea, as well as how that value is shared between the various parties, and Table 1 summarizes these results as well. Note that in deriving these results we assume that the employee's judgment about the value of her invention is correct; if that were not the case, the results in Table 1 regarding commercialization mode would remain unchanged (since all parties would still make decisions based on their ex ante beliefs), but the ex post sharing of value between the parties would change.

First, consider value appropriation by the employee. As Table 1 shows, in cases with low uncertainty (*i.e.,* Cases I and II), the employee appropriates value $\psi_r = \beta(V(1-\mu) - C)$. In other words, she captures the Kirznerian rents from her invention, less the share of its value owed to her current employer for the use of its complementary resources. While this is generally less than the value created by the employee's idea, it is worth noting that in the low uncertainty case the

Kirznerian rents may represent a substantial portion of the value created by the invention, especially when its dependence on complementary assets is low. In fact, the employee's potential gain is highest for extremely low levels of uncertainty, where essentially all of the value from her invention is ex ante contractible. As structural uncertainty rises, the employee's ability to expropriate the value of her invention generally falls. In particular, in the case with high uncertainty and low firm-specificity, the best that the employee can hope for is to appropriate $\psi_s = \beta(V - C) - S$ by undertaking a spin-out (Case III), which serves as a floor for employee appropriation. While in this case the employee captures both the Kirznerian and Knightian rents from her invention independent of the firm's complementary resources, the total value created is lower because of the positive start-up costs associated with setting up her own business. In essence then, the employee's decision to pursue a spin-out is essentially her choice to pursue Knightian rents at the expense of additional start-up costs, a choice she makes only if the other alternatives available to her are inadequate. In fact, given high uncertainty (and low dependence on complementary resources), the employee is generally better off with high firm-specificity (Case IV), which allows her to appropriate ψ_f, *i.e.* she receives both the Kirznerian rents from her invention, as well as a share of the Knightian rents corresponding to the firm-specific parts of its value, without having to incur start-up costs. Spin-offs are thus seen as a last resort—a way for the employee to capture at least part of her invention even when it is too uncertain and not sufficiently firm-specific to be valued by anyone else. So long as spin-offs are feasible however, outcomes for the employee are positive. Though she never truly captures the full value of her invention, she generally benefits substantially from its commercialization.

In contrast, where both the dependence on firm complementary resources and structural uncertainty are high, Table 1 shows that the employee gains essentially nothing from her invention. This is because both of the employee's potential outside options are ruled out in this case—the spin-

out option by the lack of the invention's independence, and the mobility option by the high uncertainty—leaving the employee with no real recourse to appropriate the value from her invention. The employee is thus largely indifferent between Case V and Case VI, *i.e.*, it makes little difference to her whether her invention is commercialized by the firm or not, because even if it were commercialized, she would be unlikely to see much gain from it. Figures 2a and 2b show how the value appropriated by the employee as a share of the maximum potential value created (*i.e.*, τV) varies with uncertainty and firm-specificity for high and low levels of independence from the firm's complementary assets respectively (corresponding to Figure 1a and 1b).

Insert Figures 2a, 2b, 3a, and 3b about here

Table 1 also shows the value appropriated by the firm, which is further laid out in Figures 3a and Figures 3b, which correspond to Figures 2a and 2b for the employee above. To begin with, as already mentioned, the firm always appropriates a value equal to the share of the total value created that is owed to its complementary resources—*i.e.*, $(1-\beta)(V-C)$—except in Case V, when the idea is abandoned and no value is created at all. In addition, the firm acts as the residual claimant in Cases II and IV, appropriating the value of the Knightian rents earned by the invention (less the opportunity cost of using its resources). Finally, the firm's appropriation of value from its employee's invention is highest in Case VI, where the firm appropriates essentially the entire value of the invention for itself. Note that the pattern in Table 1 of firm value capture being greater, the greater the firm-specificity of knowledge used by the employee's invention is consistent with a knowledge based view of the firm (Brown & Duguid, 1991; Grant, 1996; Kogut & Zander, 1992; Liebeskind, 1996), which argues that firms create and capture value by enabling the transfer and development of knowledge within their boundaries in ways that cannot be achieved across them. Our model highlights the flip side of this argument—that the value appropriated by the firm in this way may come at the expense of the employee who generates the ideas driving value creation,

especially where these ideas not only build on firm-specific knowledge but require complementary assets specialized to the firm as well. Note also that at least some of the value appropriated by the firm comes as a (positive) ex post surprise to it—in all cases where it serves as the residual claimant (Cases II, IV and VI) the firm captures more value ex post than it expected to ex ante.

Turning to value creation, value creation is highest in Case I, where the invention is commercialized by the rival; lower in Cases II, IV and VI, where the invention is commercialized by the firm, on account of the higher opportunity costs of using internal firm resources (Cr); still lower in the spin-off case (Case III), due to the high start-up costs associated with the spin-out (S); and finally, lowest in the case of abandoned ideas (Case V) where no value is created at all. Note that the total value created is equal to the sum of the value appropriated by the firm and the employee (*i.e.*, the value of the invention is shared between them), except in the case of commercialization by the rival (Case I), where the rival makes an ex post gain of $\mu\beta V$ as the residual claimant to the Knightian rents from the employee's invention.

Summary and implications

Overall, Table 1 highlights the complex way in which our three key drivers—dependence on complementary assets, structural uncertainty, and firm-specificity of knowledge—interact to influence both the means by which the employee's invention is commercialized, and the way in which the value from that invention is appropriated. More specifically, it highlights, first, the critical role of structural uncertainty in driving the outcomes of employee invention. For inventions with low uncertainty, the terms of exchange are determined by the market, with the employee relying on her outside option to capture the Kirznerian rents from her invention, irrespective of whether the invention itself is commercialized by the firm which currently employs the inventor, or its rival. In contrast, where uncertainty is high, market discipline no longer applies, and the firm and inventor must engage in a more challenging bargaining process, with outcomes that vary widely both in terms

of the eventual means of commercialization (if any), and the sharing of value between the two players.

