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An empirical investigation of determinants of effectual and causal decision logics in online and high-tech start-up firms

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Abstract Scholars have criticized effectuation research for being insufficiently embedded in a nomological network of practically relevant antecedents. To address this research gap, the current study uses a mixed-methods design. First, a qualitative study with 20 venturing experts (entrepreneurs and investors) validates various effectuation logics and uncovers the following four antecedents of effectuation and causation: founders' perceived uncertainty, entrepreneurial experience, management experience, and investor influence. Second, a large-scale quantitative study of founders in online, software, and high-tech start-ups ($n = 435$) provides statistical support for the identified antecedents, using structural equation modeling and multigroup comparisons over early and later venture stages. The study confirms the multifaceted nature of effectuation; experimentation is the only effectual logic that reflects influences of all the determinants. Founders' prior experiences affect experimentation and causation in the early venture stage, but not during the later stages. Investor influence displays the broadest array of effects on the decision logics, offering both theoretical embeddedness for effectuation and a new, practically relevant driver.

Keywords Entrepreneurship · Uncertainty · Entrepreneurial and management experience · Investor influence · Venture stage · Mixed-methods design

JEL classification C38 · C83 · L26 · M13

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1 Introduction

In venture creation, expert entrepreneurs act differently than traditional management theory would suggest (Sarasvathy 2001). They often follow so-called effectuation logics, such as means-oriented experimentation with a focus on affordable losses, instead of traditional planning, which has been framed as causation (Dew et al. 2009; Read et al. 2009a). Effectuation processes (Sarasvathy 2001) or logics (Brettel et al. 2012; Read et al. 2009b) resemble entrepreneurial decision-making heuristics (Werhahn et al. 2015), which manifest themselves in decision-making behavior when put into practice. Effectuation offers a compelling alternative perspective for entrepreneurial research that challenges

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and complements entrepreneurial planning studies (Fisher 2012; Perry et al. 2012).

In assessing the development of effectuation research, Perry et al. (2012) suggest that it has evolved from nascent to intermediate theory, such that the focus must shift to advancing existing concepts and rigorously (re-)testing their relationships with other constructs (Edmondson and McManus 2007). Current effectuation critics note that it lacks empirical evidence and rigorous testing (Arend et al. 2015). Early effectuation studies contrasted experienced entrepreneurs with MBA students in hypothetical scenarios (Read et al. 2009a), which neither isolated entrepreneurial expertise nor dealt with a real-world entrepreneurial decision context. Although a few subsequent studies have applied rigorous statistical testing to larger samples, they use corporate employees rather than actual entrepreneurs (Blauth et al. 2014; Brettel et al. 2012; Johansson and McKelvie 2012). The present article seeks to broaden and strengthen the relations of effectuation and causation logics in a nomological network with antecedents relevant for new venture creation (Harms and Schiele 2012). We, hence, try to answer the following overarching research question: What are relevant antecedents to effectuation and causation logics, and how do they relate to the latter concepts? Doing so requires a rigorous search for potential effectuation drivers and, then, testing them with reliable and valid measures for the key constructs.

Sarasvathy (2001) proposes entrepreneurial expertise in the face of uncertainty as the original, and the only, combined driver of effectuation logics and behavior (Fischer and Reuber 2011). Yet, in the face of uncertainty, all actors might engage in some degree of effectuation, not just expert entrepreneurs (Arend et al. 2015; Engel et al. 2014). Moreover, relevant expertise might reduce uncertainty, which in turn would predict that entrepreneurs rely less, not more, on effectuation—a potential logical flaw in the theory (Arend et al. 2016). Without controlling for multiple relevant antecedents, it seems impossible to investigate this conundrum. A more comprehensive analysis of effectuation antecedents would also counter critiques about (a) a limited understanding of instances in which effectuation occurs and (b) a limited number of options to practically influence the degree of effectuation (Arend et al. 2015).

In order to identify and test effectuation antecedents, valid and accepted measurement instruments of the effectuation and causation concepts are needed. The literature has proposed both a bipolar effectuation vs. causation scale (Brettel et al. 2012; developed in a corporate R&D context) and a multidimensional, partly complementary effectuation and causation scale (Chandler et al. 2011). The latter was developed and tested in a new venture context—the same context as in the present study—and showed empirically that both concepts, effectuation and causation, can co-occur simultaneously. Debate about the most suitable measurement approach for effectuation and causation has continued; in this paper, we try to contribute to this debate by slightly refining Chandler et al.'s (2011) scale as well as establishing the measurement concept in a nomological network of antecedents.

To address the aforementioned challenges sequentially (Edmondson and McManus 2007), we use an embedded mixed-methods design (Stentz et al. 2012) in which a preliminary qualitative study informs the subsequent confirmatory quantitative study. The rich and open qualitative study uncovers additional effectuation antecedents and gives hints as to how Chandler and colleagues' effectuation scale may be improved. Establishing and testing relationships between these potential antecedents, effectuation and causation, inform our large-scale confirmatory quantitative design.

Overall, the present paper makes the following contributions. First, it finds that founders' prior management experience and investor influence operate as antecedents to effectuation and causation, in addition to the known antecedents from prior research—perceived uncertainty and prior entrepreneurial experience. Second, it reinforces the view of effectuation and causation as largely complementary or independent constructs, suggesting that using and refining Chandler et al.'s (2011) measurement approach is appropriate for current and future research. Third, the study tests a nomological network of the various effectuation logics and causation and demonstrates differentiated relationships (i.e., some antecedents affect the effectuation logics differentially). Fourth, the paper shows that the predicted relationships between the posited antecedents and decision logics vary in relation to venture development stage, such that the latter is a meaningful moderator of some parts of the nomological network.

2 Theory and hypotheses

2.1 Effectuation and causation

Sarasvathy (2001) originally introduced effectuation processes as a set of logics or heuristics that expert

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entrepreneurs use to control an unpredictable future. Subsequent research has applied these processes to other fields of decision-making (e.g., Brettel et al. 2012; Read et al. 2009a). To distinguish effectuation processes from more traditional business planning, researchers often contrast effectuation principles with causation principles (e.g., Brettel et al. 2012; Read et al. 2009a; Sarasvathy 2001) along four common dimensions (Reymen et al. 2015).

Experimentation is a manifestation of means orientation in effectuation, versus goal orientation in causation (Chandler et al. 2011). In other words, whereas causal decision-making would set an entrepreneurial goal and, then, work toward that goal with an array of traditional planning tools, the effectual entrepreneur uses his or her available means and experiments with them to exploit emerging business opportunities in an unpredictable future (Sarasvathy 2001).

Flexibility regarding unforeseeable events in effectuation has been contrasted with carrying out a planned strategy under causal logics (Reymen et al. 2015). Whereas in the latter case, entrepreneurs view unpredictable events as a hurdle to implementing a business plan, the principle of flexibility involves viewing unexpected events as opportunities, with the aim of leveraging them (Read et al. 2009b).

