RATIONALITY AND HEURISTICS: HOW VENTURE INVESTIGATION EFFORTS AND PRIOR STARTUP EXPERIENCE DRIVE BUSINESS MODEL DEVELOPMENT AND VENTURE PROGRESS IN NASCENT TECHNOLOGY VENTURES

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ABSTRACT

Why do some nascent entrepreneurs have more developed business models than others? And do more developed business models facilitate venture progress? In this study, we examine the effects of rational venture investigation and experience-based heuristics as dual drivers of business model development in nascent technology ventures. We propose that business models serve as cognitive schemas that entrepreneurs leverage for venture progress. Using a unique longitudinal dataset of nascent technology ventures, we find that both venture investigation efforts and prior startup experience have a positive effect on business model development. More developed business models, in turn, facilitate a venture's progress, measured as recruiting employees and acquiring early customers. The business model not only has a direct impact on venture progress, but importantly, serves as a mediator that translates the founder's venture investigation efforts and prior startup experience into venture progress. Our study provides unique empirical evidence that rational and heuristics-based approaches positively and independently impact business model development, which significantly contributes to nascent venture progress.

Keywords: Business models, technology ventures, startup experience, venture investigation, heuristics, rationality, entrepreneurship.

INTRODUCTION

New venture emergence can be fundamentally viewed as the result of entrepreneurial choice—the result of founders making and enacting decisions about how to organize a new firm, which markets to enter, how the firm will create and capture value, and what the firm's boundaries will be vis-à-vis suppliers, partners, and customers (Doz and Kosonen, 2010; Gruber et al., 2008; Witt, 2007). In this view on firm creation, the business model construct offers a cognitive framework for conceptualizing the entrepreneur's "envisioned business" (Witt, 2007, p. 1125) and enables an emerging company to experiment with various forms of value creation and capture (Andries et al., 2013; Blank, 2013). However, little is yet known about what drives initial business model development, and despite the widespread practitioner adoption of the business model concept, research is still scarce on whether and how business model development influences a venture's emergence. In this study, we take a cognitive lens to address these questions in the setting of nascent technology ventures.[1]

In the cognitive view, business models are "schemas that organize managerial understandings about the design of firms' value-creating activities and exchanges" (Martins, Rindova and Greenbaum, 2015, p. 99). As such, they represent accumulated knowledge, provide frames for interpreting new information, and organize knowledge at different levels of abstraction (Fiske and Taylor, 1991; Martins et al., 2015). A business model is thus a "cognitive frame" enabling an entrepreneur to develop and use conceptualizations of issues to simplify and interpret the environment, aiding the decision-making process (Chong and Druckman, 2007; Sund et al., 2021). Cognitive frames are especially helpful in situations where uncertainty is high (Kaplan, 2008), as in the context of new venture emergence. In essence, a business model forms a template or "blueprint" for the new venture, enabling entrepreneurs to garner resources and

[1] Note that our focus is not on the content or innovativeness of a business model, but on the extent to which a business model has been developed for the nascent venture.

build the ventures they envision to exploit their identified opportunities.

In this paper, we draw on two different perspectives in the entrepreneurship literature to examine why some nascent entrepreneurs have more developed business models than others: a rational, investigation-based approach and a heuristic, experience-based approach. On the one hand, from a rational perspective, nascent entrepreneurs can utilize purposeful venture investigation efforts to generate information and analysis about aspects of the venture opportunity, e.g., customers, competitors, the regulatory environment, and required resources (Blank, 2013; Camuffo et al., 2020; Marvel et al., 2020). This rational investigation can then be harnessed to make informed decisions about the nascent venture and its business model. On the other hand, nascent entrepreneurs are also likely to rely on "cognitive shortcuts" or heuristics in making decisions (Baron, 1998; Bingham and Eisenhardt, 2011; Forbes, 1999, 2005a). Rational investigation may be difficult or suboptimal given resource constraints, time pressure, and rapidly changing environments (Miller, 2007), so nascent entrepreneurs will resort to heuristics that facilitate "fast and frugal" decisions (Forbes, 2005a; Gigerenzer and Brighton, 2009). Here, we build on extant research on entrepreneurial cognition suggesting that experienced and novice entrepreneurs differ in the cognitive frameworks they use in the process of opportunity recognition (Baron and Ensley, 2006; Dimov, 2010) and use prior startup experience as our proxy for heuristics-based decision making. Experienced entrepreneurs tend to exhibit greater clarity and richness of content and they focus on factors related to starting and running a company (Baron and Ensley, 2006). They are thus likely to make business model decisions intuitively, based on pattern recognition and heuristics. In order to fully understand how entrepreneurs develop their initial business models, and whether rational or heuristic-based

antecedents to business model development are more salient, it is important to *jointly* examine both the rational, investigative antecedents and the experience-based heuristic influences.

We further examine whether business model development facilitates venture progress, measured as recruiting early employees and acquiring customers. The business model may serve multiple functions — internally, it may help the nascent entrepreneur identify and prioritize the appropriate venture initiation actions; externally, it may help in communicating the vision or "compelling story" of the emergent company to potential stakeholders, increasing its perceived legitimacy and the likelihood of gaining external support. Though conceptual and qualitative research (e.g., Amit and Zott, 2015; Andries et al. 2013), widespread practitioner enthusiasm (e.g., Blank, 2013) and public policy (e.g., Huang-Saad et al., 2017) indicate strong interest and usefulness of the business model construct in the startup process, little quantitative research has actually tested its effects (Grossman, 2016). We address this gap by examining the effects of business model development on nascent venture progress. In particular, we expect that business model development will facilitate the hiring of early employees and attracting early customers. We further propose that a business model will serve as a cognitive schema that helps to translate a founder's experience base and venture investigation efforts into startup action: the development of a business model will (partially) mediate the impacts of venture investigation and prior startup experience on venture progress, thus facilitating the formation of a new organization.

Our research setting is a sample of 112 founders of nascent technology ventures participating in a free two-day training workshop based on the lean startup approach (Blank, 2013; Ries, 2011). The initial workshop targets nascent technology entrepreneurs at the earliest stages, enabling us to examine the role of experience, venture investigation, and business models at initial venture emergence in a population of nascent entrepreneurs undergoing a standardized

training. Follow-up survey data collected a year after the initial data are used to measure our venture progress dependent variables. Technology ventures provide a particularly relevant setting because of the fungibility of technological competencies—a new technology may give rise to numerous market opportunities but the business models to pursue those opportunities are usually not clear from the outset (Gruber et al., 2008; Shane, 2000).

Our study makes two main contributions to the entrepreneurship and business model literatures. First, we shed light on the antecedents of nascent ventures' initial business model development. While considerable research has been conducted on understanding why and how established and young firms change their business models (e.g., Andries et al., 2013; Gerasymenko et al., 2015; Osiyevskyy and Dewald 2015; Saebi, Lien and Foss, 2017), little has been said in the academic literature about how business models are ideated in the first place. As complex structural representations of an emerging firm's activity systems, business models are difficult to create from scratch, requiring the design of a multidimensional, interrelated system of attributes (Baden-Fuller and Morgan, 2010; Martins et al., 2015; Snihur and Zott, 2020), with nascent entrepreneurs serving as the "imaginative architects" (Porac and Tschang, 2013, p. 251) building such systems. Our results indicate that both rational and heuristic approaches are at play in initial business model design—both venture investigation efforts and prior startup experience have a positive effect on the extent to which a business model is developed.