Second, Table 1 emphasizes the critical role that dependence on complementary assets plays in determining the advantage of the firm relative to the employee in situations where high uncertainty makes external market options irrelevant. Where the employee's invention is largely independent of the firm's complementary assets, the advantage lies with the employee, and the firm must share as much value with the employee as it can in order to keep the employee from leaving with her idea, and even then it may not succeed. Conversely, where the invention's dependence on complementary assets is high, the employee loses nearly all her bargaining power, and the firm can appropriate most if not all of the value from her invention. Thus, high uncertainty may be only moderately harmful to the employee for inventions that are independent of her employer, but extremely damaging to her prospects when dependence on firm complementary assets is high. Interestingly, Table 1 also shows that high dependence on complementary assets is potentially a mixed blessing for the firm. While it is certainly true that high dependence increases both the share of value the firm is able to capture from the invention in general, and its bargaining power relative to the employee in cases with high uncertainty, it may also prove costly in cases where the firm itself does not adequately appreciate the value of the employee's invention. In such cases, high dependence on complementary assets may cause the employee's idea to be abandoned, causing the firm to lose out on the potential value it would have captured had the invention been independent enough for the employee to pursue it on her own.

Third, and related to the point above, Table 1 also highlights the role of firm-specificity, stressing, in particular, the mixed benefit it offers to both the firm and the employee. For the firm, low firm-specificity, and the resulting lack of an adequate appreciation of employee inventions may prove costly not only in cases with high dependence on complementary assets when ideas are

abandoned, but also in cases where the low dependence on complementary assets is combined with moderate levels of structural uncertainty, causing the firm to offer too little to its employees and resulting in the loss of inventions that could have been more profitably commercialized internally. On the other hand, in cases with high uncertainty and low dependence on complementary assets, low firm-specificity may keep the firm from overpaying for employee ideas, allowing it to potentially capture more value from inventions developed independently by its employees through the appreciation in the value of its complementary assets than it would have appropriated if it had commercialized the inventions internally. At the same time, Table 1 suggests that firm-specificity may not always act to the detriment of employees. While in cases where dependence on complementary assets is high or uncertainty is low, firm-specificity is generally irrelevant to the employee, in cases with low dependence and high uncertainty, greater firm specificity may actually be beneficial to the employee, helping her to avoid bearing high start-up costs and enabling her to receive a better offer from her employer.

Finally, Table 1 offers a novel perspective on entrepreneurial spin-outs. Consistent with prior work that sees spin-outs resulting from disagreements between the employee and the firm on the value of the former's idea (Klepper & Thompson, 2010), our model also highlights such differences in valuation, but suggests, first, that such disagreements only result in spin-outs when they are accompanied by high structural uncertainty and low dependence on firm's complementary resources, and second, that such disagreements may arise not as a result of either entrepreneurial overconfidence or entrepreneurial foresight, but simply as a function of the extent to which the specific invention imagined by the employee draws on firm-specific knowledge.

Entrepreneurial spin-outs are thus seen not as a drain on the critical knowledge resources of the firm, but as the logical flip-side of knowledge-based arguments for the source of firm competitive advantage (Grant, 1996; Kogut & Zander, 1992; Liebeskind, 1996). Inventions that are

certain and easily evaluated and contracted for all realize their value through the market; only inventions that are uncertain and hard to contract for give rise to entrepreneurial opportunities for rents to be realized over the long-run through the creation of firms with residual claimants (Foss & Foss, 2005; Grossman & Hart, 1986; Kaul, 2013; Klein, 2008). Where such inventions draw heavily on the knowledge and complementary resources of existing firms they are best commercialized within these firms and become a source of enhanced competitive advantage for them (Grant, 1996; Kogut & Zander, 1992). Conversely, where such inventions are largely independent of the knowledge and resources of existing firms they are best developed through the founding of new firms, independent of their founders' former employers, *i.e.*, through spin-outs.

Other results

While our discussion thus far has focused on the role of dependence on complementary resources, structural uncertainty, and firm-specificity of knowledge, the model also points to several other factors that may influence how an invention is commercialized and its value appropriated. First, both $\bar{\beta}$ and $\bar{\mu}$ are increasing in start-up costs S, meaning, unsurprisingly, that the lower these costs, the more likely it is that spin-outs are feasible and the greater the chance that the employee will pursue them. Interestingly, though, lower start-up costs tend to lower $\dot{\rho}$ but raise $\hat{\rho}$, meaning that as start-up costs decrease, spin-outs are actually less likely to be preferred at moderate levels of uncertainty (because the firm is more likely to recognize that spin-outs are a viable option for the employee), though more likely to be preferred at high levels of uncertainty.

Second, the model shows that the premium on the use of firm's internal resources r has an impact on the likelihood of internal commercialization, with both $\bar{\rho}$ and $\hat{\rho}$ increasing in r. Thus, the more capacity constrained the firm's internal resources, or the stronger the other investment opportunities available to it, the less likely it is to internally commercialize the invention, and the more willing it is to allow the invention to be commercialized by a rival or via spin-out (Cassiman &

Ueda, 2006). Conversely, in the extreme case where there is no additional opportunity cost of using firm resources (*i.e.*, $r = 0$), the firm always matches the rival's offer and the inventor never moves to a rival firm. Note that even in this case spin-outs are still possible so long as $\mu > \bar{\mu}$ and $\rho < \dot{\rho}$—the firm may still incorrectly believe that the employee values the rival option more than the spin-out and so end up failing to match the employee's best outside option.

Third, the model also confirms that how an invention is commercialized depends upon both τ and V, *i.e.*, on the value of the invention. Specifically, it shows that both $\bar{\beta}$ and $\bar{\mu}$ are decreasing in V, implying that the more valuable the invention, the more likely it will be commercialized through a spin-out, with this effect being especially strong for high levels of uncertainty, since $\hat{\rho}$ is increasing in V. At the same time, the model also suggest that in cases where spin-out is not feasible, more value creating inventions (*i.e.*, those with higher τ) are more likely to be commercialized, and more likely to result in net gains for the employee.