The effectual principle of *pre-commitments* emphasizes entrepreneurs' prior and emerging ties to other actors in the marketplace. In contrast to competitor analysis or targeted and planned partner selection (e.g., with regard to intellectual property acquisition; Reymen et al. 2015), under the notion of pre-commitments, entrepreneurs view their venture success as embedded in an evolving network of connections to other market actors. Early ties with customers or suppliers help develop the venture by incorporating market feedback and shaping the overall business opportunity (Read et al. 2009a).

Finally, the effectual principle of *affordable loss* reflects the often limited financial means of a new venture and the environment's inherent unpredictability (Chandler et al. 2011; Sarasvathy 2001). It is based on the idea that no investments should be made that could endanger the survival of the venture despite the unpredictability of the future. This principle contrasts with profit maximization according to an established business plan, in which resources are acquired and employed to maximize expected returns in different scenarios of an uncertain future (Reymen et al. 2015).

In contrast, *causation* processes have been characterized as "planned business strategy" incorporating goal orientation and profit maximization, competitive analysis, market research and target market selection, planned production and marketing efforts, as well as control systems (Chandler et al. 2011).

Since Sarasvathy's (2001) original description of effectual processes, a few researchers have examined whether they are opposite and mutually exclusive to causal decision logics (e.g., Brettel et al. 2012), whether they complement each other (e.g., Dew et al. 2009), or whether they are largely independent (Chandler et al. 2011; Perry et al. 2012), with conflicting results (Reymen et al. 2015). Recent studies suggest that causal processes help a venture stay focused and predict what is predictable, whereas the application of effectual logics helps entrepreneurs stay flexible and able to exploit opportunities as they arise (Reymen et al. 2015; Smolka et al. 2016).

2.2 Determinants of effectuation and causation

2.2.1 Perceived uncertainty

To date, uncertainty is probably the most discussed driver of effectuation, primarily because it is pivotal to Sarasvathy's (2001) original deliberation of effectuation processes. In her understanding, uncertainty means that future events are unpredictable, and their occurrence cannot be associated with a probability distribution (Knight 1964); a notion similar to Milliken's (1987) "state uncertainty," which describes the unpredictability of relevant future states of the world. Sarasvathy (2001) proposes that effectual, rather than causal, processes are targeted toward controlling such an unpredictable future, rendering event and response uncertainty[1] (McKelvie et al. 2011; Milliken 1987) less relevant in this context. While causation reflects the rational planning before committing to a course of action and, then, sticking to it (Delmar and Shane 2003), effectuation describes how entrepreneurs cope with uncertainty by creating an opportunity once they have decided to act, rather than remaining inactive until an opportunity is discovered (McMullen and Shepherd 2006). Thus, effectuation can help overcome uncertainty's blocking or delaying

[1] According to Milliken (1987), event uncertainty relates to an "individual's inability to predict what the impact of environmental events or changes will be on his/her organization." Response uncertainty "is defined as a lack of knowledge of response options and/or an inability to predict the likely consequences of a response choice" (p. 137).

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influence on entrepreneurial action (Lipshitz and Strauss 1997). It offers ways to bear uncertainty in the present and reduce perceived uncertainty in the future (McMullen and Shepherd 2006), with information gathered during the course of action (Sarasvathy 2001).

As such, effectuation and causation are heuristics used at the individual decision-maker level. Hence, *perceived uncertainty* in the view of the decision-makers—the entrepreneurs—should take precedence over more objective assessments of uncertainty: an entrepreneur would rely more on effectuation if he or she perceives the situation to be uncertain (and still full of opportunities to be created), than, for example, in later stages of the venture, when the focus turns more toward exploiting the opportunities created (Reymen et al. 2015). Perceived uncertainty is the individual-level construct that explains individual-level decision-making (Meissner and Wulf 2014). To sum up, we hypothesize, in line with prior effectuation theorizing, that:

> H1: Perceived uncertainty increases (a) experimentation, (b) flexibility, (c) affordable loss, and (d) pre-commitments and (e) decreases causation.

2.2.2 Entrepreneurial experience

The second extensively discussed determinant of effectuation and causation, *entrepreneurial experience*, refers to the extent to which entrepreneurs have founded and/or worked in a responsible position in new ventures before, incorporating aspects such as seizing business opportunities and persevering to see the venture through to fruition (Chandler and Jansen 1992). In entrepreneurship literature, entrepreneurial or start-up experience is the most frequently studied aspect of human capital (McMullen and Shepherd 2006) and is associated with entrepreneurial intentions (Krueger 1993), different opportunity-related evaluations and decisions compared to novice entrepreneurs (Shepherd et al. 2015), higher decision speed in new ventures (Forbes 2005), and greater new venture success (Stuart and Abetti 1990). Although Sarasvathy (2001) differentiates expertise and experience, recent research suggests that entrepreneurial experience may be sufficient to drive the application of effectuation (Engel et al. 2017; Harms and Schiele 2012; Politis 2008). Furthermore, experiencing entrepreneurial habit or culture in new ventures (distinct from a causation-oriented corporate culture) may foster adaptation to effectual decision logics. This is true even without completing the full learning cycles with successful outcome feedback, which is necessary to develop expertise. In both cases, prior entrepreneurial experience would strengthen an entrepreneur's initial reliance on learned effectual decision logics and weaken initial reliance on causation. We can, therefore, hypothesize the following:

> H2: Entrepreneurial experience increases (a) experimentation, (b) flexibility, (c) affordable loss, and (d) pre-commitments and (e) decreases causation.

2.2.3 Management experience

The first newly considered determinant of effectuation and causation is founders' prior management experience; defined as a founder's conceptual and human competence involving, for example, effective delegation, motivating people, organizing and coordinating tasks, supervising, influencing, leading, and maximizing resource allocation effectiveness (Chandler and Jansen 1992). These competences are related to causal decision-making logics. Management experience is often acquired through professional tenure in responsible positions in corporations or management consultancies (Engel et al. 2017; Reuber 1997). Lee and Tsang (2001) found that management experience is positively associated with venture growth in Singapore, indicating that it represents a set of skills important to venture success. Herein, we assume that experience with traditional planning and executing processes, as mirrored in management experience, promotes causation rather than effectuation processes. We can, therefore, hypothesize the following:

> H3: Management experience decreases (a) experimentation, (b) flexibility, (c) affordable loss, and (d) pre-commitments and (e) increases causation.

2.2.4 Investor influence

Last, we posit that investor influence, conceptualized as any type of influence on founders' decision-making from parties involved in the venture (e.g., venture capitalists, business angels, incubators), can serve as a determinant of effectuation and causation. Prior literature generally supports the notion of deliberate investor

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influence (e.g., Wiltbank et al. 2009). Venture capital involvement more typically occurs in developing the organization rather than the venture's technical core (Flynn 1991) and can take various forms (e.g., business advice, access to investors' networks, and provision of funds). Although Reymen et al. (2015) report that investors often urge their ventures into a narrower, more focused venture scope, suggesting a higher level of causation, investors' advice may also foster entrepreneurs' creative thinking by challenging assumptions or providing outside-in views, similar to management consultants (e.g., Ginsberg and Abrahamson 1991), thus leading to more flexibility and experimentation. Furthermore, many investors provide access to their varied business networks (Wiltbank et al. 2009), thereby fostering a venture's possibilities for pre-commitments. Finally, when investor influence is high (e.g., when a venture capital fund is invested in a start-up), the provision of funds alleviates the need for a strict affordable loss logic.