We further show that business model development partially mediates the relationships between venture investigation and venture progress and prior startup experience and venture progress. The mediating effect of business model development highlights the cognitive processes needed to translate venture investigation efforts into a framework that can then be harnessed for business launch. The mediating effect may also illuminate why prior studies have found

inconsistent results related to the effects of prior experience on outcomes such as venture progress, likelihood of first sale, and venture survival (e.g., Colombo and Grilli, 2005; Davidsson and Honig, 2003; Dimov 2010; West and Noel, 2009). Our findings contribute to the growing literature in entrepreneurship about the roles that human capital and cognition play in the entrepreneurial process, enriching the understanding of why prior startup experience matters and how rational and heuristic approaches work in parallel in entrepreneurial decision making (Baron, 2007; Baron and Ensley, 2006; Davidsson and Honig, 2003; Dimov, 2010; Forbes, 2005a; Miller, 2007; Zhang and Cueto, 2017).

Second, our results contribute to theory development and provide unique empirical evidence on the role that business models play in venture emergence. By drawing on cognitive theory, we conceptualize the business model as a tool for venture emergence and propose mechanisms through which initial business model development influences the venture emergence process. Our results indicate that more developed business models significantly contribute to the progress of nascent technology ventures – both directly and by mediating the effects of venture investigation and startup experience. Our findings highlight the importance of making business model decisions early in the venture's life. Overall, our study corroborates the utility of the business model construct in the startup process, with implications beyond scholars and practitioners to policy-makers supporting the creation of new firms.

THEORY DEVELOPMENT AND HYPOTHESES

Business models as cognitive frameworks

A growing literature spanning strategy, innovation, and entrepreneurship research has embraced the business model concept (Massa et al., 2017), defining it as a distinct unit of analysis capturing the system of interdependent activities through which a firm creates and captures value

(Martins et al., 2015; Zott and Amit, 2010). The business model is increasingly recognized as key to competitiveness and financial performance (Snihur and Zott, 2020; Zott and Amit, 2007, 2008), and a major focus in the literature has been to understand how incumbent firms adapt their business models to cope with dynamic external conditions (Chesbrough, 2010; McGrath, 2010; Osiyevskyy and Dewald, 2015). In entrepreneurship, the search for a repeatable and scalable business model has been portrayed as a primary function of a startup organization (Blank, 2013), with business model experimentation driving the survival and growth of new firms (Andries et al., 2013).

Reviews of the business model literature by Massa et al. (2017) and Martins et al. (2015) have identified differing theoretical perspectives with varying interpretations and explanations about what business models are and how they are formulated and changed.[2] In this paper, we take a cognitive view, where business models are seen as mental models or schemas, as "cognitive structures providing a theory of how to set boundaries to the firm, of how to create value, and how to organize its internal structure and governance" (Doz and Kosonen, 2010, p. 371). Our focus is on business models as cognitive frameworks that nascent entrepreneurs use to develop their understanding of a business opportunity and the corresponding exploitation strategy and organizational form (Leatherbee and Katila, 2020; Perkmann and Spicer, 2014).

Consensus in the field suggests that a business model consists of multiple dimensions, a set of interrelated components defining the firms' product/service offering, target market, internal capabilities and economic factors (Zott et al., 2011). On top of these four, some scholars also add competitive strategy and personal factors to allow for generalizability and to account for the need to translate core competencies and the value proposition into a sustainable marketplace

[2] Massa et al. (2017) identified three interpretations of business models as: (1) attributes of real firms, (2) cognitive/linguistic schemas, and (3) formal conceptual representations of how a business functions. Martins et al. (2015) distinguished between a rational positioning view, an evolutionary view, and a cognitive view.

position (Andries et al., 2013; Morris et al., 2005). In this paper, we adopt the latter, broader view, and use the six-category business model conceptualization by Andries and colleagues (2013, adapted from Morris et al. (2005); see Appendix 2). In the following sections, we explore the effect of two different entrepreneurship approaches to business model development (Miller, 2007; Zhang et al., 2020; Zhang and Cueto, 2017): first, a rational, investigative methodology; and then an intuitive, heuristic approach based on past startup experience.

Impact of venture investigation on business model development

An entrepreneur who has conceived of a nascent venture idea must "identify and implement a specific approach to creating and capturing value from the idea" (Gans, Stern, and Wu 2019, p. 739). To do so, the entrepreneur engages in an iterative learning process, continuously assessing and evaluating the venture opportunity (Cooper and Artz, 1995; Dimov, 2007), searching for knowledge about markets and products (Corbett, 2005, 2007) that can be structured and analyzed so that it becomes actionable for progressing the startup. Past research has shown that such pre-launch planning is advantageous for mitigating risk and uncertainty in the startup process (Cope, 2005; Delmar and Shane, 2003). In this literature, the concept of "business planning" has generally encompassed the founders' efforts to gather information as well as the subsequent analysis and codification of how that information will be used to exploit the opportunity (Castrogiovanni, 1996; Delmar and Shane, 2003). We seek to conceptually disentangle the two, and separately consider (1) the founder's venture investigation efforts through which knowledge is acquired and (2) the decision-making process whereby the associated learnings are incorporated and translated into business model design.

In order to learn about the venture opportunity and the alternative business models that could be pursued, nascent entrepreneurs will seek out information and generate real data about,

e.g., customers, competitors, partners, regulators, and required resources (Blank, 2013; Marvel et al., 2020) by "getting out of the building" to conduct interviews and observations. These purposeful venture investigation efforts serve to generate critical new information and first-hand insights to understand the venture opportunity. The challenge then is making sense of what is often "noisy learning" (Gans et al., 2019). As entrepreneurs navigate new domains with high uncertainty, their investigation efforts are likely to generate incomplete, contradictory, and unreliable information. Rational entrepreneurs will expand their investigation efforts to increase the reliability of new information and generate associated confidence. More multifaceted investigation efforts will lead to knowledge with higher reliability and usefulness (Leiponen and Helfat, 2010). Entrepreneurs seeking many different types of stakeholders, researching the broader operating environment, and translating market information into financial projections will garner more knowledge than entrepreneurs investigating more narrowly.