Some extensions

In addition to these results from our main model, a few extensions of the model are also worth considering. First, consider the case where the employee's invention has the potential to cannibalize the sales of the firm (Campbell & Franco, 2013). In such a case, the resources of the firm may lose their value in their current use if the invention is commercialized by someone else (Kaul, 2012), so that the opportunity cost of using internal resources is actually lower than the cost of market resources, *i.e.*, $r < 0$. In such a case, the firm will always match the rival's offer (since $r < 0 \Rightarrow \bar{\rho} < 0$) and the employee will never move to a rival firm. Further, the threat of cannibalization will also strongly motivate the firm to try and avoid spin-outs; in particular, so long as the firm recognizes that the employee's best outside option is a spin-out, it will always make an offer high enough to convince the employee to stay with the firm.

Next, while we have assumed thus far that the employee's subjective assessment of her invention is correct, we can also relax that assumption and consider the case where the employee is over-confident. As mentioned above, this does not change the choice of commercialization mode, only the distribution of value among the various parties. Suppose, for instance, that it is the firm that correctly assesses the value of the invention, rather than the employee. In this case, the employee's outcomes are unchanged in every case, except in the case of spin-outs, while the firm makes exactly the gain that it expected to gain ex ante (*i.e.*, it experiences no surprising gains ex-post). In the spin-out case, the employee now always makes a loss, at least relative to what she could have earned if she had accepted the firm's offer, and potentially in absolute terms as well. Conversely, in Case IV, where the employee accepts offer ψ_f, she captures essentially all the rents from her invention that are independent of her employer's resources. Note also that in this case ideas that are abandoned are those that have no real value, so there is no true loss from their abandonment.

Finally, consider the case where property rights in the employee's invention are poorly defined ex ante, which is a case often considered in the prior literature (Anton & Yao, 1994, 1995; Franco & Filson, 2006; Luo, 2014). As mentioned above, this would have an effect similar to that of lowering β in our model, since it would essentially allow the firm to appropriate a greater portion of the value created by the invention. In particular, if start-up costs were high enough, weak property rights may limit the employee's ability to pursue a spin-out, since she may be unable to realize enough value from the spin-out (given appropriation by the firm) to cover these costs. Assuming that the employee understood how her idea was valued on the market, however, she could still pursue the rival option, so that with low enough uncertainty she could still claim the Kirznerian rents from her invention. Where weak property rights were combined with high uncertainty, however, the employee may have no viable outside option and may be unable to appropriate the value of her invention.

Discussion

Our study offers a new perspective on the phenomenon of employee spin-outs, examining how the nature of an employee's idea—its structural uncertainty, firm-specificity of knowledge utilized in the idea, and dependence on the employer's complementary resources—impact how the idea is commercialized and who appropriates the value from it. Using a formal model of the bargaining between the employee, her current employer, and a rival firm, we show that these three characteristics of the employee's invention interact in complex ways. In particular, we suggest that employees pursue spin-outs when their ideas are too uncertain to be contractible to other market participants, but sufficiently independent and non-firm specific that the employee is better off pursuing them on her own rather than commercializing them through the firm. Our model also predicts how the threshold values necessary to motivate the employee to pursue spin-outs change with the start-up costs the employee faces, the value of her idea, and the opportunity cost of the firm's internal resources.

In developing these insights, our study contributes to the existing literature in a number of ways. First, while prior work on entrepreneurial spin-outs has discussed the role of weak property rights (Anton & Yao, 1994, 1995; Franco & Filson, 2006) or incompatibility between employee innovation and the firm's ongoing business activities (Cassiman & Ueda, 2006; Hellmann, 2007) in driving spin-outs, we draw attention to the nature of the employee's idea, suggesting that it is only those ideas that are structurally uncertain but relatively unconnected to the parent firm that will result in spin-outs. This is important not only because it offers an alternate knowledge-based explanation of employee spin-outs, but because it helps explain why some employee inventions result in spin-outs, while others do not, despite being generated within the same firm and under the same property rights regime. In emphasizing the nature of employee ideas, moreover, our study connects to a growing literature that draws on the Austrian economics tradition to discuss the

subjective nature of entrepreneurial judgment under uncertainty, and the need for entrepreneurial action to overcome the contract incompleteness that results (Foss *et al.*, 2007b; Foss *et al.*, 2008; Kaul, 2013; Klein, 2008; Knight, 1921; Sautet, 2002). Not only are we among the first studies to apply this perspective to the study of entrepreneurial spin-outs, we also contribute back to this work by exploring how the fact of being employed may influence the entrepreneur's choice set, with her links to her current employer both constraining her from pursuing an independent business, and making available commercialization opportunities that independent inventors may not enjoy. In fact, our study suggests that firm-specificity may itself contribute to the uncertainty around employee inventions, with part of the reason the entrepreneur is unable to contract for the full value of her ideas through the market is that they build on knowledge that is specific to her employer.

Second, our study not only examines the drivers of spin-outs, it also considers the possibility of the employee moving to a rival firm, with our formal model considering both choices as alternate external options available to the employee. In doing so, our study connects two different strands of the literature—one on entrepreneurial spin-outs and the other on employee mobility—that have often been studied independent of each other. More generally, our study offers a more holistic perspective on the commercialization of employee inventions, with our formal model incorporating a range of different outcomes—including spin-outs, mobility, internal commercialization, and even abandonment of the idea—and developing a coherent and integrated explanation for the conditions under which each of these outcomes is likely to prevail. In addition, while focusing on characteristics of the employee's idea, our model also integrates the explanations offered by prior work into a single framework, incorporating, for instance, the higher opportunity cost of firm's internal resources (Cassiman & Ueda, 2006) and the regulatory costs of start-ups (Djankov *et al.*, 2002), while allowing for the inclusion of such factors as weak property rights (Anton and Yao, 1994; 1995) and cannibalization (Campbell and Franco, 2013).