This suggests a mixed and possibly conflicting relationship between investor influence and effectuation or causation. Investors will demand higher accountability and thus increase the use of causation in new ventures, while the provision of funds reduces the need to heed an affordable loss logic, thereby reducing the use of (some) effectuation. But only if investors urge entrepreneurs to "stick to the plan" and adopt a full-out causal logic would we expect a reduced reliance on the other effectual decision logics. We argue that investor influence may often go hand in hand with an increased reliance on specific effectual decision logics. Access to the investors' network, for example, clearly allows higher pre-commitments. Furthermore, investor advice may help entrepreneurs to see new perspectives outside their current expectations, thereby helping them to react more flexibly and to act on contingencies, similar to benefits gained from outside management consultants (e.g., Ginsberg and Abrahamson 1991). Finally, if a means orientation, as manifested in greater experimentation or trial-and-error activity, increases venture success (Read et al. 2009b), then experienced investors may want to foster just that in their ventures (e.g., Baum and Silverman 2004). Along similar lines, some venture capitalists specifically invest in the entrepreneurs and their experience (i.e., the means) rather than the plan (Stuart and Abetti 1990). Taken together, these expectations deviate from an undifferentiated high-causation-low-effectuation view and, instead, suggest regarding effectuation as a multifaceted construct with possibly distinct relationships between each effectual logic and each construct in the nomological network. Regarding investor influence, we expect the following:

> H4: Investor influence increases (a) experimentation and (b) flexibility, (c) decreases affordable loss, and increases (d) pre-commitments and (e) causation.

2.3 Venture development stage as a boundary condition

We investigate venture stage (i.e., early, currently expanding, or established) as a potential moderator of the hypothesized relationships (e.g., Brinckmann et al. 2010; Klyver and Terjesen 2007).[2] Successful venturing has a steep learning curve (Brinckmann et al. 2010; Shepherd et al. 2015); therefore, we speculate that the influence of prior professional experience on founders' decision-making will decrease the longer the venture is in the market. We can, therefore, hypothesize the following:

> H5: Entrepreneurial experience has a more pronounced influence on (a) experimentation, (b) flexibility, (c) affordable loss, (d) pre-commitments, and (e) causation in early venture stages than in later stages.
> H6: Management experience has a more pronounced influence on (a) experimentation, (b) flexibility, (c) affordable loss, (d) pre-commitments, and (e) causation in early venture stages than in later stages.

3 Qualitative study

We started our empirical work with a qualitative study, interviewing founders and then investors to shed light on the conceptual nature of effectuation and causation, their measurement, and their respective potential determinants.

[2] Although extant entrepreneurship literature recognizes new venture stages, studies are ambiguous regarding what constitutes a certain stage and how many exist. Some use a dichotomy (e.g., new vs. established, Brinckmann et al. 2010); others differentiate more stages (e.g., discovery, emergence, young, established; Klyver and Terjesen 2007). Herein, we distinguish early stage, expansion, and later stages as experienced by our informants.

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3.1 Sample and procedure

The sampling frame includes interviewees from online (e-commerce, marketplaces, and online services) and high-tech (software) start-ups, as well as investors active in these domains. We selected interviewees to achieve a balanced sample in terms of their entrepreneurial experience (ranging from novice to serial entrepreneurs) and company development stage (early stage to later stages). During the initial interviews, when we discussed what would later be coded as the "affordable loss" principle and how outside funds can eliminate the need to use this, we perceived that investors played a major role in entrepreneurial decision-making, so we complemented the sample with one venture capitalist investor, one for-profit seed capital incubator, and one academic incubator (Bøllingtoft and Ulhøi 2005). Each investor had at least one engagement with an online or software start-up. We began the sampling with personal contacts made during start-up networking events in a major European city and, then, used snowballing and third-party recommendations to uncover further contacts. Web Appendix 1 contains the basic sample characteristics.

First, we sent every informant an email describing the study's goals and content and requesting participation. Next, if the candidate agreed, we made an appointment for an in-person or telephone interview. The first author conducted all interviews and audiotaped all conversations with the interviewees' permission. The interviews lasted between 25 and 45 min. In-person interviews were conducted at the interviewees' business locations; the telephone interviews also took place while the participants were at their respective work location. All experts showed high interest in the study and willingly disclosed all requested information.

To ensure the comparability of the different interviews while also having scope to explore new themes as they arose during the interview (Gioia et al. 2013), we used a semi-structured interview guideline. The actual questions asked covered all topics of the guideline and were woven into the natural flow of the conversation. Web Appendix 2 contains the interview guidelines used with both the founders and the investors.

3.2 Analysis and interpretation

To analyze the interview material, we applied content coding in two cycles (Miles et al. 2014). In the first-cycle coding, we summarized each interview and reduced it to the crucial statements, extracted as essential transcripts and interview memos. We complemented this phase with additional information about the interview context and interviewee, to make sense of the sometimes ambiguous interview material. In the second-cycle coding, we systematized and ordered the condensed text material from the first cycle, then compared and matched interviewees' statements with effectual and causal decision logics, as well as with uncertainty and entrepreneurial experience. This process resembles content coding according to the initial theoretical topics, which then serve as deductively derived categories. From these data, management experience and investor influence emerged as additional categories and thus also as determinants of the decision logics. Furthermore, we identified interviewees who strongly gravitated toward effectuation or causation, and those who mixed logics. This categorization (Miles et al. 2014) highlighted specific facets of the constructs. Beyond rich descriptions and variations of the various concepts, we looked for associations and co-occurrences between them, for example, investor influence alleviating the need to stick to the "affordable loss" principle, to inform our subsequent hypotheses building.

3.3 Results

3.3.1 Dimensions of effectual and causal decision logics

Overall, the interviewees indicated a variety of decision principles: some followed effectuation logics while others strongly leaned toward causation, but the majority gave evidence of employing elements of both (see Web Appendix 1). These findings support the notion of effectuation as a multifaceted concept with distinct and partly independent dimensions as well as a potential complement, but not a replacement for causation.

In some cases, the effectual logic of experimentation emerged clearly: entrepreneurs described their business model development as trying out different approaches while following broad goals. They developed different prototypes and tested them in cooperation with customers. For example[3]:

> "When we started, there was no role model, because we only experimented with our model …

[3] For more interviewee quotes in support of our findings, see Web Appendix 3.

