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Situating the construct of lean start-up: adjacent conversations and possible future directions

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Abstract

The lean start-up approach has garnered tremendous amount of interest in recent years and has become mainstream among entrepreneurs. However, this practitioners' conversation has been largely decoupled from the broader academic literature in management and technology strategy. This article attempts to fill this gap. We situate the construct of lean start-up within its underlying roots in the research traditions of organizational learning, real options, new product development, and technology evolution. We then comment on the economic and technological forces that have caused this organizational form to become prevalent. By juxtaposing these related, but distinct, lines of research we are able to identify a number of novel and interesting avenues for researchers in both entrepreneurship and the broader management literature that lie at the intersection of these domains.

JEL classification: D21, L26, M13

1. Introduction

Technological evolution has long been understood as a search process (Dosi, 1982; Nelson and Winter, 1982; Vincenti, 1994; Fleming, 2001), a process that inevitably entails some "dance" between "problems" (demand factors) and "solutions" (technological supply) (Di Stefano *et al.*, 2012). These dynamics are nicely summarized by Mowery and Rosenberg (1979: 143):

> Any careful study of the history of an innovation is likely to reveal a characteristically iterative process in which both demand and supply forces are responded to. Thus, successful innovations typically undergo extensive modification in the development process in response to the perception of the requirements of the eventual users, on the one hand, and on the other, in response to the requirements of the producer who is interested in producing the product at the lowest possible cost. Innovations that are not highly sensitive to both sets of forces are most unlikely to achieve the status of commercial success.

This "dance" between technologies and markets has drawn considerable attention in recent years under the rubric of "lean start-up" (Blank, 2003, 2012; Ries, 2011, 2016, 2017), a set of ideas which has become widely adopted within the practice of entrepreneurial management. The core of the lean start-up approach is the rejection of an entrepreneurship model based on business planning in lieu of the adoption of an iterative approach driven by experimentation.

The ideas around the construct of lean start-ups have important normative value and suggest useful avenues of advance for the associated academic literature as well. However, in ways that are not helpful to the effort of advancing the academic literature, as well as arguably not maximally supportive of the practitioner oriented agenda, the discourse around lean start-ups has been largely decoupled from its underlying roots in the broader literature in management.

To fill this gap, we first situate the discussion of lean start-ups in this larger field, taking into account how the lean start-up framework relates to these related streams of literature. In particular, we argue that the lean start-up framework has important roots, and points of connection and contrast with, work in organizational learning, real options, new product development, and, as suggested at the outset, the broader literature on technological evolution.[1] We then discuss the economic and technological forces that have caused the lean start-up framework to have a natural saliency in the current business environment. Further, the particular economic context in which lean start-ups have gain saliency suggest, as a corollary, possible boundaries to the applicability of the lean start-up approach. Ultimately, by juxtaposing these related, but distinct lines of work, we are able to identify a variety of novel and interesting avenues for researchers in both entrepreneurship and the broader management literature that lie at the intersection of these domains.

2. What is the lean start-up?

Originally articulated by Blank (2003, 2012), and subsequently developed more fully by Ries (2011, 2016, 2017), the notion of lean start-up is built on the idea that a start-up should engage in efficient experimentation as it attempts to navigate its course to commercial success. While there are multiple facets of the lean start-up framework, we argue that the two central elements are the notions of minimum viable product (MVP) and pivoting.

Ries (2016) defines the MVP as an early version of a new product that allows a start-up to collect a meaningful degree of learning about customers with the least effort. Therefore, the MVP is the simplest version of the proposed product that can gain traction with a set of possible customers and, as a result, generate informative feedback about the nature of the product offering. Building a MVP requires clarifying the key assumptions behind an envisioned business model and seeking evidence to confirm or falsify these assumptions. In other words, the MVP is essentially an experiment.

The notion of pivoting is characterized as a "change in strategy without a change in vision" (Ries, 2016). The vision—the general, long-term direction of the entrepreneurial effort—is presumed to stay relatively fixed, while the strategy used to implement this "vision" is expected to change through the execution of a series of pivots based on the feedback obtained from product market activity. Pivoting constitutes a shift in the trajectory of the development effort based on the knowledge obtained through the learning process. That shift might be with respect to one or more of the many dimensions of the proposed business model, including the target set of customers, characteristics of the technology or service, or how the value created by the good or service is to be monetized. Specifically, Ries (2011) provides a taxonomy of pivots, including shift of market context (i.e. customer segment or need pivot, channel pivot), technological adaptation (i.e. "zoom-in" or technological pivot, or platform pivot), and broader changes affecting the entire business model (i.e. value capture or business architecture pivot).

This set of ideas constitute what we see as a notion of "leanness."[2] Not only is a MVP the target of a given development effort, but it is suggested that the new enterprise be resource constrained and focus on a single development effort at any one point in time. Thus, while the firm may pivot, and in that sense engage in change and experimentation, the firm is not engaging in parallel development efforts as is often called for in settings of high levels of uncertainty regarding desired technological paths (Nelson, 1961). Thus, these efforts are lean not only with respect to the

1 We do not suggest that this is an exhaustive set of related antecedent literatures, but rather a set of unarguably important lines of inquiry in the adjacent academic literature.