Third, in addition to predicting the way in which the employee's idea is commercialized, our formal model also examines how the value from that idea is appropriated (Coff, 1999). In particular, we are able to study how the value from the employee's idea is shared between the employee and her employer, thus providing a conceptual reconciliation between prior research that emphasizes the economic benefits of spin-outs (Hellmann & Perotti, 2011; Klepper & Simons, 2000; Klepper & Sleeper, 2005) and work that sees them as a drain on firm knowledge resources (Campbell *et al.*, 2012b; Kim & Marschke, 2005; Pakes & Nitzan, 1983). Moreover, because we focus on the uncertain and firm-specific nature of the employee's idea, our study also connects research on entrepreneurial spin-outs to the literature on the knowledge-based view of the firm (Grant, 1996; Kogut & Zander, 1992; Liebeskind, 1996). In particular, we suggest that the two may be seen as flip-sides of the same argument: inventions developed by employee that draw on firm-specific knowledge or rely heavily on firm complementary resources are best commercialized internally, resulting in a knowledge-based advantage for the firm; while inventions that are less related or reliant on the firm are best commercialized independently, giving rise to spin-outs. Far from representing a loss of critical firm-specific knowledge, therefore, spin-outs represent an important outlet for employees to pursue ideas that have little relevance to the firm. Moreover, the results from our model suggest that spin-outs may be pursued as a commercialization mode of last resort, with employees choosing to start their own businesses only when the uncertainty regarding their idea is so high that they are better off incurring the start-up costs associated with spin-outs rather than settling for the limited value available through contract with existing firms.

As with any study, our work has its limitations. To begin with, while the predictions from our model are generally consistent with the existing empirical evidence, our paper is a conceptual one, and the arguments we make must therefore be verified by future empirical testing. Moreover, our use of a formal model, while enhancing the rigor of our theoretical argument, and allowing us to

study complex interactions between our predictors of interest, does require us to make several simplifying assumptions. Future work could consider extending the model by relaxing some of these assumptions, for instance by allowing for teams of employees coming together to pursue a common idea instead of limiting the analysis to a single employee, or modeling a more formal bargaining process between the various actors. Future work could also more systematically explore the possibility of separating the invention from the inventor, thus allowing for the invention to be traded on the market for ideas (Gans & Stern, 2000, 2003).

To conclude, our study offers a novel theory of entrepreneurial spin-outs, arguing that spin-outs results when the structural uncertainty around an employee invention is so high that the employee would prefer to start her own firm to appropriate the value from her invention as a residual claimant rather than contract it out either to her current employer or a rival firm. We develop a rigorous formal model examining the bargaining process between various actors with different beliefs about the value of the invention given its structural uncertainty, and show that spin-outs are, in fact, theoretically associated with high structural uncertainty, but only when such uncertainty is combined with low firm-specificity of the knowledge used in the invention, and low dependence of the invention on the firm's complementary resources. Our model further predicts the various alternate ways in which an employee invention may be commercialized when spin-out is not the best option, and the appropriation of value by both the employee and the firm that results. We thus offer an integrated and holistic theory of the commercialization of employee ideas as a function of the nature of those ideas, providing an alternate explanation for the incidence of entrepreneurial spin-outs, while linking work in this area to research on employee mobility, entrepreneurial action under uncertainty, and the knowledge-based view of the firm.

REFERENCES

Acs ZJ, Audretsch DB. 1988. Innovation in large and small firms: an empirical analysis. *The American Economic Review*: 678-690.

Agarwal R, Campbell BA, Franco A, Ganco M. 2016. What do I take with me?: The mediating effect of spin-out team size and tenure on the founder-firm performance relationship. *Academy of Management Journal* **59**(3): 1060-1087.

Agarwal R, Echambadi R, Franco AM, Sarkar MB. 2004. Knowledge transfer through inheritance: Spin-out generation, development, and survival. *Academy of Management Journal* **47**(4): 501-522.

Agarwal R, Ganco M, Ziedonis RH. 2009. Reputations for toughness in patent enforcement: Implications for knowledge spillovers via inventor mobility. *Strategic Management Journal* **30**(13): 1349-1374.

Agarwal R, Shah SK. 2014. Knowledge sources of entrepreneurship: Firm formation by academic, user and employee innovators. *Research Policy* **43**(7): 1109-1133.

Anton JJ, Yao DA. 1994. Expropriation and inventions: Appropriable rents in the absence of property rights. *American Economic Review* **84**(1): 190.

Anton JJ, Yao DA. 1995. Start-ups, spin-offs, and internal Projects. *Journal of Law, Economics, & Organization* **11**(2): 362-378.

Anton JJ, Yao DA. 2002. The sale of ideas: Strategic disclosure, property rights, and contracting. *The Review of Economic Studies* **69**(240): 513.

Arora A, Nandkumar A. 2012. Insecure advantage? Markets for technology and the value of resources for entrepreneurial ventures. *Strategic Management Journal* **33**(3): 231-251.

Barney JB. 1986. Strategic Factor Markets: Expectations, Luck, and Business Strategy *Management Science* **32**(10): 1231-1241

Barney JB. 1991. Firm resources and sustained competitive advantage. *Journal of Management* **17**(1): 99-120.

Bhidé AV. 2003. *The origin and evolution of new businesses*. Oxford University Press.

Brown JS, Duguid P. 1991. Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization science* **2**(1): 40-57.

Buenstorf G, Klepper S. 2009. Heritage and agglomeration: the Akron tyre cluster revisited. *The Economic Journal* **119**(537): 705-733.

Busenitz LW, Barney JB. 1997. Differences between entrepreneurs and managers in large organizations: Biases and heuristics in strategic decision-making. *Journal of Business Venturing* **12**(1): 9-30.

Camerer C, Lovallo D. 1999. Overconfidence and excess entry: An experimental approach. *The American Economic Review* **89**(1): 306-318.

Campbell BA, Coff RW, Kryscynski D. 2012a. Re-thinking competitive advantage from human capital. *Academy of Management Review* **37**(3): 376-395.

Campbell BA, Ganco M, Franco AM, Agarwal R. 2012b. Who leaves, where to, and why worry? employee mobility, entrepreneurship and effects on source firm performance. *Strategic Management Journal* **33**(2): 65–87.

Campbell JD, Franco AM. 2013. Cannibalization, innovation and spin-outs, DRUID, Copenhagen Business School, Department of Industrial Economics and Strategy/Aalborg University, Department of Business Studies.