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> Hence we made changes to our platform nearly every month." (E13)

Founder interviewees exhibited differential use of the flexibility logic, such that some founders leaned toward more flexibility regarding changes in the market and potential adaptations of their business model as changes arose. Another example pertained to built-in flexibility in products and business models, which helped them prepare for potential future changes in the environment:

> "We haven't segmented the market yet and we haven't positioned ourselves yet. It all happens a bit along the way, and there surely will be some surprises. However, I see this more as a sporting challenge and not as something that frightens us." (E17)

In contrast, other founder interviewees set up an initial business plan and stuck to it:

> "The model was supposed to be the way it is now from the very beginning." (E6)

Affordable loss as an effectuation logic surfaced in most interviews; these founders were reluctant to make large investments. Prototypes tended to be cost-efficient so that bigger investments were not necessary at an early stage. For example:

> "I mean, of course I can issue a market study and whitewash everything. But I prefer making a conservative plan internally that takes into account all potential costs and enjoy the surprise when it comes out better." (E12)

Finally, we observed pre-commitments in the form of early customer involvement in product development, including customer obligations to purchase the cooperatively developed product, as the following quote illustrates:

> "We specifically want to cooperate with partners in interesting market segments and then optimize [our offer] for them. We want to do this together with people who will buy it in the end." (E17)

In contrast to existing literature that portrays pre-commitments as contrary to a competitor orientation (e.g., Brettel et al. 2012), a different notion emerged from our data: these founders know their competition well and even regard them as "coopetitors" (e.g., Bengtsson and Kock 2000), in that the competitors help develop the same market in a cooperative function.

> "That's more like 'Hey, here is somebody who copies us.' Well there is one or the other in the U.S. who has taken a similar path as we have, and we develop similarly. One of those now also came to Germany and he helps us develop the market. He is a direct competitor, who addresses the same customers that we have and who explains the product from his perspective. The customers then even better understand our product." (E12)

Our interview material revealed that founders, regardless of whether they leaned toward effectuation or causation, are sophisticated in using both principles. The bulk of the data contradicts the suggested bipolar opposition of some decision principles, such as pre-commitments versus competitive market analysis (Brettel et al. 2012). Some founders knew from the beginning what their venture concept, their customers, and their competitors looked like, and this knowledge helped them to create a corresponding business model that they did not change substantially. In other cases, the ventures copied and adapted a business model previously established in another regional market. These entrepreneurs also mentioned sales forecasting and other projections. Most of our interview subjects knew their competition well, even if they relied on pre-commitments with customers and other partners:

> "Well, we always try not only to look at us, but also to take into account market developments. We try to project the future a bit. Then you can—at least partially—make yourself independent from market trends and developments." (E14)

In summary, this material corroborates the existence of various and differentiated effectuation logics, as delineated by Chandler et al. (2011) and their application in practice. However, it also shows that the effectuation and causation logics are complementary and partly independent, not polar opposites.

3.3.2 Perceived uncertainty

Founder interviewees differed in the degree of perceived uncertainty they reported for their venture. Those who mentioned high uncertainty leaned toward more

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experimentation with prototypes and business models. They frequently mentioned early cooperation with customers and doubted the value of market research and forecasts for their ventures:

> "Forecasting is not possible in our case … Nobody would believe it. It is much more important to sell our stuff and receive customer order[s]." (E5)

Some experts, looking back at the early days of their companies, reported that their expectations and assumptions did not materialize, which disrupted their concrete business plan:

> "The business plan we originally had, we did not meet. It was very, very ambitious and characterized by lots of ignorance. Honestly speaking, it was great nonsense." (E16)

However, even in circumstances of high uncertainty, some founders still preferred planning over experimentation, possibly because of their management background and/or investor influence.

3.3.3 Entrepreneurial experience

Entrepreneurial experience featured prominently as a second potential determinant of effectuation and causation. More experienced entrepreneurs relied less on market forecasts and more on early customer involvement and on their personal networks for their business purposes:

> "Through my experience as a founder I can use my network a lot better." (E12)

3.3.4 Management experience

Our data also suggest that management experience has a distinct influence on the uses of effectual and causal decision logics. Founders with prior management consulting or corporate management jobs tended to approach their venture more predictively, relying heavily on customer and market analyses:

> "I have lots of experience in making estimates, writing business plans and executing product calculations. I have been occupied with making market analyses quite often." (E6)
> "We [company founders] had a lot of experience with regards to market entry strategies and we all worked in consulting firms previously." (E2)

3.3.5 Investor influence

Investor influence emerged as another new determinant of effectual and causal decision logics. Some interviewees rejected claims of any influence by their investors:

> "No, not really [they did not really take any influence], they just provided us with funds." (E14)

However, many others reported a high degree of influence, noting that investors wanted a say in major decisions for the venture and on imposing targets and milestones. This influence often resulted in the founders exhibiting a greater orientation toward goal-setting and planning, reflecting causal decision logics. Some founders regarded the exertion of this influence as helpful, but others viewed it as obstructive:

> "They can of course influence the course of action if it does not go that well and then set clear milestones. Then, these milestones have to be met, otherwise they won't provide more money; or management has to be exchanged." (E13)
> "There are super, mediocre and bad investors. Good investors help you with the strategic alignment, with acquisitions and networking." (E16)

The investors in our sample also confirmed this nuanced picture, recognizing that their degree of influence varies with the circumstances:

> "Once it's the investor's turn, he will set milestones and will stick to the business plan. They have to be met then." (I3)
> "Oh yeah, we exert quite some influence on their decisions … Until now, it works really well in an informal way … and it seems to be well accepted by the founders. We also keep sticking to the initially-set goals." (I1)
> "We give many liberties … If at all, the founders come up to us and ask us questions." (I2)

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Some investors noted their contributions, such as providing access to their business networks or fostering pre-commitments. Others noted that investors' engagement beyond just advice, such as the provision of funds, can alleviate founders' needs to adhere to a strict affordable loss logic:

> "No, we don't stretch the money from our VC over a longer period because we have two-month milestones. So, it wouldn't make sense to just risk a little … Overall, it is really important whom you bring onboard." (E5)

In a few cases, the involvement of investors and their influence confronted the founders with new ideas and challenges, fostering even more experimentation and flexibility on their part.

Overall, our qualitative study reinforces and complements our theoretical reasoning in several ways. The application of effectual and causal logics seems to be complementary or partly independent, rather than exclusive. The examples of applying effectuation also led us to refine the quantitative measurement scale initially developed by Chandler et al. (2011). Finally, our interview study revealed management experience and investor influence as potentially meaningful determinants in effectuation and causation.

4 Quantitative study

To test our formal hypotheses, we conducted a large-scale, online survey among knowledgeable key informants, including for example founders, and applied structural equation modeling (SEM). Although we acknowledge the drawbacks of a single-informant, single-wave observational design (e.g., Antonakis et al. 2010), our approach yielded one of the largest datasets in effectuation research to date. Because founders generally have limited time due to their efforts in building their venture (Forbes 2005), we expected a low response and completion rate (Gruber et al. 2010). In addition, considering that a significant number of ventures are founded by single people, a multiple informant design would have excluded these ventures. The variables of interest are, at best, difficult to assess for someone who is not the founder and decision-maker. Thus, founders were our best key informants. Even in ventures with two or more entrepreneurs, we expected a high drop-out rate after collecting the first round of data, and this danger can apply to both multiple-informant and multiple-wave data collections.