2 The use of the term lean is also broadly evocative of the idea of lean manufacturing, sometimes termed the Toyota System (Morgan and Liker, 2006). However, the connections between the two sets of ideas is rather specific to the role of continual feedback based learning that is a critical element of the Toyota production system, while, other elements of the Toyota system, such as inventory control practices, relationships with suppliers, are not central to the set of practices around lean start-ups.

target aspiration of a MVP, but they are also lean with respect to the restriction to a singular developmental trajectory.

While there are a number of anecdotal accounts of lean start-up successes, a nascent more systematic empirical literature has begun to emerge as well. McDonald and Eisenhardt (forthcoming) introduce the idea of "parallel play" to define the process new ventures use to search for a viable business model. Using a multiple-case qualitative study of the social investing market, this analysis reveals that ventures actively test their "assumptions about profit logics" and operate with a "loosely connected activity system" before committing to a business model. The idea of hypothesis testing is also emphasized by the experimental work of Camuffo *et al.* (forthcoming). Using a randomized controlled trial on a set of early-stage venture teams, the authors induce the treatment group to use a scientific approach in decision-making based on "developing frameworks for predicting the performance of their idea and to conduct rigorous tests of their hypotheses very much like scientists do," while the control group is free to follow their preferred default approach. Ventures using a "scientific" approach perform better and pivot more, suggesting that the scientific approach facilitates the recognition of valuable ideas. Also using a randomized controlled experiment, Eesley and Wu (2017) use a two-by-two design with students randomly primed to take an adaptive or planning-based approach and to seek a mentor with a diverse or non-diverse network. They find that the planning-based approach leads to better outcomes in the short-term, while in the longer term the adaptive approach performs better, with the effect amplified when coupled with mentors with diverse networks. Finally, Bennett and Chatterji (2017) provide large-sample survey-based evidence on the entrepreneurial process. Part of the survey specifically explores whether the entrepreneurs take "lean" steps (steps aimed at gathering information while investing small resources, consistently with the lean start-up perspective, such as building a prototype or getting feedback from past users) or "heavy" steps (steps requiring some degree of commitment and larger amount of resources, such as writing a business plan or obtaining intellectual property). While lean and heavy are not substitutes, individuals can consider doing both, they find that potential entrepreneurs are somewhat more likely to take "heavy" steps than lean steps.

Generally speaking, this research has characterized lean in terms of setting and testing explicit hypotheses (Camuffo *et al.*, forthcoming; McDonald and Eisenhardt, forthcoming), being flexible and open to change (Bennett and Chatterji, 2017; Eesley and Wu, 2017), and making low-commitment investment (Bennett and Chatterji, 2017). These features are closely related to the core constructs of MVP and pivoting. Building a MVP entails setting hypotheses and testing them through a low-commitment investment, while pivoting suggests changing course, based on the feedback received from the MVP, and naturally requires strategic and organizational flexibility.

3. Theoretical roots and antecedents

One interesting question is how sharp a break the current discourse around lean start-ups represents in actual behavior of new enterprises, to what extent was planning strongly privileged relative to experimentation, to what extent did the practitioner literature, such as discovery-driven planning (McGrath and MacMillan, 1995, 2009), agile software development (Beedle *et al.*, 2001), and design thinking (Beckman and Barry, 2007; Brown, 2008; Martin, 2009) prefigure these ideas. However, our interest is linking and embedding the ideas around lean start-up in the broader management and technology strategy literatures. In particular, we focus on the links to the research traditions of organizational learning, real options, new product development, and technological evolution as especially relevant.[3]

We start this with a discussion of organizational learning as, arguably, this line of work provides the broadest conceptual framing for a consideration of the lean start-up approach to experimentation. We follow this by exploring the connections and contrasts of the lean start-up approach with work on real options. This perspective shares with lean start up a sensibility to the intentional design of experimental approaches that is generally less salient in the organizational learning literature. We then shift to work that explicitly focuses on technological innovation, starting with a more "micro" view of experimentation provided by work on product development. Finally, we shift to the more "macro" consideration of technological change as reflected in work on technology evolution.

3 We have chosen these four bodies of literature as they represent what we believe are the strongest conceptual associations with the lean startup. We are certainly aware there are other important related literatures, including the works on effectuation (Sarasvathy, 2001), bricolage (Baker and Nelson, 2005), and improvisation (Miner *et al.*, 2001).

3.1 Organizational learning

In an abstract sense, the lean start-up approach can be viewed as applying the scientific method to the problem of business development: an a priori hypothesis is posed, this hypothesis is tested with data, and that data is use to confirm or refine the initial hypothesis, and a new experimental trial is posed. There is the important further additional element that if the experiment is deemed successful, then the next iteration should be carried out at greater scale than the preceding effort. There is a substantial literature on the optimal design of sequential experiments (cf., DeGroot, 1962). However, given the high level of ambiguity in which a lean start-up is carried out, the statistical decision problem approach is not readily applicable to this context. Rather, it is more closely associated to a problem of organizational and individual learning.