Cassiman B, Ueda M. 2006. Optimal project rejection and new firm start-ups. *Management Science* **52**(2): 262-275.

Chatterji AK. 2009. Spawned with a silver spoon? Entrepreneurial performance and innovation in the medical device industry. *Strategic Management Journal* **30**(2): 185-206.

Coff R, Raffiee J. 2015. Toward a theory of perceived firm-specific human capital. *Academy of Management Perspectives* **29**(3): 326-341.
Coff RW. 1999. When competitive advantage doesn't lead to performance: The resource-based view and stakeholder bargaining power. *Organization Science* **10**(2): 119-133.
Coff RW. 2010. The coevolution of rent appropriation and capability development. *Strategic Management Journal* **31**(7): 711-733.
Coff RW, Coff DC, Eastvold R. 2006. The knowledge-leveraging paradox: How to achieve scale without making knowledge imitable. *Academy of Management Review* **31**(2): 452-465.
Dequech D. 2006. The new institutional economics and the theory of behaviour under uncertainty. *Journal of Economic Behavior & Organization* **59**(1): 109-131.
Dierickx I, Cool K. 1989. Asset stock accumulation and sustainability of competitive advantage. *Management Science* **35**(12): 1504-1511.
Djankov S, La Porta R, Lopez-de-Silanes F, Shleifer A. 2002. The regulation of entry. *Quarterly journal of Economics*: 1-37.
Dyer JH, Hatch NW. 2006. Relation-specific capabilities and barriers to knowledge transfers: creating advantage through network relationships. *Strategic Management Journal* **27**(8): 4.
Elfenbein DW, Hamilton BH, Zenger TR. 2010. The small firm effect and the entrepreneurial spawning of scientists and engineers. *Management Science* **56**(4): 659-681.
Evans DS, Leighton LS. 1989. Some Empirical Aspects of Entrepreneurship. *American Economic Review* **79**(3): 519-535.
Fleming L. 2001. Recombinant uncertainty in technological search. *Management Science* **47**(1): 117-132.
Forbes DP. 2005. Are some entrepreneurs more overconfident than others? *Journal of business venturing* **20**(5): 623-640.
Foss K, Foss NJ. 2005. Resources and transaction costs: how property rights economics furthers the resource-based view. *Strategic Management Journal* **26**(6): 541-554.
Foss K, Foss NJ, Klein PG. 2007a. Original and derived judgment: An entrepreneurial theory of economic organization. *Organization Studies* **28**(12): 1893-1912.
Foss K, Foss NJ, Klein PG, Klein SK. 2007b. The entrepreneurial organization of heterogeneous capital. *Journal of Management studies* **44**(7): 1165-1186.
Foss NJ, Klein PG, Kor YY, Mahoney JT. 2008. Entrepreneurship, subjectivism, and the resource-based view: toward a new synthesis. *Strategic Entrepreneurship Journal* **2**(1): 73-94.
Franco AM, Filson D. 2006. Spin-outs: knowledge diffusion through employee mobility. *Rand Journal of Economics* **37**(4): 841-860.
Gambardella A, Ganco M, Honoré F. 2014. Using what you know: Patented knowledge in incumbent firms and employee entrepreneurship. *Organization Science* **26**(2): 456-474.
Ganco M. 2013. Cutting the Gordian knot: The effect of knowledge complexity on employee mobility and entrepreneurship. *Strategic Management Journal* **34**(6): 666-686.
Ganco M, Ziedonis RH, Agarwal R. 2014. More stars stay, but the brightest ones still leave: Job hopping in the shadow of patent enforcement. *Strategic Management Journal* **36**(5): 659-685.
Gans JS, Hsu DH, Stern S. 2002. When does start-up innovation spur the gale of creative destruction? *RAND Journal of Economics* **33**(4): 571-587.
Gans JS, Stern S. 2000. Incumbency and R&D incentives: Licensing the gale of creative destruction. *Journal of Economics & Management Strategy* **9**(4): 485-511.
Gans JS, Stern S. 2003. The product market and the market for "ideas": Commercialization strategies for technology entrepreneurs. *Research Policy* **32**(2): 333-350.
Gompers P, Lerner J, Scharfstein D. 2005. Entrepreneurial spawning: Public corporations and the genesis of new ventures, 1986 to 1999. *The Journal of Finance* **60**(2): 577-614.

Grant RM. 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal* **17**: 109-122.
Grossman SJ, Hart OD. 1986. The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy* **94**(4): 691-719.
Hart O, Moore J. 1990. Property Rights and the Nature of the Firm. *Journal of Political Economy* **98**(6): 1119-1158.
Hellmann T. 2007. When do employees become entrepreneurs? *Management Science* **53**(6): 919-933.
Hellmann T, Perotti E. 2011. The circulation of ideas in firms and markets. *Management Science* **57**(10): 1813-1826.
Jacobides MG, Winter SG. 2007. Entrepreneurship and firm boundaries: the theory of a firm. *Journal of Management Studies* **44**(7): 1213-1241.
Jaffe AB, Trajtenberg M, Henderson R. 1993. Geographic localization of knowledge spillovers as evidenced by patent citations. *Quarterly Journal of Economics* **108**(3): 577-598.
Kaul A. 2012. Technology and corporate scope: Firm and rival innovation as antecedents of corporate transactions. *Strategic Management Journal* **33**(4): 347-367.
Kaul A. 2013. Entrepreneurial action, unique assets, and appropriation risk: Firms as a means of appropriating profit from capability creation. *Organization Science* **24**(6): 1765-1781.
Kim J, Marschke G. 2005. Labor mobility of scientists, technological diffusion, and the firm's patenting decision. *RAND Journal of Economics*: 298-317.
Kirzner IM. 1985. *Discovery and the capitalist process*. University of Chicago Press.
Klein PG. 2008. Opportunity discovery, entrepreneurial action, and economic organization. *Strategic Entrepreneurship Journal* **2**(3): 175-190.
Klepper S. 2007. Disagreements, spinoffs, and the evolution of Detroit as the capital of the U.S. automobile industry. *Management Science* **53**(4): 616-631.
Klepper S, Simons KL. 2000. Dominance by birthright: entry of prior radio producers and competitive ramifications in the US television receiver industry. *Strategic Management Journal*: 997-1016.
Klepper S, Sleeper S. 2005. Entry by spinoffs. *Management Science* **51**(8): 1291-1306.
Klepper S, Thompson P. 2010. Disagreements and intra-industry spinoffs. *International Journal of Industrial Organization* **28**(5): 526-538.
Knight FH. 1921. *Risk, Uncertainty and Profit*. Houghton Mifflin Company: New York.
Kogut B, Zander U. 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science* **3**(3): 383-397.
Langlois RN. 1992. Transaction-cost economics in real time. *Industrial and corporate change* **1**(1): 99-127.
LeRoy SF, Singell Jr LD. 1987. Knight on risk and uncertainty. *Journal of political economy* **95**(2): 394-406.
Levinthal DA, Wu B. 2010. Opportunity costs and non- scale free capabilities: profit maximization, corporate scope, and profit margins. *Strategic Management Journal* **31**(7): 780-801.
Liebeskind JP. 1996. Knowledge, strategy, and the theory of the firm. *Strategic Management Journal* **17**(S2): 93-107.
Luo H. 2014. When to sell your idea: Theory and evidence from the movie industry. *Management Science* **60**(12): 3067-3086.
McMullen JS, Shepherd DA. 2006. Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. *Academy of Management Review* **31**(1): 132-152.
Muendler M-A, Rauch JE, Tocoian O. 2012. Employee spinoffs and other entrants: Stylized facts from Brazil. *International Journal of Industrial Organization* **30**(5): 447-458.