To harness their investigation efforts into tangible action, entrepreneurs then also need to analyze and make sense of this newly acquired knowledge. The business model, as a higher-order cognitive schema, will allow an entrepreneur to structure his/her beliefs about the opportunity and the emerging organization (Martins et al., 2015). Given that the business model is a multifaceted, complex framework consisting of many interrelated components, entrepreneurs must simultaneously consider different facets of the opportunity to make decisions about business model dimensions. We expect that nascent entrepreneurs who have conducted more venture research – by having engaged in more venture investigation efforts – will benefit from broader and richer knowledge content which they can translate into validated hypotheses or design decisions regarding components of the venture's value creation and capture system. In

short, entrepreneurs who engage in more venture investigation efforts will thus be in a better position to develop their nascent ventures' business models. We hypothesize:

H1: The more venture investigation a nascent entrepreneur performs, the more developed will be the business model for the entrepreneur's venture.

Impact of startup experience on business model development

The basic premise underlying studies of the importance of startup experience is that the specific human capital, i.e., the knowledge and skills that founders have gained through their previous experience with launching and managing ventures may provide considerable advantages as they embark on the entrepreneurial process. The prior experience provides expertise in identifying and undertaking the steps associated with starting a venture, as well as navigating the uncertainties involved (Dimov, 2010). However, studies on the impact of prior entrepreneurial experience have led to inconsistent findings regarding venture outcomes such as emergence, performance and survival—Davidsson and Honig (2003) and Colombo and Grilli (2005), for example, found that entrepreneurial experience contributes to venture progress and growth, while Dimov (2010) and West and Noel (2009) did not find a significant direct impact of prior entrepreneurial experience on venture emergence and performance. Nevertheless, scholars have identified other clear benefits from having prior entrepreneurial experience; experienced founders will generate more ideas and identify more opportunities (Gruber et al., 2008, 2012), put more emphasis on building networks and partnerships (Dew et al., 2009), will make faster decisions (Forbes, 2005b), and may get access to external funding more easily (Chatterji, 2009).

Some of these benefits of having prior entrepreneurial experience can be ascribed to having established broader networks of potentially useful contacts and a higher level of perceived legitimacy (Mosey and Wright, 2007; Nagy et al., 2012). However, there are

indications in the literature that a key advantage from having prior entrepreneurial experience comes from the associated cognitive benefits relative to novice entrepreneurs (Baron, 2007). Startup experience allows the development of strong cognitive frameworks that improve the evaluation and selection of opportunities and the formulation of more sophisticated judgments (Baron, 2007; Baron and Ensley, 2006; Cassar, 2014). These cognitive frameworks, or schemas, play an important role in the perception of events and objects and the detection of connections between them (Baron and Ensley, 2006).

In particular, the cognitive frames of experienced entrepreneurs differ from those of novices because cognitive frames are shaped by an individual's prior life experiences (Baron, 2007) and the associated learning process (Baron and Ensley, 2006). Because of the learning that takes place as entrepreneurs gain experience in the intricacies of starting a new venture, they develop cognitive frameworks that are more clearly defined, richer in content, and more concerned with factors related to starting a new venture than those of their inexperienced counterparts (Baron and Ensley, 2006; Matlin, 2005). Higher experience should thus result in more developed, multifaceted business models. Moreover, experienced entrepreneurs are more likely to resort to cognitive shortcuts in order to make "fast and frugal" decisions (Forbes, 2005b; Gigerenzer and Brighton, 2009). Relying on pattern recognition, experienced entrepreneurs will be able to make intuitive decisions related to value creation and capture, anchoring more business model components on insights gained during prior startup experiences. We thus hypothesize:

H2: The more prior startup experience a nascent entrepreneur has, the more developed will be the business model for the entrepreneur's venture.

Impact of business model development on venture progress

Cognitive frameworks have been shown to be particularly useful to guide decision making in situations of high uncertainty, such as nascent venture development, influencing managerial decision making and the strategic actions that firms undertake (Kaplan, 2008; Nadkarni and Barr, 2008). Frames and mental maps have been shown to help individuals with focusing their attention, highlighting priorities, and supplying missing information, thus facilitating strategic decision making (Fiol and Huff, 1992; Hodgkinson et al., 1999).

We expect that the development of a business model, as a cognitive frame representing an emerging venture's design, will facilitate the venture's progress. A business model delineates how the entrepreneur wants to create and capture value in his/her venture and how he/she wants to structure the firm (Bock et al., 2012; Doz and Kosonen, 2010). As a cognitive frame, a business model can transform abstract, broad goals into concrete action steps to allow faster decision making and efficient resource allocation. As such, we expect that business models will accelerate venture progress with regard to two key aspects: recruiting employees and acquiring customers. Recruiting early employees is an important milestone for a nascent firm, made challenging by resource limitations and a lack of legitimacy (Coad et al., 2017). Acquiring early customers is a critical indicator of nascent venture success and long-term survival (Gimmon and Levie, 2020; Wang et al., 2014).

Business models are unique concepts, encompassing both the firm and the network level, explicitly including stakeholders and their activities in the model (Amit and Zott, 2001; Zott and Amit, 2013). Since the business model explicitly accounts for a firm's stakeholders and resource needs for value creation and capture, a more developed business model will help an entrepreneur determine the venture's human resource needs and define its target customers. With a more

developed business model, the nascent entrepreneur will possess a better understanding of the venture's value proposition and activity system, enabling the effective communication of this vision to potential employees and customers.

Past research has indicated that the successful recruitment of external stakeholders additionally depends on symbolic actions and the level of preparedness demonstrated by the entrepreneur to potential resource holders (Chen et al., 2009; Huang and Knight, 2017; Zott and Huy, 2007). A more developed business model can convey the higher "quality" of the entrepreneur when recruiting early employees or pitching customers as it illustrates careful consideration of market needs, product/service attributes, and value creation and capture. It can demonstrate that the nascent venture adheres to professional structures and processes and has already reached a higher level of organizational achievement (Zott and Huy, 2007). Both the level of preparedness that the entrepreneur displays and the symbolic actions that he/she takes have been shown to help with the successful recruitment of key stakeholders, such as customers, employees, and investors (Chen et al., 2009; Zott and Huy, 2007). Because of these multiple roles that the firm's business model can play, i.e., as a tool to structure and communicate the organization's intended value creation and capture, and also as a signal and a proxy for the entrepreneur's level of preparedness, we expect that the extent to which a nascent venture's business model is developed will be associated with the venture's progress. In particular, we hypothesize that more developed business models will help accelerate the recruiting of employees and acquisition of early customers for nascent technology ventures:

H3: More developed business models will be positively associated with nascent venture progress, exhibited as (a) recruiting employees and (b) acquiring customers.

Mediating role of business model development

In the previous hypotheses, we have argued that a founder's venture investigation efforts and prior startup experience will influence the development of his/her venture's business model, which in turn will be linked with the venture's startup progress. Implicitly, then, this suggests that venture investigation and startup experience affect performance *via* their impacts on the firm's business model. We thus expect that business model development will play a mediating role between venture investigation and venture progress, as well as between startup experience and venture progress.