In this spirit, writing well prior to the coining of the term lean start-up, Lynn *et al.* (1996: 19) discuss the new product development problem as one of 'probe and learn':

> Probing and learning is an iterative process. The firms enter an initial market with an early version of the product, learn from the experience, modify the product and marketing approach based on what they learned, and then try again. Development of a discontinuous innovation becomes a process of successive approximation, probing and learning again and again, each time striving to take a step closer to a winning combination of product and market.

Consistent with this perspective provided by Lynn *et al.* (1996), as a general property, learning processes are premised on feedback. Actions associated with success are reinforced and actions associated with failure avoided (Levitt and March, 1988; Argote, 2013). Feedback based learning processes are central to process improvement efforts in lean manufacturing, as well as to the discovery and refinement of business initiatives in the context of lean start-ups. However, in contrast to the usual treatment in the organizational learning literature (March and Simon, 1958; Levitt and March, 1988; Argote, 2013) in which experiential learning is typically viewed as a by-product of action, within the lean start-up approach there is a sense of a more self-conscious design of the choice of action (experimental trials) and the information that the effort will provide for future design efforts (Levinthal, 2017). Specifically, the lean start-up approach explicitly distinguishes between a learning intensive phase, where the venture looks for product market fit, and a scaling phase, following the achievement of product market fit. While the literature on lean start-ups maintains that learning is important throughout all phases of a start-up's development, the emphasis on self-conscious, dedicated effort on experimentation is specific to the first phase, while the leveraging of the learning obtained is central in the second phase.

This contrast between a phase of "experimentation" and a subsequent "scaling" process has a close correspondence to the notion of the exploration-exploitation tradeoff that is central to the organizational learning literature (Gittins, 1969; Holland, 1975; March, 1991; Posen and Levinthal, 2012). The exploration-exploitation tradeoff balances the returns to making use of what is currently viewed as the best action versus foregoing that action and searching alternative, potentially superior actions. The lean start-up approach does not explicitly incorporate a loss associated with the opportunity cost of foregoing the best known alternative. Rather, the lean start-up faces the pressure of generating revenue and for the initiative to achieve some degree of self-financing before its initial capital stock is burned up. This limited capitalization and the associated need for self-financing provides the pressure and incentive to, in short order, solve the problem of what constitutes a viable product for a specific market.[4]

Lean start-up differs from the exploration-exploitation tradeoff not only in that the issue of opportunity cost is replaced by a kind of survival criterion, but the feedback dynamics underlying the termination of broad search and the ensuing narrowing down of search and experimentation also differ. Within the lean start-up approach, experimentation narrows when the initiative begins to gain traction in the marketplace. When the joint characteristics of the product or service offered, the specific markets to which this effort is directed, and the mechanisms by which value is appropriated result in meaningful financial returns, then broad search (and pivots) stop and a narrower fine-tuning of the product, market, and value appropriation mechanisms begins. However, what constitutes a meaningful

4 It is important to contrast the notion of "viable" as in a product-market match that can make the enterprise financially sustaining and the idea of a "minimally viable" product that denotes a product-market match sufficient to elicit some degree of consumer traction, but not necessarily financial health of the enterprise or its longer run survival.

financial return, whether achieving aspirations of becoming a "unicorn"[5] or a more modest financial return, is a critical factor in this argument and one that has not been highlighted in this framework. The notion of aspiration level, central to the literature on the behavioral theory of the firm (Cyert and March, 1963; Greve, 2003; Gavetti *et al.*, 2012), appears closely related to this notion of "fit," a connection worth exploring as we discuss below.

3.2 Real option theory

A real option entails making an initial investment in an initiative that provides access to some future investment opportunity, an opportunity that will be exercised or not contingent on the information acquired subsequent to the initial investment. While the real option framework has been widely used to represent and formalize situations of investment under uncertainty, in important respects it is clearly distinct from the lean start-up approach. There are arguably two fundamental differences between real options and lean start-ups. First, a real option approach suggests a go, no-go response to feedback: the option is either exercised or the firm chooses to forego the option and terminate the initiative. In contrast, the lean start-up approach emphasizes the importance of pivoting, of changing various facets of the business proposition in response to what is learned from the feedback received through the prior effort. This contrast is similar to the contrast Adner and Levinthal (2004b: 120) make between the exercise/abandonment approach of a real option with a discovery/learning approach: "The implicit imagery [of a real option] is of a firm buying a ticket to engage in some pre-specified opportunity set, thus ignoring the potential for the firm to mold and enhance initiatives, learn about new opportunities, and discover new possible initiatives not conceived of at the time of the initial investment."

The other fundamental contrast is that an options approach is meaningful only if there is more than one option available to the decision-maker. Putting aside the implicit "outside option" of disbanding the enterprise and reallocating human and financial capital in that manner, a lean start-up approach suggests a single trajectory at any given point in time. This stands in contrast with the real option approach which emphasizes the merits of many simultaneous initial bets. Thus, while from the perspective of a venture capitalist a set of lean start-ups would have this property of parallel experimentation, a lean startup itself is primarily a sequential experimentation effort from the perspective of the entrepreneur.