Pakes A, Nitzan S. 1983. Optimum contracts for research personnel, research employment, and the establishment of" rival" enterprises. *Journal of Labor Economics* **1**(4): 345-365.
Penrose ET. 1959. *The Theory of the Growth of the Firm*. Basil Blackwell: Oxford.
Raffiee J, Coff R. 2016. Micro-foundations of firm-specific human capital: When do employees perceive their skills to be firm-specific? *Academy of Mangement Journal* **59**(3): 766-790.
Rao H, Drazin R. 2002. Overcoming resource constraints on product innovation by recruiting talent from rivals: A study of the mutual fund industry, 1986-94. *Academy of Management Journal* **45**(3): 491-507.
Sautet F. 2002. *An entrepreneurial theory of the firm*. Routledge.
Schumpeter JA. 1934. *The Theory of Economic Development*. Oxford University Press: New York.
Siggelkow N, Levinthal DA. 2003. Temporarily divide to conquer: Centralized, decentralized, and reintegrated organizational approaches to exploration and adaptation. *Organization Science* **14**(6): 650-669.
Singh J, Agrawal A. 2011. Recruiting for ideas: How firms exploit the prior inventions of new hires. *Management Science* **57**(1): 129-150.
Wezel FC, Cattani G, Pennings JM. 2006. Competitive implications of interfirm mobility. *Organization Science* **17**(6): 691-709.
Wu B, Knott AM. 2006. Entrepreneurial risk and market entry. *Management Science* **52**(9): 1315-1330.
Zott C. 2003. Dynamic Capabilities and the Emergence of Intra-industry Differential Firm Performance: Insights from a simulation study. *Strategic Management Journal* **24**(2): 97-125.

TABLE 1. Summary of Model Results

Structural uncertainty	Firm Specificity	Dependence on Firm Complementary Resources	
		High $\beta \leq \bar{\beta}$	Low $\beta > \bar{\beta}$
High	*High*	**Case VI Internal Commercialization** $\mu > \tau;\ \rho > \underline{\rho}$ Employee: 0 Firm: $V - C(1+r)$ Social Loss: Cr	**Case IV Internal Commercialization** $\mu > \bar{\mu};\ \rho \geq \max(\dot{\rho}, \hat{\rho})$ Employee: $\psi_f = \beta\big(V\big(1-\mu(1-\rho)\big) - C\big) - Cr$ Firm: $V - C(1+r) - \psi_f$ Social Loss: Cr
High	*Low*	**Case V Abandoned Ideas** $\mu > \tau;\ \rho < \underline{\rho}$ Employee: 0 Firm: 0 Social Loss: $V - C$	**Case III Employee Spin-out** $\mu > \bar{\mu};\ \rho < \max(\dot{\rho}, \hat{\rho})$ Employee: $\psi_s = \beta(V - C) - S$ Firm: $(1-\beta)(V - C)$ Social Loss: S
Low	*High*	**Case II Internal Commercialization** $\mu \leq \tau \ or\ \mu \leq \bar{\mu};\ \rho \geq \bar{\rho}$ Employee: $\psi_r = \beta(V(1-\mu) - C)$ Firm: $V - C(1+r) - \psi_r$ Social Loss: Cr	
Low	*Low*	**Case I Employee Mobility** $\mu \leq \tau \ or\ \mu \leq \bar{\mu};\ \rho < \bar{\rho}$ Employee: $\psi_r = \beta(V(1-\mu) - C)$ Firm: $(1-\beta)(V - C)$ Rival: $\mu\beta V$ Social Loss: 0	