Venture investigation and startup experience may of course have direct effects on venture progress. For example, a customer discovery interview may lead to an actual sale even without the cognitive process of first incorporating insights into the business model framework, and some benefits of experience, such as broader networks and reputation, may directly facilitate the nascent venture's relations with external stakeholders (Chatterji, 2009; Mosey and Wright, 2007). However, we propose that, in addition to such direct effects, a significant portion of the benefits of both venture investigation and startup experience will take place through the mediating cognitive process of business model development as it enables entrepreneurs to translate their analytical findings and experience-based intuitions into a detailed, actionable "roadmap" that then facilitates the venture's progress. We hypothesize:

H4: A nascent technology venture's business model development will (partially) mediate the relationship between the founder's venture investigation efforts and the venture's progress, exhibited as (a) recruiting employees and (b) acquiring customers.

H5: A nascent technology venture's business model development will (partially) mediate the relationship between the founder's prior startup experience and the venture's progress, exhibited as (a) recruiting employees and (b) acquiring customers.

Figure 1 summarizes the research model of this study.

--Insert Figure 1 about here--

METHOD

Sample and data collection

Our population consists of nascent technology-based ventures drawn from self-identified technology entrepreneurs participating in the Accelerating Commercialization of Collegiate Engineering and Science (ACCESS) study funded in conjunction with training related to the NSF I-Corps program. The respondents for this study participated in a two-day regional workshop for customer discovery and business model training based on the lean startup approach (c.f., Blank, 2013; Ries, 2011). During the second day of this training event, respondents completed the first wave of our survey with questions on the nascent ventures' startup progress, business model development, human capital, resource acquisition, and the startup team. The first wave data (t=1) were collected on a rolling basis from respondents who participated in the program between December 2014 and November 2017. In our study, we focus on responses from lead founders since they actively build the team, make final decisions, and have the greatest impact on the venture (De Jong et al., 2013). Because the survey was given during the program, we have a high response rate of nearly 100% (307 complete surveys). About one year after the initial survey, we distributed a subsequent survey (t=2) focusing on the venture's progress. We obtained a response rate of 36.5% (112 lead founders of 112 nascent ventures) for this second-wave survey, which is in line with that of other studies (e.g., Rutherford et al., 2017). Our study's

dependent variables, employee recruitment and customer acquisition, are measured using the second-wave data.

We ran *t*-tests on all our variables to compare respondents who completed only the first round survey with those completing both rounds, finding only minor significant differences ($p<0.05$). Those who only completed the first survey round were on average slightly less educated, had slightly smaller founding teams, and had more likely already hired at least one employee. Overall, as most of our core variables (startup experience, venture investigation, business model development, and customer acquisition) were unaffected, and we control for firm size at t=1 (measured by number of employees) in our analysis of employee recruitment at t=2, attrition bias is unlikely to be affecting the results of our study.

The study design allowed for measuring the independent and mediator variables in the initial survey (t=1) and the dependent variables, employee recruitment and customer acquisition, in the subsequent survey (t=2). Although common method variance is often of concern in cross-sectional single-respondent studies (Phillips, 1981), it is largely alleviated by the one-year time period between the two surveys. Nonetheless, we verified that common method variance was not an issue using Harman's one-factor test for all study variables (Podsakoff and Organ, 1986).

The research setting of a training program introducing business models is unique and provides clear benefits by introducing shared terminology that participants can use to answer questions on the concept. In addition, the ventures are technology-based and have a university affiliation. Moreover, because entrepreneurs enter the program when their ventures are still emerging (more than 60% of our sample ventures were not yet legally established at the time of the first survey), we are able to examine business model development at the earliest stages – before firms are represented in venture databases – and the associated effects on venture

progress. Technology ventures provide a particularly relevant setting for our study because a new technology may give rise to numerous market opportunities and the business models to pursue those opportunities are usually not clear from the outset (Gruber et al., 2008; Shane, 2000). Successfully creating a technology-market link—of which having paying customers can be considered as an important proof—is therefore considered as one of the biggest challenges for technology ventures (Molner et al., 2019) and makes this an appropriate setting to study business model development, employee recruitment, and customer acquisition.

Measurement: Dependent variables

Employee recruitment. Employee recruitment is measured by a binary variable indicating if the venture had hired any employees (beyond the (co-)founders). Acquiring resources, such as employees, is a challenge for nascent ventures as they are typically resource-constrained and lack proven competencies (Zott and Huy, 2007). Because several factors, such as inexperience in hiring, capital restrictions, and the uncertain future of the nascent venture may further complicate the hiring process (Coad et al., 2017), attracting employees is an important accomplishment for nascent technology ventures. Hiring the first employee has even been called the "single biggest growth event" facing a young firm (Coad et al., 2017, p. 25).

Customer acquisition. Customer acquisition is measured by a binary variable indicating if the venture had received any money, income, or fees from the sale of goods or services, i.e., whether the firm had attracted paying customers. As a specific technology may give rise to numerous market opportunities and matching customer segments (Gruber et al., 2008; Shane, 2000), attracting paying customers is an important early-stage signal of nascent venture success. Moreover, early customers can contribute to a new venture's legitimacy (Wang et al., 2014), and

also lead to the venture's long-term survival and success (Gimmon and Levie, 2020). Customer acquisition is thus an important milestone for nascent technology ventures.

Measurement: Independent variables

Venture investigation. Venture investigation is conceptualized as the number of activities out of five that a new venture had initiated at least three months prior to the time of the first survey. These five activities were derived from the Panel Study of Entrepreneurial Dynamics survey (PSED, 2011) and include (1) collecting information about competitors, (2) developing financial projections, (3) determining regulatory requirements, (4) defining market opportunities, and (5) talking with potential customers about the product or service of the new business. Appendix 1 lists the full phrasing of each item used in our survey. For each activity, we asked whether the venture had started the activity and when. Based on this detailed time information, we then determined whether the activity had been completed at least *three months prior to the survey*. We chose to use a three-month time lag to account for time for engaging in venture investigation efforts to be visible in the firm's business model. We used alternative time lags in our robustness checks. Cronbach's alpha for this construct equals 0.85. We also validated this novel construct by means of a Confirmatory Factor Analysis, in which we loaded each of the five items onto a latent venture investigation construct. The model showed good fit with χ^2/df = 2.56, RMSEA = 0.08, GFI = 0.99, CFI=0.96 and SRMR = 0.03 (Hooper et al., 2008; Hu and Bentler, 1999) and each item loaded significantly onto the venture investigation construct (p<0.001). Moreover, the construct's composite reliability of 0.85 and its average variance extracted (AVE) of 0.54 are above the respective thresholds of 0.70 (Fornell and Larcker, 1981) and 0.50 (Bagozzi and Yi, 1988), thereby demonstrating internal consistency.

Startup experience. This variable measures the respondent's number of years of work experience in a startup. Because of the university affiliation requirement for participation, most respondents in our sample are researchers, professors, postdoctoral fellows, and students and thus typically have not previously started a venture. By operationalizing startup experience as the "number of years of work experience in a startup", we capture the extent of experience in a startup. This variable is highly correlated with the number of startups the respondents have (co-)founded in the past (r=0.59, p<0.0001).