3.3 Product development

New ventures are, in some sense, free-standing product development efforts and, in that regard, it is important to consider the established literature on new product development. This line of work has offered various contributions that are germane to the consideration of lean start-ups.

A central concept in the product development literature is that of a design funnel (Wheelwright and Clark, 1992 and Clark and Wheelwright, 1993). This process entails starting from a large set of ideas, screening them, and allocating resources to a small set of promising ones. This perspective places emphasis on defining and refining the product design before moving to implementation and commercialization. This approach shares some elements of a real-option sensibility, in that multiple initiatives are considered and then there is a focus on the most promising ones; and, in that regard, the approach is at odds with the lean start-up orientation of pushing hard early on a specific manifestation of the development effort before the design is finalized.

In another line of work, Clark and Fujimoto (1990, 1991) point to the importance of linking with latent customers of the development effort and identify the notion of "product integrity," which has both an internal dimension—the coherence between the product components—and an external dimension—the coherence between product performance and customers' expectation. After discussing formal mechanisms leading to internal integrity—including coordination committees, engineering liaisons, and project managers, Clark and Fujimoto (1990) observe that these structural mechanisms are generally "focused inward; they do not address integrity's external dimension. So unless the company makes a deliberate effort to integrate customers into the development process, it is likely to create products that are fresh, technologically advanced, and provide good value but that often fall short with sophisticated consumers." While this work certainly incorporates an aspect consistent with the lean start-up—the focus on the

5 A unicorn, in the jargon of the startup community, is a new venture that reaches a valuation of one billion dollars or more.

demand side and the importance of market uncertainty–it does not highlight the role of actively experimenting on the market to obtain such customer feedback, which is perhaps the core element of the lean start-up.

In more recent work, Thomke (1998, 2001) introduces a more experimental approach to product development. Thomke (1998) proposes two basic modes to conduct an experiment: computer simulation and rapid prototyping, two activities akin to, respectively, offline and online learning (Gavetti and Levinthal, 2000). In subsequent work, Thomke and Bell (2001) consider the optimal timing of changing the mode of experimentation as a function of the cost of experiments and the nature of the feedback associated with the two forms of experimentation. In Thomke's work, the emphasis is primarily on experimentation as a way of solving technical uncertainty. In contrast, the form of experimentation emphasized by the lean start-up approach is primarily on the demand side, and has the objective of reducing commercial uncertainty.

Iansiti (1995) and MacCormack *et al.* (2001) propose the notion of flexible new product development (NPD) process, which brings the approach to product development more closely aligned with that suggested by that of lean start-ups. Contrasting a traditional approach to NPD which he characterizes as focusing "on developing a structured process with clearly defined and sequential phases, through which the future product is defined, designed, transferred to the manufacturing plant, and rolled out to the market," Iansiti (1995: 38) argues for a flexible NPD approach in which the firm has "the ability to gather and rapidly respond to new knowledge about technical and market information as the project evolves."

Elaborating on these ideas, MacCormack *et al.* (2001) define traditional NPD processes as consisting of three distinct phases: concept development, detailed design, and system-level test. These phases are performed sequentially, with each phase beginning once the previous phase is concluded. Critically, feedback on market performance is received only in the third phase, once the concept is frozen. When market uncertainty is high, this approach is likely to be ineffective. Instead, a flexible NPD process in which these stages overlap may be preferable. In this way, the firm obtains market feedback before the concept is frozen and can incorporate such information in developing the concept and finalizing the detailed design. Clearly, this property is broadly consistent with the lean startup approach. Indeed, the overlap between phase 1 and phase 3 in the flexible NPD approach is indicative of the degree of experimentation within the NPD process.

3.4 Technological evolution

The literature on technology evolution has long recognized the centrality of the dual role of forces of supply side driven technical change and needs of the external market. While early work tended to privilege one mechanism over another, with Schmookler (1966) being a particularly strong articulation of the primacy of demand considerations, contemporary research has tended to take a more balanced view (see Di Stefano *et al.*, 2012 for a review). Indeed, Mowery and Rosenberg (1979) argue for the inherent difficulties of partialling out so-called "demand-pull" and "technically-push" effects and suggest that the process of technology evolution is best understand through the consideration of the interplay of the two mechanisms.

Rosenberg's (1963) work on general purpose technology depicts a particularly important dynamic by which technologies evolve over time through their interaction with distinct application domains. Rosenberg (1963) details how the basic technology underlying the machine tool industry first emerged in the context of the developing of precision boring equipment for the manufacture of rifles. This technology was then applied to sewing machines, bicycles, and automobiles, until finally developing into a large independent industry (Rosenberg, 1963). Thus, the technology of machine tooling ultimately, much like computer technology years later, developed in a manner not circumscribed by the particular application domain of its "birth."

While the emergence of a general purpose technology is one possible dynamic, a related but distinct dynamic is associated with speciation events in which an existing technological trajectory finds application in a new domain and a qualitatively distinct trajectory commences in this new domain (Levinthal, 1998). Examining the history of wireless communication, Levinthal (1998) documents how the scientific laboratory equipment of Hertz was applied by Marconi to the problem domain of wireless telegraphy and a distinct technological form emerges, a form that itself experiences subsequent speciation events into radio and cellular communication. Cattani (2006) further develops these ideas in the context of Corning's development of fiber-optics technology, examining the process of "exaptation," whereby "traits" developed in one context, by chance, prove to have merit in a distinct market context.