4.1 Sample characteristics and sampling procedures

For the data collection, we identified founders in three innovative industries, which are as follows: online, software, and high-tech start-ups. This choice promised a sufficiently large database and enabled comparisons with prior studies that had used similar samples (Coviello and Joseph 2012; Zott and Amit 2007). To contact potential key informants, we used the following two professional network sites: Xing and LinkedIn. Both offer search functions and allowed us to contact potential respondents directly; they also are popular among founders, providing wide access to the target population. Through Xing, we contacted founders located mostly in Germany, Austria, and German-speaking parts of Switzerland; we used LinkedIn to reach out to founders from the United Kingdom, Ireland, and the Netherlands. In screening the first-round search results, we determined whether the indicated start-up was active or had an online presence. With this approach, we identified 2591 founders who matched these criteria.

For the main data collection, we used an online survey instrument with 66 items (see Web Appendix 4), arranged in a user-friendly way and available in both English and German. We ensured that there was language equivalence with idiomatic back-and-forth translation by different translators. Because online surveys are flexible in terms of completion time and ease of access, they help to minimize premature termination. We also incentivized participants to increase the response rate (Helgeson et al. 2002): first, we donated 1 euro to an Ethiopian health center for each completed survey, and, second, we gave away ten packages of award-winning coffee through a lottery. We contacted all potential participants by email, providing a short introduction to the study, a survey link, and notices of the charity incentive and the lottery. We ran the data collection over a period of four months and we sent reminder emails 10 to 14 days after the initial invitation. Overall, 435 respondents replied to our request and completed the questionnaire, 39 of these after a reminder. This produced a return rate of 16.8%, which is slightly higher than Gruber et al.'s (2010) similar target population. Most ventures characterized themselves as online start-ups (76.3%) involved in mobile and e-commerce, services, games, or marketplaces. Software

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(16.3%), high-tech (5.3%), and professional service start-ups were also represented. Most founder teams consisted of two (40.2%) or three (32.4%) people, and most respondents (56.8%) viewed their venture as in the early stage. More sample details are in Web Appendix 5.

4.2 Construct measures

Table 1 provides the complete list of items measured, while Table 2 displays their respective bivariate correlations. We operationalized all constructs as reflective, multi-item measurements, rated on seven-point Likert scales ranging from 1 ("not at all") to 7 ("totally").

Decision logics: To measure effectual and causal decision logics, we relied on Chandler et al.'s (2011) scale. As mentioned previously, in contrast to Brettel et al.'s (2012) bipolar scale, Chandler et al.'s scale allowed participants to rate effectuation and causation independently, which mirrored our qualitative study findings better. In addition, because the original scale featured only two items for measuring pre-commitments and three for affordable loss, we developed supplementary indicators from the qualitative study's insights (Pre3, Pre4, AL3).

Determinants of decision logics: A founder's perceived uncertainty describes his or her uncertainty regarding circumstances that are relevant for the venture, including future developments and trends, and how they may become business relevant. At its core, it is a type of Knight's (1964) uncertainty that refers to a future whose events are unknown and unpredictable (Wiltbank et al. 2009). We developed items reflecting these notions, which also emerged in our qualitative study.

We generated three items measuring entrepreneurial experience, which described the founder's experience in start-up companies at the time of venture creation. A high degree of entrepreneurial experience manifests itself in one's own experience in venture creation or professional high-responsibility activities in new ventures (Dew et al. 2009). Prior research has mostly asked for the number of different ventures or the years that a respondent has spent in a start-up, to capture entrepreneurial experience. We decided to use indicators that asked for an assessment of the respective entrepreneurial experience of the team, because we expected that we would get mostly one response per contacted start-up.

Similarly, we measured management experience as the respondent's professional experience in corporations or management consultancies with an equivalent level of responsibilities. The notion of management experience came mainly from the qualitative interviews and as the other side of the coin of relevant prior experiences of venture creation. We operationalized it with three newly created indicators.

Finally, investor influence emerged as a determinant from the qualitative study, and we drew on this material to create four reflective items. Areas of investor influence include consulting and decision support with regard to the development of the venture.

Controls: We used several control variables. Participants identified the number of founders (one to five, or more than five), age in six-month steps, and a subjective assessment of their start-up's development stage (early, expansion, or later).

4.3 Measure assessment

To ensure the content validity of all the scales, we first ran an item-sorting task (Anderson and Gerbing 1991), in which participants received a description of every construct and all the items, in a randomized order. They then assigned each item to a construct. We ran this procedure with 13 colleagues and doctoral students at a university affiliated with the first two authors. We altered two problematic items that emerged from this task (see Table 1 and Web Appendix 6 for details). Second, we conducted three think-aloud interviews (Presser et al. 2004) with respondents from the target population (founders). These interviews uncovered the respondents' cognitive processes and led to another slight adaptation of some wording of items (see Table 1 and Web Appendix 6). Finally, after approximately one-quarter of the main data collection had been completed, we conducted quantitative pretests of the measures on the indicator and construct levels (descriptive statistics, reliability analysis, and exploratory factor analysis). Although these analyses exhibited unsatisfactory results for a few items that we subsequently excluded when conducting the validation procedure with the full data set (Table 1), the satisfactory overall outcomes allowed us to continue the data collection with confidence.

To validate the measures in the full data set, we used reliability analysis, exploratory factor analysis (EFA), and confirmatory factor analysis (CFA), similar to Wieseke et al. (2012). The EFA of all items (Promax rotation) revealed three items (Flex1, AL3, Caus6) that had low factor loadings; so, we excluded them from further analyses. We assessed each construct's convergent validity using Cronbach's alpha, composite reliabilities, and average variance extracted (AVE) (see

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Table 1 Item statistics

Construct	Item wording	M	SD	Min	Max	CFA	
						Factor loading	Item reliability
Experimentation							
Ex1	We experimented with different products and business models.	3.86	2.05	1	7	0.71	0.51
Ex2	The offer that we now provide is essentially the same as originally planned. (reverse coded)	3.89	1.84	1	7	0.70	0.50
Ex3	The offer that we now provide is substantially different than we first imagined.	3.03	1.90	1	7	0.73	0.53
Ex4	We tried a number of different approaches until we found a business model that worked.	3.60	2.00	1	7	0.80	0.65
Affordable loss							
AL1	We were careful not to commit more resources than we could afford to lose.	5.54	1.66	1	7	0.79	0.62
AL2	We were careful not to risk more money than we were willing to lose with our initial idea.	4.66	1.84	1	7	0.65	0.42
AL3	We carefully pondered potential risks when making decisions on investments.[b,c]	5.17	1.61	1	7	–	–
AL4	We were careful not to risk so much money that the company would be in real trouble financially if things did not work out.	5.46	1.64	1	7	0.81	0.65
Flexibility							
Flex1	We allowed the business to evolve as opportunities emerged.	5.31	1.53	1	7	0.66	0.44
Flex2	We adapted what we were doing to the resources we had.[c]	5.40	1.51	1	7	–	–
Flex3	We were flexible and took advantage of opportunities as they arose.	5.64	1.32	1	7	0.77	0.59
Flex4	We avoided courses of action that restricted our flexibility and adaptability.	5.94	1.15	1	7	0.61	0.37
Pre-commitments							
Pre1	We used a substantial number of agreements with customers, suppliers, and other stakeholders to reduce the amount of uncertainty.	4.01	1.80	1	7	0.74	0.54
Pre2	We used pre-commitments from customers and suppliers as often as possible.	4.16	1.84	1	7	0.77	0.60
Pre3	We approached customers and suppliers actively to coordinate business opportunities.[b]	5.18	1.70	1	7	0.81	0.65
Pre4	Our decisions have been coordinated with customers and suppliers.	4.29	1.78	1	7	0.75	0.56
Causation							
Caus1	We analyzed long run opportunities and selected what we thought would provide the best returns.	4.58	1.64	1	7	0.61	0.37
Caus2	We developed a strategy to best take advantage of our resources and capabilities.	5.06	1.44	1	7	0.59	0.35
Caus3	We designed and planned business strategies.	5.34	1.40	1	7	0.69	0.47
Caus4	We organized and implemented control processes to make sure we met objectives.	4.34	1.67	1	7	0.63	0.39
Caus5	We researched and selected target markets and did meaningful competitive analysis.	4.93	1.59	1	7	0.57	0.33
Caus6	We had a clear and consistent vision for where we wanted to go with our company.[c]	5.60	1.35	1	7	–	–
Caus7	We designed and planned production and marketing efforts in detail in advance.	4.26	1.64	1	7	0.66	0.44
Perceived uncertainty							
Uncert5	It was not clear what developments and trends should be given special attention.	3.37	1.67	1	7	0.64	0.40
Uncert6	We could hardly assess how the general conditions would develop for our company.	3.80	1.68	1	7	0.87	0.75
Uncert7	We could hardly assess how our business opportunities would develop.	4.26	1.60	1	7	0.79	0.63