Measurement: Mediator variable

Business model development. To measure the extent to which the nascent technology venture's business model is developed, we asked respondents to code their business models along the business model categorization scheme by Andries et al. (2013) presented in Appendix 2. We added the option "don't know" to each of the 16 items so that entrepreneurs could indicate that specific business model decisions had not yet been made. Our business model development measure is based on the number of "don't knows" that respondents indicated. We took the count of the number of items for which respondents had not made a choice yet and reverse-coded it, such that higher values for our variable indicate that the nascent technology venture's business model was more developed, i.e., decisions had been made on more components of the business model. As validation for our measure, we looked at the correlation between this measure and a set of 21 self-developed items representing a firm's progress pertaining the business model canvas components (Osterwalder and Pigneur, 2010). All items correlate significantly with our measure (p<0.10; for most of the items p<0.001), supporting the construct validity of our business model development measure.

Measurement: Control variables

Gender. This binary variable indicates whether the entrepreneur is female (1), or male (0).

Education. This ordinal variable measures the respondent's highest level of education ranging from 1= "up to eighth grade" to 10="Law, MD, PhD and EdD degrees" (see Appendix 1 for details). The answer categories are based on the PSED questionnaire (PSED, 2011).

Industry experience. We control for the founder's industry experience, measured as the number of years of work experience the individual has in the industry in which the new venture competes (e.g., Dimov, 2010). Prior research has shown that experience in the same industry as the startup's can provide valuable knowledge, skills, and personal connections that may enhance the founder's ability to mobilize new resources for the businesses (Dencker and Gruber, 2015; Dimov, 2010).

Research experience. Given that the entrepreneurs in our sample all have a university affiliation, with many respondents pursuing academic careers, we also control for the number of years of research experience in a field related to their nascent venture. This may impact a venture's startup progress, as prior research has shown that a founder's industry-specific technical experience contributes to the growth of new technology-based firms (Colombo and Grilli, 2005).

Number of founders. We control for the number of founders (including the respondent) because founders in a venture team typically each bring a network of potentially useful ties with them (Grossman et al., 2012). A larger founding team can thus approach a larger pool of potential customers or employees from pre-existing ties, which may influence venture progress. Moreover, larger teams may have more knowledge and experience and are more likely to reach critical entrepreneurial milestones (Beckman et al., 2007).

Number of advisors. We asked respondents how many advisors they have for their venture, which includes all formal and informal contacts on which respondents have relied for meaningful information, knowledge, or inspiration related to the new venture. We include this variable as a proxy for the entrepreneur's external network and to control for the potential impact that advisors may have on a firm's business model development and nascent venture emergence (Chrisman and McMullan, 2004; Rotger et al., 2012).

Firm size. We control for firm size measured as the log number of employees (beyond the founding team) that a venture has at t=1. This variable not only controls for firm size, but also serves as a strong firm-fixed effect in the analysis of employee recruitment.

Technology readiness. This measurement is based on the Technology Readiness Level (TRL) scale widely used in the aerospace and defense industries (Mankins, 1995). Readiness schemes can act as early indicators of technology venture progress, are frequently used to manage industrial innovation (Magnaye et al., 2010; Ward et al., 2012), and can also impact startup investment (Brush et al., 2012). We therefore include an ordinal variable ranging from 1 = "Effect demonstrated in laboratory" to 6 = "Product fully realized" as a control variable in our study. Appendix 1 provides a full description.

Financial resources. Access to external funds has been shown to have a positive impact on short- and medium-term survival and growth (Bertoni et al., 2011; Shane and Stuart, 2002). We therefore control for this important variable by including a dummy variable set to 1 if the firm had received outside investment.

Venture age. This variable measures the nascent venture's age in years at the time of the data collection, and is calculated as the time elapsed between the founder's reported date of starting the first efforts on the venture and the survey administration date.

Sector dummies. We control for potential sector effects that may have an influence on the outcomes with indicators for life sciences, software/data science, and engineering. The reference category contains all other sectors.

Finally, we also included the lagged customer acquisition binary variable (measured at t=1) in our analysis of customer acquisition and employee recruitment at t=2. Appendix 1 summarizes the measurement items used in our study.

Model estimation

Because we operationalize business model development as the count of the number of decided business model items, we use a Poisson regression to test the proposed positive effect of venture investigation (H1) and startup experience (H2) on business model development. We confirm that overdispersion (i.e., the variance does not substantially exceed the mean) is not an issue (p>0.99), and therefore, a Poisson regression may be used.

We use a probit regression to test the effects of business model development on employee recruitment and customer acquisition (H3a and H3b). The binary nature of these variables necessitates a different approach to mediation testing (for testing Hypotheses 4 and 5) than the traditional multiple regressions approach (e.g., Baron & Kenny, 1986). Instead, we follow the simulation approach[3] of Imai et al. (2010a), used also by Klyver et al. (2020) and Vaznyte et al. (2020). Fit parameters are extracted for the observed outcome and mediator, and then simulated via the quasi-Bayesian Monte Carlo approximation by King et al. (2000) to extract point estimates and confidence intervals, as well as estimating the Average Causal Mediation Effect (ACME), i.e., the fraction of the independent variable's effect transmitted by the mediating variable, as well as the Average Direct Effect (ADE) (Hicks and Tingley, 2011). This approach enables a sensitivity analysis, discussed more fully in the robustness checks below.

[3] Specifically, we used the *medeff* package in Stata 16.

RESULTS

Descriptive statistics and correlations of the variables used in the Poisson analyses of business model development and the probit regressions of venture progress (Table 1, Panels A and B respectively) reveal that our sample ventures had fairly developed business models: the range in our sample was from 4 to 16, with an average of 13.48. 30% of sample ventures had a fully developed business model (i.e., a business model score of 16). On average, founders had been working on the ventures for 1.2 years and had engaged in 1.55 venture investigation activities. By the time of the second survey, which was about a year after the first survey, 24% indicated having employees and 10% of firms had attracted customers. 27% of founders were female. Respondents typically had a Master's degree (score 9 on the education variable), 5.04 years of industry experience, 5.98 years of research experience, and 2.89 years of startup experience. Ventures had an average of 2.53 founders and 2.64 advisors. 34% of firms were active in life sciences, 25% in software/data sciences, and 19% in engineering. The Variance Inflation Factors (VIF) in all our models were lower than 3 – well below the suggested cutoff of 10 (Ryan, 1997), suggesting that multicollinearity is not a likely problem in our study.

--Insert Tables 1 and 2 about here--

The Poisson regression used to test Hypotheses 1 and 2 shows that venture investigation has a strong significant, positive impact ($p<0.001$) on the venture's business model development (Table 2). In limited dependent variable models, such as Poisson regressions, it is important to also look at the average marginal effects (AME), or the changes in probability of the predicted outcome due to a one-unit change in the independent variable, and their significance, to assess the effect of a variable on the dependent variable (Hoetker, 2007; Norton et al., 2004). We find that the AME of venture investigation is positive and significant ($\beta=0.89$, $p<0.001$), thereby

providing support for Hypothesis 1. Table 2 further shows a positive, significant effect of startup experience on business model development (p<0.001) with an estimated significant and positive AME (β=0.78, p<0.001). This provides support for our hypothesized positive relation between startup experience and business model development (Hypothesis 2).