More generally, a perspective has emerged within the literature that considers technology evolution as a process of technologies with a set of performance attributes moving through a space of diverse users and potential application markets. For instance, Malerba *et al.* (1999) trace the impact of distinct submarkets on the possible histories of computer technology. Adner and Levinthal (2001) examine the pattern of technology evolution, and in particular the prominence of process and product innovation, through a relatively diverse "space" of potential users. Franke and von Hippel (2003) examine the impact of technological change as a result of diversity at the level of individual users. While much of this work treats the unit of analysis as an overall technological trajectory advancing in a particular manner, Christensen and Bower (1996) focus on the linkage between a particular firm's technological trajectory and their focal customers.

Studies of technology evolution recognize both the cumulative building of technical capabilities and broader technological systems and the role of feedback and selection from the settings in which these technologies are situated. In that regard, technological evolution is understood as an iterative process of both technical advances and market feedback (Kline and Rosenberg, 1986). While the focus is generally at a more macro level than that considered by work on lean start-ups, the fundamental dynamics of planned and unplanned experimental trials and market reaction are common to both literatures.

3.5 Summary

Figure 1 provides a summary of the lean start-up framework and the existing perspectives of organizational leaning, real options, product development, and technology evolution. The most immediate divergence among the approaches discussed is in the level of analysis. The lean start-up approach clearly focuses on the entrepreneurial venture as the main unit of analysis. The organizational learning literature often takes a micro approach, with learning processes often analyzed at the individual or team level, as well as the level of the organization as a whole. The real option approach generally focuses on large enterprises, emphasizing the management of large portfolios of real options. The product development literature typically examines the dynamic of individual R&D teams, and is less focused on enterprise outcomes. Finally, the technological evolution literature takes a macro approach, focusing on the evolution of broad technological trajectories.

A critical difference among these approaches is the number of initiatives that the firm is considering at each point in time. The lean start-up assumes the pursuit of a single initiative, which gradually changes and improves through a series of experiments and pivots. The organizational learning literature is largely agnostic on this issue of singular or multiple initiatives, though much of the literature emphasizes the tradeoff between refining established processes (exploitation) and broader search over novel alternatives (exploration). The real option approach presumes the decision-maker considers a multiplicity of initiatives. The product development literature, at least with regard to the

	Lean Startup	**Organizational Learning**	**Real Options**	**Product Development**	**Technology Evolution**
Unit of Analysis	Entrepreneurial venture	Individual, team, firm	Firm	R&D team	Technology trajectory
Initiatives	Single	Single	Multiple	From multiple to single (funnel)	Ecology of possible trajectories
Feedback	Product markets	Focal performance dimension	Signal (technology or product market)	Technical performance	Product markets
Selection Criterion	Product Market Fit	Aspiration level	Anticipated economic payoff	Gating	Survival
Flexibility	Pivoting	Local and distant search	Flexibility *across* options not within	Iterative refinement	Iterative refinement & shift in application domain

Figure 1. Lean start-up and related perspectives.

classic design funnel approach, suggests a winnowing down of a large set of options, though more recent writings in this tradition have emphasized the importance of iterative design efforts. Finally, while work on technology evolution literature typically focuses on the development of a single technological trajectory, there is a general sense of a realized or latent "ecology" of possibly competing, or supplementary, trajectories.

The five perspectives differ in terms of the source of feedback. Within the lean start-up approach, feedback is primarily from the product market as a result of customers' reaction to the minimally viable product. Similarly, technology evolution studies generally assume that feedback mostly originates in product markets. The organizational learning literatures defines feedback as performance along a focal performance dimension, which may be an individual level outcome or an aggregate organizational outcome. In the real option perspective, feedback is a signal received subsequent to an initial investment, without generally specifying whether this signal is primarily of a commercial or technical nature. In the product development domain, feedback is primarily about the technical performance of the product.

The selection criteria as to what constitutes a level of performance that justifies continuing with an initiative varies across the five approaches, though operationally the contrasts are less clear. The lean start-up approach emphasizes the notion of product market fit, but what constitutes "fit" is not clearly delineated. In the organizational learning perspective, the selection criterion is achieving a "satisficing," above aspiration level, level of performance (Cyert and March, 1963). Arguably the real option approach provides the clearest selection criteria of a strict economic calculus of profitability. The gating criteria discussed within the product development literature suggests a multi-dimensional criterion of technical performance and projected market value, though how these various attributes are aggregated to an ultimate decision criterion is not, in general, clear. In studies of technology evolution, the primary selection criterion is generally the survival of the technology vis-à-vis alternative competing technologies.