Figure 1a Commercialization Choice – Low Dependence on Complementary Assets

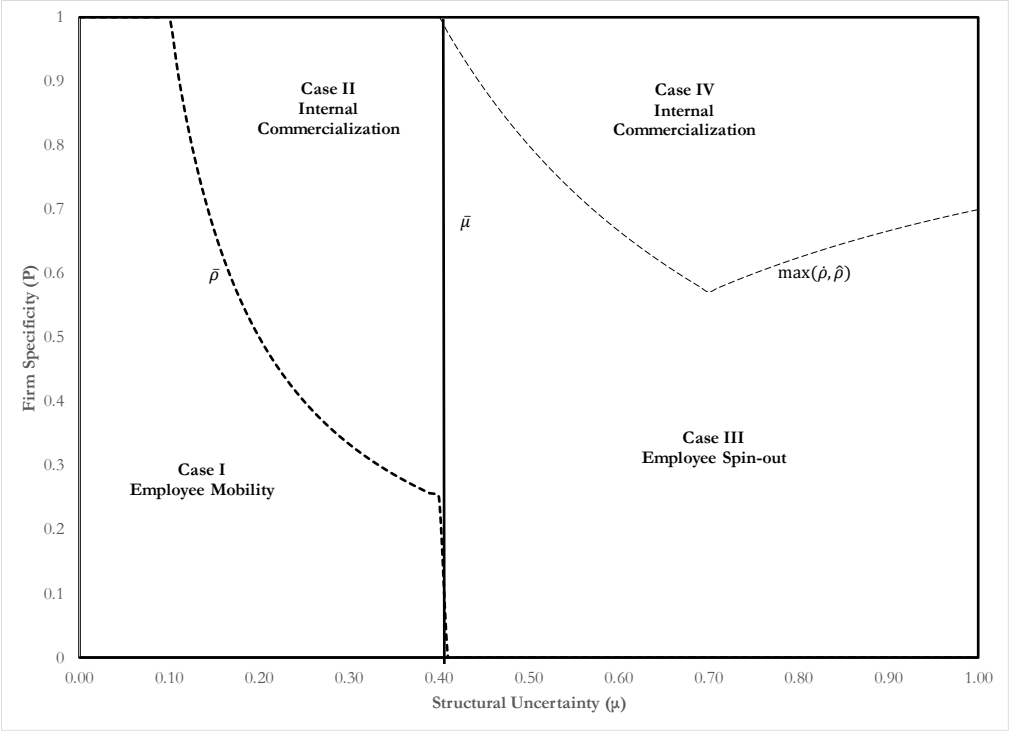

Figure 1b Commercialization Choice – High Dependence on Complementary Assets

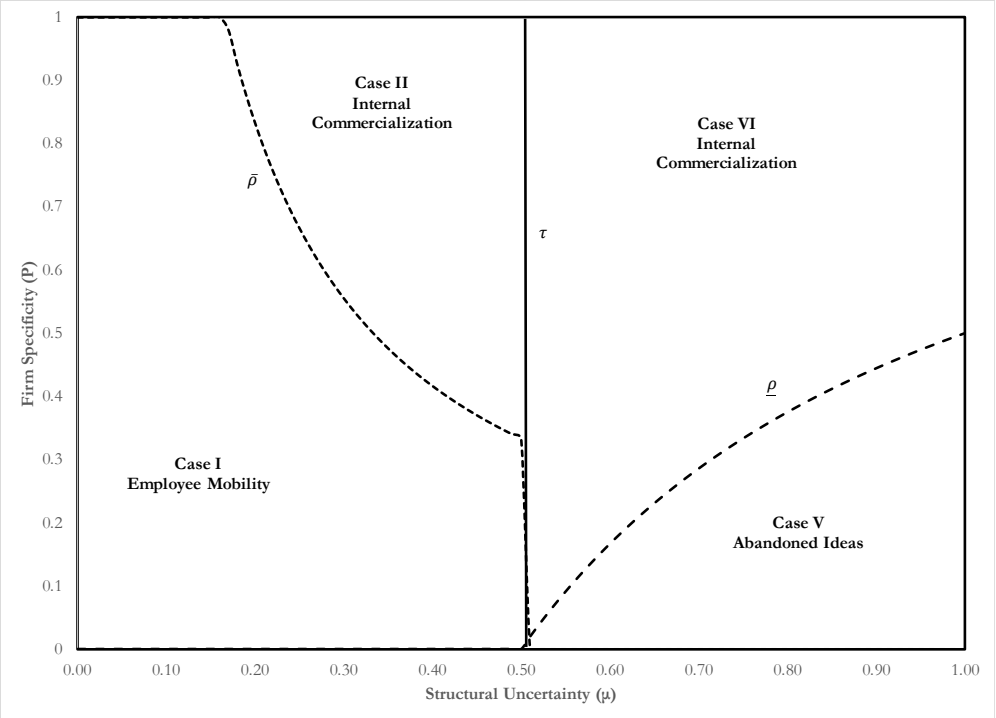

Figure 2a Employee Value Appropriation – Low Dependence