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Table 1 (continued)

Construct	Item wording	M	SD	Min	Max	CFA	
						Factor loading	Item reliability
Entrepreneurial experience				1	7		
EntrExp1	Members of the founding team have previously worked for a long time in start-ups.	4.03	2.37	1	7	0.82	0.68
EntrExp2	Members of the founding team have worked in leading positions in start-ups before founding this company.	4.08	2.44	1	7	0.97	0.94
EntrExp3	There was a profound start-up experience in our founding team before founding this company.[a]	3.93	2.25	1	7	0.90	0.81
Management experience							
MgmtExp1	Members of the founding team have previously worked for a long time in management positions.	4.55	2.27	1	7	0.94	0.89
MgmtExp2	Members of the founding team have worked in leading management positions before founding this company.[b]	4.54	2.23	1	7	0.95	0.90
MgmtExp3	There was a profound management experience in our team before founding this company.[a]	4.53	2.12	1	7	0.92	0.84
Investor influence							
Inv1	Important decisions are always discussed with our investors.	3.02	2.38	1	7	0.86	0.75
Inv2	Our investors take influence on which management decisions are made.	2.28	1.77	1	7	0.92	0.84
Inv3	Our investors give us good advice on how we can further develop our business.	2.88	2.15	1	7	0.81	0.66
Inv4	Our management decisions are influenced by our investors.	2.45	1.86	1	7	0.95	0.91

All items measured on a Likert-type scale range from 1 = "not at all" to 7 = "totally." There were no missing values, so that the number of observations is $n = 435$ for every item

[a] Item wording changed after item-sorting task (Anderson and Gerbing 1991)

[b] Item wording changed after think-aloud interviews

[c] Items excluded after EFA

Table 3). All measurement models exhibited satisfactory Cronbach's alphas, ranging between 0.71 and 0.96. In particular, the modified measurement of pre-commitments (alpha = 0.85) improved considerably over Chandler et al.'s (2011) original operationalization (alpha = 0.62). The assessment of all the constructs' composite reliability also showed satisfactory results, with values ranging between 0.72 and 0.96; this is above the common threshold of 0.6 (Bagozzi and Yi 1988). The AVE also was above the commonly accepted minimum of 0.5 (Fornell and Larcker 1981) for all constructs except flexibility (0.46) and causation (0.39). Because we largely used the same scales as Chandler et al. did, in order to preserve conceptual comprehensiveness[4] and allow comparability with other studies, we decided to retain those items and constructs in the model, despite their lower AVE. Overall, the CFA supported the validity of our measures with good model fit ($n = 435$, χ^2[d.f.] = 791[459], $p < 0.001$, χ^2/d.f. = 1.72, root mean square error of approximation [RMSEA] = 0.04, standardized root mean square residual [SRMR] = 0.04, normed fit index [NFI] = 0.90, non-normed fit index [NNFI] = 0.95, comparative fit index [CFI] = 0.96; Schermelleh-Engel et al. 2003). In line with Voorhees et al.'s (2016) recommendation, we assessed discriminant validity by comparing every construct's AVE with the highest squared correlation with any other construct (Fornell and Larcker 1981). Every construct's AVE was larger than its highest squared correlation with any other construct, which established discriminant validity.

In studies that measure independent and dependent variables using the same source, common method variance or bias may arise (Podsakoff et al. 2003). We checked for this issue by comparing the original CFA measurement model with one in which we also modeled a homogeneous, unmeasured latent method factor,

[4] Little et al. (1999) suggest keeping such indicators in a model to prioritize conceptual concerns over maximizing indicator reliabilities.