Finally, the five approaches differ with respect to flexibility. The lean start-up proposes a substantial degree of flexibility, embodied in the notion of pivoting. Based on the feedback received, the venture iteratively adapts its product or business model in order to approach the point of product market fit. In work on organizational learning, flexibility is often expressed in the choice between local search and distant search. Flexibility in the context of the real option approach is primarily across initiatives, emphasizing the possibility of selecting promising initiatives and abandoning others. In the product development literature, especially in the more recent work by Iansiti and MacCormack, there is a notion of iterative refinement, though this is largely with respect to technological features and not encompassing the broader business model as in the case of lean start-ups. In the evolution of technological trajectories, somewhat similar to the case of lean start-ups, flexibility takes the form of both the link between the technology and various latent niches and the iterative refinement within a niche. In this literature, however, the focus is on the shift in application domain, while the lean start-up approach calls attention to a variety of elements of a candidate business model, such as how value is best captured, and does not privilege application domain as a primary basis of pivoting.

Looking across these approaches, it appears that parallelism across initiatives and flexibility within initiatives operate as substitutes. The lean start-up approach and real options provides the starkest contrast with the lean start-up privileging the role of flexibility within a given initiative, but emphasizing the engagement with a single initiative at any point in time. In sharp contrast, a real options approaches emphasizes a high degree of parallelism of initiatives, but generally treats individual initiatives as rigid apart from the flexibility, or option, of the go/no-go decision. While work on technology evolution is open to the dynamics of possible technological trajectories, it also engages with a potential population of competing and supplemental trajectories. The suggested approach from the product development literature provides a mixed perspective, with the design funnel suggesting the importance of an initial degree of parallelism with a subsequent emphasis on "building" and "testing" of a small subset of these efforts. Lastly, the organizational learning tends to contrast a focal alternative with some set of latent alternatives.

4. Technological and economic drivers

The energy and attention around the lean start-up approach cannot be separated from the technological and institutional context in which it has arisen. We suggest that a set of significant technological and economic changes have created an environment particularly favorable to a conception of an entrepreneurial management based on experimentation, flexibility, and market feedback. In particular, we point to the growth of internet enabled commerce,

cloud computing, open source programming, rapid prototyping, and crowdfunding as some of the important enabling factors.

The advent of web-based applications and the web as a mode of distribution have enabled the possibility of essentially continuous product releases in software-related sectors. This has allowed start-ups to experiment on the product market, obtain customer feedback, and adapt the product development process through multiple, rapid iterations. While Cusumano and Selby (1995) observe the application of the Toyota system of production to the development of software at Microsoft—what they termed the software factory with its process of a daily cycle of build-compile-test—this process was focused on development efforts around the technical merit of the software and not on a cycle of commercial activity. It is the advent of the web as a platform that has allowed this build-compile-test cycle to be applied to the commercial sphere as well.

Further, with the emergence of cloud-based computing, even modestly capitalized start-up enterprises are able to rapidly scale up as their offerings gain commercial traction. The introduction of Amazon's cloud computing service in 2006 is reasonably viewed as a technological shock that has lowered the cost of experimentation for start-ups operating in sectors where computation is an important component of the business model (Ewens *et al.*, 2018). In addition, the open source movement (Lerner and Tirole, 2002, 2005) has given entrepreneurs access to software capabilities at substantially lower costs. This trend has radically increased the speed at which early stage, financially constrained ventures are able to produce and launch software-based products.

Even outside software-related contexts, the costs of experimentation has starkly decreased. In particular, the developments of rapid prototyping techniques (Barkan and Iansiti, 1993), such as computer-aided technologies [computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE)] and more recently 3D printing, have dramatically impacted the fixed costs and temporal lags associated with offering novel iterations of physical goods and thereby lowered the cost of experimentation for firms outside the Internet and software domains.

Finally, it is useful to note that the financing environment in which startups operate has become substantially more "democratic" in recent years. The access to funding has become easier, allowing entrepreneurs to obtain the financial resources needed to build and commercialize early stage products more readily. One important factor contributing to this trend has been the introduction of Kickstarter and other crowdfunding platforms (Mollick, 2014; Mollick and Kuppuswamy, 2016). Additionally, besides providing the financial capital to develop a MVP with which to get feedback on the product market, crowdfunding is itself a channel to obtain market feedback. The proliferation of institutions such as accelerators and incubators have also provided a supportive context for early stage experimentation.

5. Boundaries and contingencies

While it has unquestionable merits, the lean start-up is unlikely to correspond to a universal best practice. New ventures can follow a non-lean approach, which emphasizes planning, prediction, and some degree of commitments, rather than experimentation and discovery. Such an approach would entail building a product or service that has undergone considerable evaluation prior to any full public commercialization. While this may sound counterintuitive in our current context, this planning oriented approach has been quite prominent in entrepreneurship teaching and practice (Sahlman, 1997). Using the language of the entrepreneurship literature, start-ups waiting to commercialize the product until fully complete are said to operate in "stealth mode." Ultimately, there is a range of product development approaches defined by two extremes of complete reliance on experimentation (lean start-up) and virtually no use of experimentation (stealth mode). It is worth considering some potential boundary conditions, suggesting situations in which choosing the lean start-up approach may not be preferred. These boundary conditions, in turn, suggest a number of interesting opportunities for future empirical work that can consider the contingent merit of a lean start-up approach.