Probit regressions are used to investigate the effect of business model development on employee recruitment (H3a) and customer acquisition (H3b) (Table 3). The estimated effect of business model development on employee recruitment is significant and positive (p<0.10). Although the associated AME is only significant at the 10% level, the marginal effects at fixed values are significant and positive (p<0.10) at values below 13. This suggests that especially at lower values of business model development, business model development will contribute positively to employee recruitment. Overall, we find a positive relation between business model development and employee recruitment, thereby supporting Hypothesis 3a. While the coefficient of venture investigation in Table 3 is not significant at p<0.10, its AME is significant and positive (β=0.07, p<0.10), indicating that venture investigation also has a direct, positive impact on employee recruitment. We do not find a direct effect for startup experience.

Table 3 further shows a significant, positive effect of business model development on customer acquisition (p<0.05). In line with our hypothesis, its marginal effect is also significant and positive (β=0.10, p<0.05). We thus find support for H3b. We further note the direct, positive impact of startup experience on customer acquisition (p<0.10). We do not find a similar effect for venture investigation.

--Insert Tables 3 and 4 about here--

The mediation analysis (Table 4) indicates that both venture investigation and startup experience have a significant, positive indirect effect – through business model development –

on employee recruitment. For both variables, the 90% confidence intervals do not include 0 and are positive, which means that the indirect effects of venture investigation and startup experience on employee hiring are significant at $p<0.10$. Both predictors, venture investigation and startup experience, show average mediation effects of 0.02 with confidence intervals (CI) of [0.00,0.05] and [0.00,0.04], respectively. For venture investigation, we see that not only the indirect effect is significant, but also its direct effect on employee hiring. This is consistent with the results of our probit regression on employee recruitment (Table 3), where the AME of venture investigation – despite an insignificant coefficient – was significant and positive. In total, 23% of the total effect of venture investigation on employee hiring is mediated by business model development. This percentage is the same for the effect of startup experience on employee hiring. Overall, the significant positive, indirect effects of venture investigation and startup experience on employee recruitment ($p<0.10$) provide support for Hypotheses 4a and 5a. For customer acquisition, we see that venture investigation and startup experience also have a significant, positive indirect effect through business model development. Here, the effects are significant at $p<0.05$. The indirect, mediating effect of venture investigation accounts for 74% of its total impact on customer acquisition; the average mediation effect equals 0.06 (with a [0.02,0.11] CI). For startup experience, the average mediation effect equals 0.05 (with a [0.01,0.10] CI) and 67% of its total effect on customer acquisition is mediated. Overall, the significant, positive indirect effects of venture investigation and startup experience (both significant at $p<0.05$) provide support for Hypotheses 4b and 5b.

Robustness checks and post-hoc tests

In our hypotheses, we proposed two separate, direct effects of venture investigation and startup experience on business model development. However, it is possible that the variables interact.

Rational venture investigation efforts could be more beneficial for founders with more startup experience, suggesting a positive interaction effect. Conversely, less experienced entrepreneurs might be able to compensate for their lack of experience with venture investigation efforts, suggesting a negative interaction. Furthermore, the effects of heuristics and rationality on business model development could be non-linear and have diminishing returns. Therefore, we tested an interaction term between venture investigation and startup experience as well as a potential non-linear (i.e., inverted U-shaped) effect on business model development. These were not supported.

As an alternative specification to the probit model, we used a Cox proportional hazards model to investigate the effect of business model development on employee recruitment and customer acquisition (H3a and H3b), while better accounting for the time until the event (i.e., the employee or customer acquisition). Our results are robust to this alternative model specification.

The effect of business model development on employee recruitment (H3b) appears to be significant mainly for lower values of business model development, suggesting a potential non-linear relationship between business model development and employee recruitment. Therefore, we conducted an analysis in which we included a squared term of business model development and found that its coefficient is negative and moderately significant ($p<0.10$). Together with the marginal effects analysis, this suggests that higher values of business model development first contribute to a higher likelihood of attracting employees until a threshold, after which the impact (slightly) declines.

Mediation estimation. One of the advantages of using the Imai et al. (2010a) approach to mediation is the ability to conduct sensitivity analyses afterwards to confirm that the Sequential Ignorability (SI) assumption holds, namely: first, that the treatment is statistically independent of

potential outcomes and mediators, which in experiments is typically done by means of randomization (this assumption is also sometimes called the "no omitted variable bias" assumption); and (2) that the observed mediator should be ignorable similar to exogeneity assumptions (Hicks and Tingley, 2011; Imai et al., 2010b). Violation of the SI assumptions cannot be directly tested, but it is possible to assess how an estimated quantity would change for different degrees of violation of the key identification assumption, and therefore, to assess the likelihood that the identified relationships can indeed be seen as causal mechanisms (Hicks and Tingley, 2011; Imai et al., 2011; Vaznyte et al., 2020). We used Stata's *medsens* command to estimate a sensitivity parameter ρ, which indicates the correlation between the error terms of the mediation and the outcome models. Our results indicate that the ρ at which our ACME would equal 0 (and there would thus be no mediation) is 0.8 for customer acquisition (for both venture investigation and startup experience). As ρ represents a correlation, and thus takes values between [-1,1], a ρ value of 0.8 is quite substantial, and thus shows the robustness of our results. For employee attraction, the ρ for both venture investigation and startup experience equals 0.2, which is lower but aligned with robust mediation reported elsewhere (e.g., Vaznyte et al., 2020), supporting the robustness of our mediation findings.

Time lag. In our main analyses, we used a time lag of three months prior to the survey to account for the time needed to integrate the venture investigation efforts into the nascent venture's business model. In robustness checks, we replaced the three-month time lag by a one-month lag and a six-month lag, and ran two sets of additional analyses using these shorter and longer time periods. Our results remained the same.

DISCUSSION

The objective of this study was to shed light on how nascent entrepreneurs develop and leverage business models to build their firms. Founders' early decisions about target markets, value creation and capture, firm boundaries, and resources have been shown to have strong imprinting effects on the organizations they build (Boeker, 1989). Examining the initial development of business models, their antecedents, and their outcomes provides valuable insight into organizational emergence.

Contributions to the business model literature

We conceptualized the business model construct as a cognitive schema that organizes an entrepreneur's understanding about the design of his/her firm's value-creating activities and exchanges (Amit and Zott, 2001; Martins et al., 2015; Morris et al., 2005). We focused on the extent to which a business model has been developed and proposed that more comprehensive business models would be advantageous in the entrepreneurship process. We found that more developed business models facilitate the venture's progress, as measured by having hired early employees and having acquired first customers – two important outcomes for nascent ventures (Coad et al., 2017; Gimmon and Levie, 2020). These findings provide empirical support for the lean startup approach emphasizing early business model development. Despite widespread popularity and adoption by education and policy (e.g., Blank, 2013; Ries, 2011; Huang-Saad et al., 2017; Snihur et al., 2018), empirical evidence of the effectiveness of the approach has been lacking (Grossman, 2016). Our study contributes to the rapidly growing field of business model literature (c.f., Massa et al., 2017; Wirtz et al., 2016) by proposing new theory on what the antecedents, functions, and outcomes of business model development are in a venture's infancy. Our study highlights the importance of developing a business model early on.