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Table 2 Item correlations

Item		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Ex1	1	1																	
Ex2	2	0.42**	1																
Ex3	3	0.47**	0.64**	1															
Ex4	4	0.64**	0.55**	0.55**	1														
AL1	5	−0.12**	−0.03	−0.10*	−0.07	1													
AL2	6	−0.06	−0.12*	−0.13**	−0.07	0.51**	1												
AL3	7	−0.03	−0.12*	−0.10*	−0.08	0.38**	0.35**	1											
AL4	8	−0.05	−0.05	−0.10*	−0.06	0.64**	0.52**	0.43**	1										
Flex1	9	0.37**	0.22**	0.25**	0.34**	0.09	0.03	0.06	0.02	1									
Flex2	10	0.025	0.01	0.05	−0.04	0.19**	0.28**	0.15**	0.15**	0.12*	1								
Flex3	11	0.21**	0.10*	0.13**	0.12*	0.12*	0.07	0.11*	0.16**	0.50**	0.21**	1							
Flex4	12	0.10*	0.04	−0.03	0.02	0.20**	0.10*	0.08	0.17**	0.38**	0.19**	0.49**	1						
Pre1	13	0.08	0.01	−0.01	0.03	0.09	0.03	0.12**	0.02	0.13**	−0.02	0.20**	0.18**	1					
Pre2	14	0.06	−0.02	−0.07	0.04	0.11*	0.08	0.13**	0.12*	0.13**	0.05	0.10*	0.18**	0.62**	1				
Pre3	15	0.11*	0.04	−0.01	0.06	0.07	0.06	0.11*	0.05	0.20**	0.06	0.21**	0.19**	0.57**	0.62**	1			
Pre4	16	0.05	−0.05	−0.05	0.00	0.13**	0.14**	0.18**	0.11*	0.14**	0.16**	0.18**	0.16**	0.53**	0.57**	0.64**	1		
Caus1	17	−0.06	−0.04	−0.08	−0.05	0.00	−0.02	0.16**	−0.00	−0.01	0.02	0.06	0.05	0.22**	0.18**	0.26**	0.23**	1	
Caus2	18	−0.10*	−0.09	−0.10*	−0.17**	0.07	0.15**	0.16**	0.04	0.01	0.15**	0.13**	0.04	0.13**	0.11*	0.17**	0.17**	0.37**	1
Caus3	19	−0.05	−0.09	−0.15**	−0.12*	0.06	0.00	0.21**	0.02	0.01	0.02	0.04	0.12*	0.20**	0.18**	0.23**	0.18**	0.39**	0.44**
Caus4	20	−0.07	−0.10*	−0.09	−0.06	−0.03	−0.04	0.14**	−0.08	0.03	−0.08	0.13**	0.09	0.18**	0.08	0.16**	0.11*	0.39**	0.37**
Caus5	21	−0.14**	−0.09	−0.12**	−0.15**	0.10*	0.12**	0.26**	0.04	−0.07	0.06	0.04	0.04	0.20**	0.19**	0.18**	0.20**	0.38**	0.31**
Caus6	22	−0.19**	−0.26**	−0.29**	−0.23**	0.06	0.02	0.13**	−0.06	−0.05	0.01	0.04	0.13**	0.12*	0.17**	0.15**	0.12*	0.32**	0.30**
Caus7	23	−0.07	−0.12*	−0.13**	−0.12*	−0.01	0.09	0.18**	−0.00	−0.01	−0.03	0.03	0.07	0.19**	0.19**	0.15**	0.17**	0.40**	0.37**
Uncert5	24	0.27**	0.16**	0.25**	0.25**	−0.18*	−0.09	−0.06	−0.09	0.13**	0.06	0.06	−0.06	0.07	−0.03	−0.01	−0.03	−0.10*	−0.12**
Uncert6	25	0.18**	0.18**	0.27**	0.22**	−0.07	−0.11*	−0.07	−0.12*	0.10*	0.06	0.04	−0.03	0.04	−0.03	−0.00	−0.07	−0.18**	−0.19**
Uncert7	26	0.15**	0.18**	0.24**	0.24**	−0.05	−0.07	−0.11*	−0.06	0.13**	0.03	0.06	−0.01	−0.04	−0.08	−0.03	−0.10*	−0.16**	−0.16**
EntrExp1	27	0.07	0.07	0.04	0.07	0.04	−0.03	−0.08	−0.00	0.06	−0.05	0.04	0.06	0.02	−0.02	−0.01	0.00	−0.01	0.01
EntrExp2	28	0.04	0.03	0.03	0.05	0.02	−0.04	−0.07	−0.01	0.02	−0.08	0.03	−0.01	0.02	−0.03	−0.01	−0.00	0.03	0.05
EntrExp3	29	−0.00	0.07	0.03	−0.02	0.01	−0.02	−0.05	−0.01	0.00	−0.11*	0.01	0.01	0.03	−0.04	−0.00	−0.02	0.07	0.11*
MgmtExp1	30	−0.12*	−0.10*	−0.12*	−0.11*	0.09	0.07	0.06	−0.02	−0.00	0.05	0.01	0.02	0.07	0.04	0.04	−0.01	0.04	0.12*
MgmtExp2	31	−0.10*	−0.10*	−0.12*	−0.10*	0.08	0.06	0.05	−0.01	−0.01	0.06	0.04	0.04	0.05	0.06	0.09	0.03	0.07	0.15**
MgmtExp3	32	−0.07	−0.06	−0.05	−0.07	0.06	0.06	0.05	−0.02	0.00	0.05	0.02	0.06	0.03	0.03	0.07	0.01	0.06	0.14**
Inv1	33	0.15**	0.05	0.04	0.09	−0.25**	−0.21**	−0.12*	−0.29**	0.05	−0.04	0.02	−0.06	0.15**	0.10*	0.11*	0.08	0.12*	0.09
Inv2	34	0.21**	0.07	0.09	0.14**	−0.27**	−0.21**	−0.15**	−0.28**	0.11*	−0.03	0.01	−0.05	0.12*	0.09	0.08	0.09	0.07	0.01
Inv3	35	0.20**	0.08	0.09	0.10*	−0.16**	−0.19**	−0.07	−0.22**	0.10*	0.01	0.09	−0.01	0.14**	0.11*	0.13**	0.08	0.15**	0.07
Inv4	36	0.25**	0.08	0.12*	0.13**	−0.24**	−0.21**	−0.16**	−0.25**	0.11*	−0.02	0.07	−0.06	0.12*	0.07	0.08	0.08	0.06	0.03

Item	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Ex1																		
Ex2																		
Ex3																		
Ex4																		
AL1																		

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Table 2 (continued)

Item	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
AL2																		
AL3																		
AL4																		
Flex1																		
Flex2																		
Flex3																		
Flex4																		
Pre1																		
Pre2																		
Pre3																		
Pre4																		
Caus1																		
Caus2																		
Caus3	1																	
Caus4	0.46**	1																
Caus5	0.37**	0.34**	1															
Caus6	0.43**	0.29**	0.34**	1														
Caus7	0.45**	0.43**	0.42**	0.32**	1													
Uncert5	−0.23**	−0.06	−0.16**	−0.21**	−0.16**	1												
Uncert6	−0.24**	−0.15**	−0.20**	−0.16**	−0.18**	0.55**	1											
Uncert7	−0.26**	−0.20**	−0.18**	−0.19**	−0.21**	0.48**	0.69**	1										
EntrExp1	0.04	0.12*	−0.03	0.05	0.05	−0.02	−0.04	−0.06	1									
EntrExp2	0.06	0.15**	0.01	0.06	0.03	−0.04	−0.09	−0.08	0.88**	1								
EntrExp3	0.17**	0.22**	0.06	0.13**	0.13**	−0.06	0.13**	−0.12*	0.74**	0.80**	1							
MgmtExp1	0.13**	0.11*	0.08	0.19**	0.08	0.07	−0.11*	0.11*	0.25**	0.28**	0.31**	1						
MgmtExp2	0.18**	0.16**	0.12*	0.24**	0.10*	0.07	−0.11*	−0.10*	0.27**	0.33**	0.36**	0.89**	1					
MgmtExp3	0.16**	0.13**	0.10*	0.20**	0.10*	0.07	−0.12*	−0.13**	0.30**	0.35**	0.41**	0.87**	0.87**	1				
Inv1	0.15**	0.17**	0.12*	0.02	0.16**	0.07	0.04	0.00	0.01	0.04	0.08	0.02	0.02	0.02	1			
Inv2	0.09	0.11*	0.02	0.00	0.12**	0.09*	0.07	0.04	−0.00	−0.01	0.05	−0.05	−0.06	−0.07	0.78**	1		
Inv3	0.12*	0.18**	0.08	0.03	0.12**	0.10*	0.07	0.03	0.05	0.04	0.08	0.02	0.04	0.00	0.78**	0.70**	1	
Inv4	0.10*	0.13**	0.02	−0.01	0.12*	0.16**	0.09	0.10*	0.01	0.02	0.07	−0.02	−0.00	−0.04	−0.81**	0.89**	0.77**	1

** $p < 0.01$ (two-tailed)

* $p < 0.05$ (two-tailed)

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assuming potential non-congeneric common method variance (Richardson et al. 2009). Both models exhibited nearly identical model fit. On average, only 0.45% of each indicator's variance was due to the method factor, producing a low value (Richardson et al. 2009). Potential common method bias can also be estimated by comparing the standardized latent construct correlations in CFAs with and without the latent method factor. In our data, they ranged between 0.002 and 0.015 (average 0.007), indicating very low to nonexistent bias. We are, therefore, confident that common method variance and bias are not issues in our data.