The first factor is naturally the cost of experimentation. While these costs have decreased, experimenting on product markets can still be costly, and this cost is likely to be a function of the industry context in which the venture is operating. For instance, while some aspects of drug development in the life sciences have changed—in particular a vast increase in the efficiency with which candidate molecules can be tested—clearly the lean approach of bootstrapping and rapid cycles of commercialization of different iterations of the product is not applicable in this setting. While in the pharmaceutical context the brake on rapid iterations of possible commercial products is in part a result

of regulatory hurdles and the associated costs and lags of research efforts, in other non-IT related fields there may still be substantial fixed costs associated with each iteration of the product development effort. When such fixed costs are relatively high, experimentation in the form of offering a series of distinct commercially viable candidate products on the market would be less desirable.

A lean approach, by going to market with an early stage product, may be associated with the disclosure of important strategic information. Naturally, this increases the awareness on the part of incumbent firms of these commercial possibilities, firms often with vast financial, technical, and marketing resources which could be marshalled to enter the market and thereby represent a substantial threat to the viability of the new venture. This issue appears not to be a major concern in the lean start-up conversation, as Blank (2013) observes:

> During the dot-com bubble, startups often operated in stealth mode (to avoid alerting potential competitors to a market opportunity), exposing prototypes to customers only during highly orchestrated beta tests. The lean startup methodology makes those concepts obsolete because it holds that in most industries customer feedback matters more than secrecy and that constant feedback yields better results than cadenced unveilings.

However, some industries are characterized by low appropriability regimes, with weak intellectual property protection and the possibility of learning from experiments on the part of the focal firm diffusing to other firms (Teece, 1986). In such settings, the risk of disclosure of critical insights associated with experimentation is potentially relevant.

The primary prescription of the lean startup approach is to obtain customer feedback through a MVP and to incorporate such information into the product. This process often requires selecting an initial target customer group of early adopters, commercializing the product to fit this market niche, and extracting feedback from it. Naturally, this sampling process may present a variety of statistical challenges. It is hard to know whether such a sample is representative of a larger population and therefore whether the feedback is applicable to the larger market. Indeed, lean startups may be subject to the myopia of learning (Levinthal and March, 1993) in that experimental efforts in settings where the financial payoff to such efforts may be relatively distant in time will tend to be viewed negatively.

Experimentation—and the consequent feedback-based adaptation—often leads to the need for change in a business model, organizational structure, or key members of the start-up team. These changes may be costly, not only financially, but also in terms of time, attention, and motivation of key members of the start-up firm. Frequent substantive experimentation will incur a number of costs associated with redirecting the start-up team's effort and may entail the demotivation and loss of confidence of employees and various stakeholders.

Finally, experimentation may lead to reputation costs. By commercializing an early stage product, start-ups face a significant probability of negative market reaction and the risk that the negative reaction of the early adopter group may spread and may have adverse reputational impacts. If the reputation is to some extent sticky, the start-up pays this reputation costs even should subsequent efforts result in a product that succeeds in meeting customers' technical requirements.

6. Implications for management research

The exercise of situating the lean startup in the broader management and technology strategy literature leads to a variety of interesting implications for research in entrepreneurship, as well as with respect to innovation in the context of larger, established enterprises.

The lean start-up approach suggests venture experimentation through the commercialization of a minimally viable product and using the resulting feedback to pivot. This decision necessarily requires the existence of a performance threshold. The identification of such a threshold poses a number of challenges. First of all, below this threshold, information is provided in the sense that customer requirements were not met; but, such feedback is not directional and is therefore not directly suggestive of what modifications should be made in a subsequent effort. In addition, an issue somewhat under-appreciated in the discussion of MVPs is that there may be substantial heterogeneity as to what constitutes a sufficient minimum among different sets of consumers (Adner and Levinthal, 2001). Further, this minimum threshold may be a function of the set of complementary goods and services available to different actors (Adner, 2012). The process of leading ventures to identify these diverse thresholds appears to be an important and yet not well developed or understood consideration.

In some sense, these comments highlight the "horizontal" dimension of what constitutes fit—fit with respect to a particular target audience and their potential needs. Arguably even less developed is the "vertical" dimension of

what constitutes "fit." Generally, fit is defined by some meaningful financial returns. However, what constitutes meaningful financial returns is a critical factor in this argument and one that has not been highlighted in this framework. The issue of aspiration level is central to the literature on the behavioral theory of the firm (Cyert and March, 1963; Greve, 2003; Gavetti *et al.*, 2012) and there would seem to be an interesting research opportunity in linking these two literatures. Is the threshold of "fit" a relatively fixed, absolute threshold or a criteria that shifts (adapts) with the venture's direct experience, perhaps declining after prior efforts at reaching a previously expressed performance criterion? Alternatively, is there a social learning element (Baum and Dahlin, 2007) as to what constitutes fit—is the criterion sensitive to the recent commercial outcomes of related ventures?