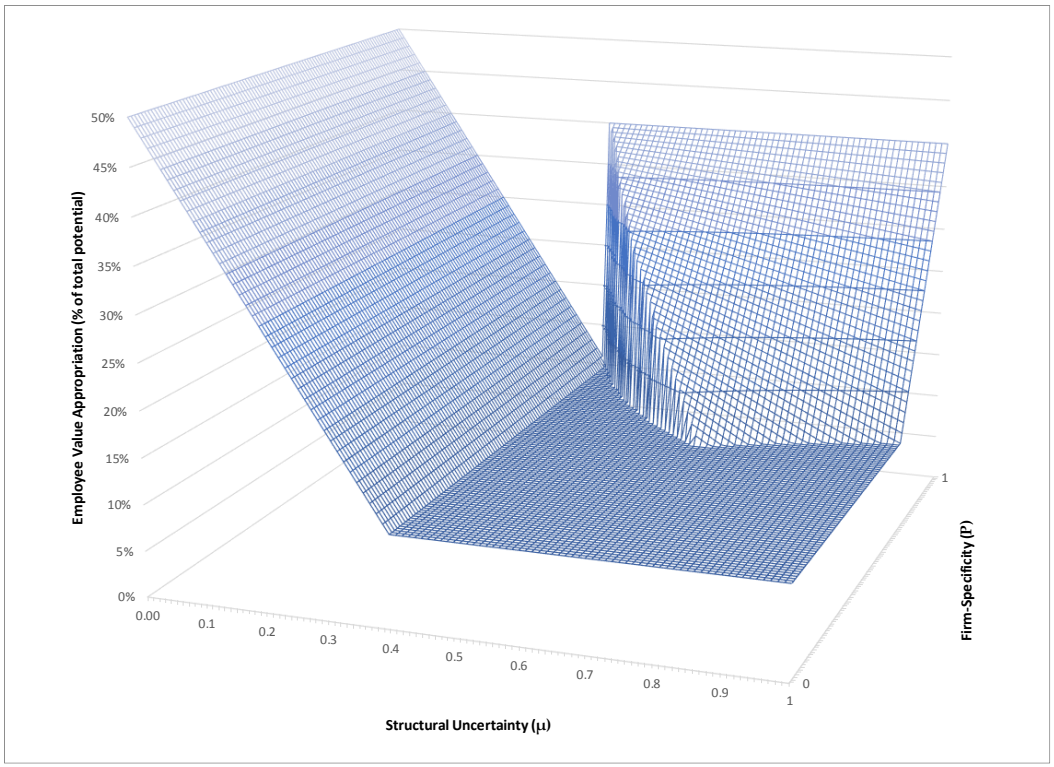

Figure 2b Employee Value Appropriation – High Dependence

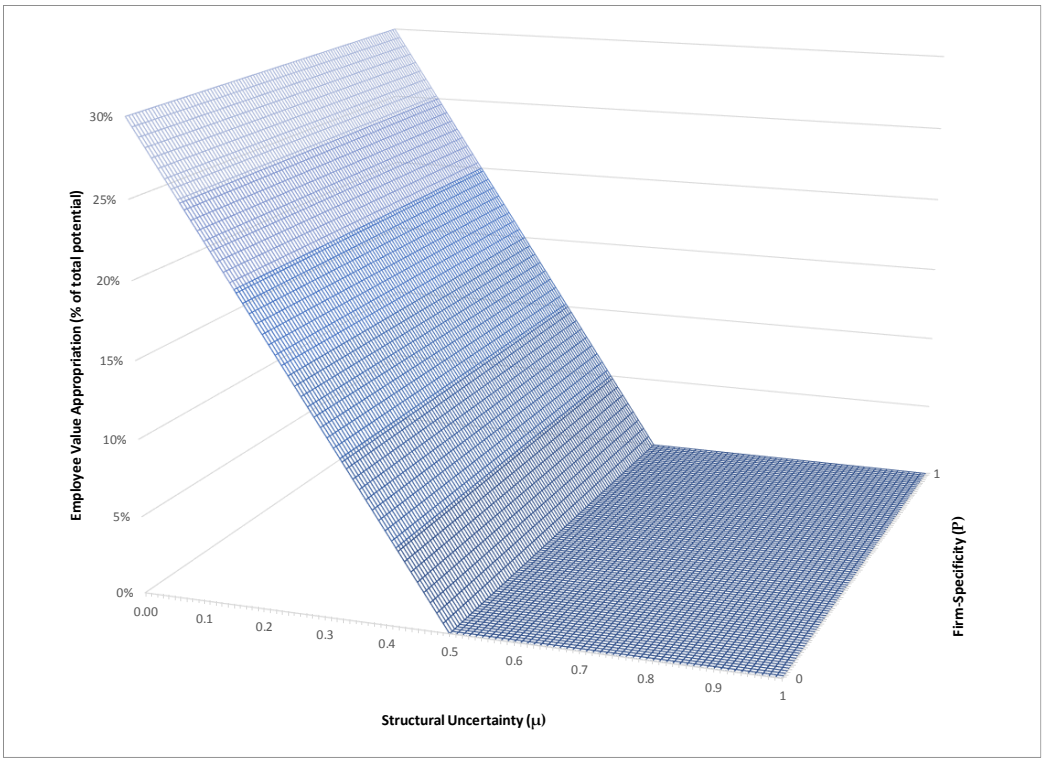

Figure 3a Firm Value Appropriation – Low Dependence

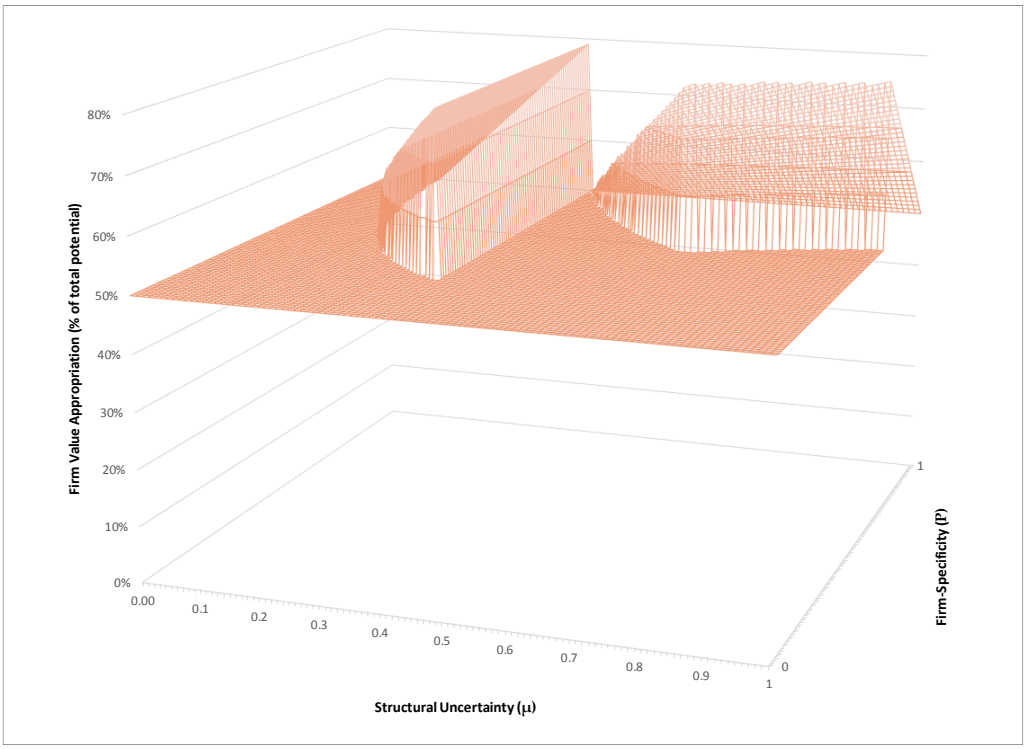

Figure 3b Firm Value Appropriation – High Dependence