Contributions to the rationality-heuristics and human capital literatures

Our findings also make important contributions to the debate in the entrepreneurship literature on the role of rationality versus heuristics. On the one hand, scholars have argued that entrepreneurs should make decisions that maximize expected utility, which suggests the importance of information and decision making based on critical reflections and learning (Miller, 2007). On the other hand, due to the uncertainty inherent in the entrepreneurial process, scholars have argued that entrepreneurs should rely on heuristics or simplifying "shortcuts" for problem solving and information processing that often stem from individual-level factors such as past experience (Baron, 2007; Forbes, 2005a; Zhang and Cueto, 2017). By conceptualizing rationality as venture investigation – represented by the activities that entrepreneurs engage in to collect information about their target markets, finances, regulatory environments and competitors – and heuristics as prior startup experience, we were able to show that both contribute positively to the development of a nascent venture's business model.

Our findings show that the effects of venture investigation and prior startup experience are non-interacting. This suggests that the contribution of venture investigation and startup experience to a venture's business model both cover different grounds, and that, ideally, entrepreneurs will have both prior startup experience *and* will engage in venture investigation efforts, as heuristics in this case do not substitute for rationality (or vice versa). In line with past research (Busenitz and Barney, 1997; Goldstein and Gigerenzer, 2002; Zhang and Cueto, 2017), our findings suggest that heuristics, and therefore also biases – which are often seen as a consequence of heuristics (Tversky and Kahneman, 1974) – do not necessarily have a negative impact in the entrepreneurship process, and that heuristics may in fact lead to positive outcomes. On the other hand, rationality, which is often seen as irrelevant or impossible in the uncertain context of nascent entrepreneurship (Miller, 2007; Zhang and Cueto, 2017), also has a significant

positive effect on nascent entrepreneurship. In assessing the relative effect sizes of venture investigation and startup experience, we found that to generate a one-unit increase in business model development, nascent entrepreneurs needed about six years of startup experience or about two venture investigation efforts. This is fascinating, as it suggests that the cognitive benefits of startup experience take significant time to develop, while venture investigation efforts might be relatively easy to carry out in the short term. Ideally, entrepreneurs will use both rationality *and* heuristics when building their nascent ventures, as both have a direct, positive impact on business model development, and an indirect, positive effect on hiring early employees and attracting first customers, two important outcomes for nascent ventures (Coad et al., 2017; Gimmon and Levie, 2020; Wang et al., 2014; Zott and Huy, 2007).

The mediating effect of business model development can potentially explain the inconsistencies in past findings on the impact of prior startup experience on venture outcomes. In his study, Dimov (2010) examined the entrepreneur's confidence in the opportunity being pursued and subsequently found no significant direct impact of startup experience on venture emergence. It is plausible that entrepreneurs with more developed business models will be more confident in the opportunities they pursue – the mixed findings related to startup experience and venture outcomes can thus potentially be explained by the identification of variables related to business model development. Here, our study contributes to the literature on human capital by offering new theory on the mechanisms through which startup experience aids with venture development.

Contributions to the business planning and venture emergence literatures

Finally, our study also has implications for the literature on the usefulness of preparation and planning on entrepreneurial outcomes. Unlike most other studies on business planning, we

conceptually disentangled an entrepreneur's knowledge search and acquisition, represented by venture investigation efforts, from the entrepreneur's decision making, represented by business model development. Our study's findings show that both steps, knowledge acquisition and decision-making, have a positive impact on nascent venture progress. Venture investigation efforts, representing an entrepreneur's efforts in collecting information about competitors, development of financial projections, determinations of regulatory requirements, definitions of market opportunities and talks with potential customers, have a positive impact on nascent venture progress – both directly on employee recruitment and indirectly through business model development on both employee recruitment and customer acquisition. As a representation of a more rational, science-based approach to entrepreneurship (e.g., Camuffo et al., 2020; Miller, 2007) , venture investigation efforts thus contribute positively to business model development and nascent venture progress. This finding resonates with earlier research suggesting that investing time in the planning process and seeking primary information sources contributes positively to the effect of business planning on venture progress (Chwolka and Raith, 2012; Gruber, 2007; Shepherd et al., 2015). Our findings further showed that 23% of the effect of venture investigation efforts on employee recruitment was mediated, compared to 74% for the customer acquisition outcome. This does not only show that for employee recruitment, the direct effect of venture investigation efforts is stronger (consistent with its significant AME), but also indicates that the value of the information and knowledge acquired through venture investigation efforts as input for business model development is stronger for customer acquisition. Our findings thus indicate that for employee recruitment, engaging in venture investigation efforts alone may be sufficient, whereas for customer acquisition, it is necessary that the information obtained through these venture investigation efforts gets translated into a more developed

business model—it is the business model development that will help acquire customers, and not so much the venture investigation efforts by themselves.

Moreover, previous studies on business plans have found mixed support for their role in venture emergence and survival (e.g., Bhidé, 2000; Delmar and Shane, 2003, 2004; Dencker, et al., 2009; Dimov, 2010; Honig and Samuelsson, 2012). Criticisms of business plans include concerns that they may stifle creativity or lead to escalation of commitment, and that the value of knowledge derived through the exercise may be short-lived in uncertain environments (Bhidé, 2000; Dencker et al., 2009; Dimov, 2010; Staw, 1981). Unlike the written, formal nature of business plans, business models and other cognitive frameworks are dynamic constructs that may be created and changed through mental operations and can even evolve into important sources of innovation (Cucculelli and Bettinelli, 2015; Martins et al., 2015). Our findings show that business models, as cognitive frames, enable the translation of rational investigation efforts and experience-based heuristics into nascent venture progress. Our result that the extent to which a business model is developed also has a direct, positive impact on the venture's recruitment of employees and acquisition of early customers suggests that business model development may share the advantages of traditional business planning without the associated weaknesses.

Practical implications

Our results show that both venture investigation efforts and startup experience have a positive impact on business model development, and that both also have an indirect effect on employee recruitment and customer acquisition *via* business model development. The effects of venture investigation efforts and startup experience are additive rather than interactive, suggesting that experienced entrepreneurs *and* their novice counterparts benefit. However, the striking differential in the magnitude of the effects (an additional venture investigation activity yields

roughly the same impact as 3 years of experience) points to high leverage for venture investigation. Therefore, experiential training programs requiring venture investigation (Huang-Saad et al., 2017; Leatherbee and Katila, 2020) can potentially provide an efficient institutional mechanism to compensate for novice levels of engagement and mitigate the associated risks.