Further, the magnitude of performance success that is interpreted as constituting product-market fit may differ substantially between the setting of a standalone start-up and an established enterprise. Indeed, the value associated with this threshold is arguably a critical part of what distinguishes corporate and stand-alone entrepreneurial efforts. For instance, Christensen (1997) notes the challenge that corporate-based entrepreneurial efforts face in generating incremental profits that are sufficiently meaningful from the perspective of a large, established enterprise. In contrast, if such efforts are financially segmented within the established firm or take place in the context of a start-up, the hurdle as to what constitutes a meaningful incremental return may be quite different. Of course, if the start-up is subject to the aspiration that it should develop into the next unicorn, then this same challenge of a high threshold may express itself in the start-up context as well. It is interesting to investigate whether the aspiration level associated with the experimentation process systematically differs in large enterprises relatively to entrepreneurial ventures.

A further interesting difference between a start-up and an established enterprise relates to the scope of investment approaches that the large corporation may employ. Arguably, large corporations may employ an investment approach that is more similar to real options. In the corporate context, a given initiative is generally one of a broader portfolio of options. In its simplest and most stark form, this can be considered to be the contrast between the firm's existing core business and its new venture initiatives. However, there may be a broader portfolio of options, or initiatives, competing for a firm's resources. It would be interesting to explore how large enterprises combine within-initiative flexibility as in the lean start-up, with the across-initiative flexibility typical of real options.

In a lean startup where there is a malleable, but singular development effort, there is unambiguous pressure and incentive for those directing that effort to succeed and gain commercial traction. In the corporate context, there are multiple lines of activity to which time, energy, and key employees can be transferred and, as a result, the productive repurposing of assets can occur more readily than in the case of a startup enterprise. In contrast, if the startup cannot pivot itself to success, reallocation must occur within markets for capital, labor, and other factor markets. The focus within a lean start-up on a singular development trajectory at any given point in time is primarily a by-product of the constraints of financial and non-financial resources under which such enterprises operate. However, this modest capitalization and the absence of a parallel "plan B" clearly has significant incentive effects on the focal actors. Illustrating this sort of effect, Shin and Milkman (2016) show in experimental research that the mere consideration of a backup plan can reduce subjects' performance on their objectives. Thus, the urgency that team members feel in the lean start-up context to achieve rapid commercial viability is unlikely to be recreated within an established corporation. How, and to what degree, can large firms approximate an incentive structure similar to that of lean start-ups is a fascinating open question.

7. Conclusion

We agree that the lean start-up approach is an important empirical reality as well as a set of distinctive ideas. However, the broader notions of feedback-based learning processes and experimentation which lie at the core of these efforts are not entirely novel. Therefore, we believe that placing the concept of lean start-ups in this broader context of the management literature is helpful to understand both its origins and its distinctive properties. Lean start-ups are not only part of a larger discourse in the management literature, but are also historically situated with respect to the technological opportunities and supporting infrastructure that potential entrepreneurs face.

The consideration of lean start-ups also poses questions regarding innovative efforts within established firms. What is the contrast between a lean start-up and a lean corporate development effort? Is, in fact, the later form feasible? McGrath and MacMillan's early work (2009) on discovery driven planning, which Blank (2013) credits with laying some of the important conceptual groundwork for his initial development of the lean start-up approach, takes

place in the corporate context. However, per the above discussion, there are several important factors that would seem to limit or temper the possibility of enacting the lean start-up approach within the context of an established firm.

In this regard, it is interesting to contrast the degree of flexibility and parallelism associated with alternative forms of entrepreneurship. The lean start-up entails a singular developmental trajectory, but one that might be subject to significant and abrupt pivots. In contrast, an established corporation of substantial scale and scope can engage in a high degree of parallelism in its development efforts. While such enterprises have the financial and non-financial resources to engage in parallel efforts, it is likely that the specific underlying initiatives are subject to greater levels of inertia and rigidity than those of a lean start-up. In part, this may result from the lack of rapid market testing that might inform appropriate pivots. But, arguably more important, are the challenges of recontracting within an established firm for what constitutes an appropriate agenda for the initiative (Gibbons and Henderson, 2012). Indeed, Klepper (2009) argues that political battles over the appropriate course of an innovative effort are an important catalyst to entrepreneurial spinouts (Campbell *et al.*, 2012). In contrast, individual entrepreneurial efforts offer the possibility of flexibility within a given initiative via pivoting. In addition, a population of distinct entrepreneurial efforts offers the possibility of diverse perspective taking and sense-making across initiatives with different sets of entrepreneurs and venture capitalists having different views of the opportunity structure that they face (Alvarez and Barney, 2007) and how to best interpret the data generated from early efforts to seize these opportunities.

At one point in time the locus of corporate R&D efforts was primarily restricted to the relatively isolated confines of corporate research parks, with a focus on learning and discovery with respect to technological challenges and a relative inattention to learning about market needs (Rosenbloom and Spencer, 1996). The failure of companies such as Xerox to successfully commercialize the products of such research efforts (Smith and Alexander, 1988) led to corporations pushing their research efforts out to their underlying operating units. Lean start-ups represent a further pushing forward of innovative efforts to prospective commercial contexts. Situating these ideas in the context of the broader management and technology strategy literature not only gives us new insights about the phenomenon itself, but also suggests a number of interesting research questions that lie at the interstices of these existing literatures and that of lean start-ups. We look forward to the further flowering of this phenomena and to our understanding of it.

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