Technology entrepreneurs face specific challenges, such as having to choose between multiple market opportunities available for a single technology (Gruber et al., 2008; Shane, 2000), making business model development more challenging. In general, nascent ventures are resource-constrained and face liabilities of newness and smallness that make resource acquisition challenging (Aldrich and Auster, 1986; Stinchcombe, 1965). Though we did not examine the effects of training in this study, our findings do suggest that business model education can help technology entrepreneurs overcome these barriers. More developed business models can act as roadmaps that aid the venture's emergence, operating as tools and symbols to structure the approach to the opportunity. Indeed, business model education is typically highly experiential with venture investigation forming an important required activity. Future research could focus on the educational processes and learning outcomes in such training programs.

Limitations and future research avenues

Our sample population is a unique and well-defined group of 112 nascent technology entrepreneurs drawn from university environments. While the two-day training program in which our sample participated may indeed accelerate nascent entrepreneurs' engagement in venture-building activities, this is unlikely to affect the nature of the relationships between venture investigation, startup experience, business model development, and nascent venture progress. We thus expect our findings to be generalizable to nascent technology entrepreneurs in other settings.

Our sample entrepreneurs show similar progress, age, and experience as those previously described in the nascent entrepreneurship literature (e.g., Dimov, 2010; Gruber et al., 2012). Nonetheless, our sample is relatively small and limited to technology entrepreneurs from one geographic region. While our theoretical model is not specific to the context of university and technology entrepreneurs, future research could replicate our study in other (geographic and non-technology) settings and investigate if, for example, the positive impact of venture investigation or startup experience, via business model development, is more salient for technology entrepreneurs than for non-technology entrepreneurs.

While we defined the focus of this paper as examining the extent to which a venture's early business model had been developed, future research could focus on the content and innovativeness of the ventures' business models, as well as on the processes by which founders and teams test and change their early business models. Research could also examine whether the role and importance of business models changes over time. For instance, business model development may be more important in the earliest stages of venture formation, with its impact decreasing upon achieving milestones such as initial acquisition of external resources.

CONCLUSION

This study sought to address the two questions of why some nascent entrepreneurs have more developed business models than others, and whether business model development actually aids nascent venture progress or not. We drew on a tension in entrepreneurship research regarding the relative importance of rationality and heuristics in nascent venture development, and found that both contribute positively to business model development. Moreover, drawing on cognitive theory, we argued and found that business models – as cognitive frames – advance nascent venture progress both directly and indirectly, by mediating the effects of venture investigation

and startup experience on nascent venture progress. Our study makes contributions to the entrepreneurship, business models, and human capital literatures. We hope that this study inspires future research into the roles that rationality, heuristics, cognition, and business models play in organizational emergence.

APPENDIX 1: Measurement items

Variable (wave in which measured)	Description
Employee recruitment (waves 1 and 2)	Binary variable: = 1 if the venture has hired any employees (not including (co-)founders) = 0 otherwise
Customer acquisition (waves 1 and 2)	Binary variable: = 1 if the venture had already received any money, income, or fees from the sale of goods or services = 0 otherwise
Venture investigation (wave 1) Cronbach alpha = 0.85	Count of the number of following activities that were initiated at least three months prior to the first survey for the new business: 1) An effort has been made to collect information about the competitors 2) Financial projections, such as income or cash flow statements or break-even analyses have been developed 3) An effort has been made to determine the regulatory requirements, such as operating licenses, permits, or health and safety regulations 4) An effort has been made to define the market opportunities 5) An effort has been made to talk with potential customers about the product or service of the new business
Startup experience (wave 1)	Number of years of experience the respondent had working in startups
Business model development (wave 1)	Measured as 16 (the total number of business model items we asked questions on – see Appendix 2) minus the number of answers for which respondents answered "don't know", thereby indicating that the business model was not yet developed with regards to that component. Higher values of this variable thus capture more developed business models.
Gender (wave 1)	1 for female respondents, 0 otherwise
Education (wave 1)	Ordinal variable, capturing the highest level of education achieved, with 1 = Up to eight grade, 2 = Some high school, 3 = High school degree, 4 = Technical or vocational degree, 5 = Some college, 6 = Community college degree, 7 = Bachelor's degree, 8 = Some graduate training, 9 = Master's degree, 10 = Law, MD, PhD, EDD degree
Industry experience (wave 1)	Number of years of experience in the industry in which the new business will compete
Research experience (wave 1)	Number of years of experience conducting research in a field related to the new business
Number of founders (wave 1)	The number of founders (including the respondent) of the new venture
Number of advisors (wave 1)	The number of advisors that the respondent indicated having relied on for the new business
Firm size (wave 1)	The number of employees (beyond the founding team) that the firm has
Technology readiness (wave 1)	Ordinal variable capturing the firm's technology readiness, with 1 = Effect demonstrated in laboratory, 2 = Application identified, 3 = Technology and application validated in laboratory environments, 4 = Technology and application validated in relevant environments, 5 = Prototype ready, and 6 = Product fully realized
Financial resources (wave 1)	Binary variable indicating whether a firm had received outside investments (1) or not (0)
Venture age (waves 1 and 2)	Represents the time in years between when the respondent first started working on the current venture and the time of the (1^{st} or 2^{nd}) survey
Sector (wave 1)	Represented by a set of 3 dummy variables, representing the life sciences, software/data sciences, and engineering sectors. The reference category contains all other sector firms.

APPENDIX 2: Business model development items
(adapted from Andries et al. 2013 who adapted from Morris et al., 2005)

Offering: How does the company create value? (select one from each set)

- Product / service/don't know
- Standardized / some customization / high customization/don't know
- Internal manufacturing or service delivery / outsourcing / licensing / reselling / value-added reselling/don't know
- Direct distribution / indirect distribution/don't know

Market: Who does the company create value for? (select one from each set)

- Type of customer (b-to-b / b-to-c)/don't know
- Local / regional / international/don't know
- Broad market / niche market/don't know
- Position of customer in the value chain: upstream supplier / downstream supplier / government / institutional / wholesaler / retailer / service provider / final consumer/don't know
- Transactional / relational/don't know

Internal capabilities: What is the company's source of competence? (select one or more across sets)

- Production / operating systems /Selling / marketing / Information management / Information mining/ Information packaging / Technology / R&D / creative or innovative capability / intellectual / Financial transactions / arbitrage / Supply chain management / Networking / resource leveraging / Don't know

Competitive strategy: How does the company competitively position itself? (select one or more across sets)

- Image of operational excellence / consistency / speed / Product or service quality / selection / features / availability / Innovation leadership / Low cost / efficiency / Intimate customer relationship / experience / Don't know

Economic factors: How does the company make money? (select one from each set)

- Pricing and revenue sources: fixed / flexible/don't know
- Operating leverage: high / medium / low/don't know
- Volumes: high / medium / low/don't know
- Margins: high / medium / low/don't know

Personal/investor factors: What are the company's ambitions? (select one)

- Subsistence model / income model / growth model / speculative model/don't know

Our *business model development* measure is calculated as 16 (the total number of items) minus the number of times a respondent indicated "don't know" on the business model questions.

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