4.4 Analysis and results

Hypotheses tests relied on covariance-based SEM using maximum likelihood estimation, computed with AMOS software and using measurement models of all constructs as validated in the CFA. In addition to the hypothesized determinants of effectual and causal decision logics, we included company age, number of founders, and development stage as control variables. Overall, the model displayed acceptable fit: $\chi^2(\text{d.f.}) = 1026(541)$, $p < 0.001$, $\chi^2/\text{d.f.} = 1.90$, RMSEA = 0.05, SRMR = 0.06, NFI = 0.88, NNFI = 0.93, and CFI = 0.94. Table 4 displays the estimation results. Among the control variables, age exerted a positive influence ($\gamma = 0.12$, $p < 0.05$) on experimentation, whereas development stage exerted a negative one ($\gamma = -0.13$, $p < 0.05$), but all other relationships involving control variables were not significant. Our hypotheses received mixed support: perceived uncertainty positively influenced experimentation and negatively influenced causation in line with H1a and H1e, respectively, but we observed no significant effect on the other effectual decision logics. Entrepreneurial experience positively affected only experimentation (H2a). In line with H3a and H3e, management experience negatively influenced experimentation and positively affected causation, but again not the other decision logics. Finally, investor influence had a positive effect on experimentation (H4a), pre-commitments (H4d), and causation (H4e); and a negative influence on affordable loss (H4c). Thus, the newly tested antecedent of investor influence had the widest, most differentiated range of effects. Furthermore, we found that distinct effectuation logics are influenced in a nuanced way, in support of the view of effectuation as a multifaceted concept.[5]

Regarding the determinants' ability to explain effectual decision logics and causation, we also found mixed results: the *R*-square values for causation and experimentation are 0.21 and 0.19, respectively, whereas the values for affordable loss (0.14), pre-commitments (0.04), and flexibility (0.02) are less encouraging. Still, the explained variances are comparable to extant studies in a corporate context with smaller samples, which indicates causation *R*-square values of 0.24 and effectuation logic *R*-square values between 0.09 and 0.28 (Johansson and McKelvie 2012).

Finally, to test our moderating hypothesis about differentiated influence strengths of founders' prior experiences on decision logics in the early and later stages of venture creation, we computed an SEM multigroup analysis (SEM-MGA), with $n = 247$ in the early stage and $n = 188$ in the later stages.[6] To compare path coefficients in the

[5] In order to check whether a more parsimonious model could also explain the phenomena of interest in a similar way (see, for example, Edwards 2001), we also computed a structural model in which we substituted the four dimensions of effectuation by effectuation as a second-order construct. According to Jarvis et al.'s (2003) decision rules for reflective versus formative construct measurement specification, effectuation must be specified as a formative higher-order construct (see also Chandler et al. 2011). We, therefore, computed factor scores for each effectuation dimension, using our CFA results and Thurstone's regression technique (Estabrook and Neale 2013). We, then, computed an effectuation index by multiplying those factor scores, in line with prior research (e.g., Homburg et al. 2002). The resulting structural model, with one effectuation index instead of four effectuation dimensions, displayed the following model fit: $\chi^2(\text{d.f.}) = 397(199)$, $p < 0.001$, $\chi^2/\text{d.f.} = 1.99$, RMSEA = 0.05, SRMR = 0.04, NFI = 0.93, NNFI = 0.96, and CFI = 0.97. These values are better than those of our full model but can mostly be explained by model parsimony. While relationships between antecedents and causation differed only very slightly from the original model (average difference in path coefficients = 0.005), there was only one significant relationship between uncertainty and effectuation ($\gamma = .184$, $p < 0.001$), but no significant relationships between entrepreneurial experience ($\gamma = 0.083$, ns), management experience ($\gamma = -0.056$, ns), or investor influence ($\gamma = -0.037$, ns) and effectuation, respectively. These results indicate that effectuation is a more valuable explanatory concept if it is understood and measured as a multidimensional composite of its dimensions rather than as a unidimensional higher-order construct.

[6] Because of sub-sample size requirements, we combined three different answers to our venture stage question into the second group, called "later stages." It comprised $n = 147$ respondents who saw their venture in "expansion," $n = 23$ in "later stage," and $n = 18$ who had answered "I do not know." We included the latter cases for theoretical and empirical reasons: on a data-collection level, we assumed that the most probable reason for respondents to tick "I do not know" regarding development phase was that they were somewhat beyond the "early phase," but they could not tell how far beyond. To further base this decision on the data properties, we also compared the age-wise distribution of those 18 cases with the 170 cases from the "later stages," because development stage and age of the venture should be related. The age distributions of "later stages" and "I do not know" were very similar and also quite different from the distribution of the "early stages."

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Table 3 Measurement model statistics

Construct	Average indicator score		Alpha	Composite reliability	AVE	Latent construct correlations in CFA[a]								
	M	SD				1	2	3	4	5	6	7	8	9
1 Uncertainty	3.81	1.40	0.80	0.81	0.59	0.13								
2 Entrepreneurial experience	4.01	2.20	0.93	0.93	0.81	− 0.10	0.13							
3 Management experience	4.54	2.11	0.96	0.96	0.88	− 0.14**	0.36***	0.13						
4 Investor influence	2.66	1.87	0.93	0.94	0.79	0.10	0.03	− 0.02	0.12					
5 Experimentation	3.59	1.58	0.83	0.83	0.55	0.36***	0.06	− 0.14*	0.18***	0.13				
6 Flexibility	5.63	1.07	0.71	0.72	0.46	0.09	0.04	0.03	0.06	0.31***	0.10			
7 Affordable loss	5.22	1.43	0.79	0.79	0.56	− 0.14*	0.00	0.05	− 0.35***	− 0.13*	0.20***	0.12		
8 Pre-commitments	4.41	1.48	0.85	0.85	0.59	− 0.04	− 0.01	0.06	0.14*	0.04	0.31***	0.14**	0.13	
9 Causation	4.75	1.10	0.79	0.82	0.39	− 0.37***	0.10	0.19***	0.16**	− 0.21***	0.11	0.04	0.36***	0.13

*** $p < 0.001$ (two-tailed)

** $p < 0.01$ (two-tailed)

* $p < 0.05$ (two-tailed)

[a] The diagonal displays the highest squared correlation with any other construct

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Table 4 Estimation results of the structural model

Determinant	Decision logic	Estimate	Critical ratio	*p* (one-tailed)	Hypothesis (direction)	Support
Uncertainty	Experimentation	0.35	5.87	< 0.0001	H1a (+)	Yes
	Flexibility	0.08	1.25	n.s.	H1b (+)	No
	Affordable loss	− 0.10	− 1.82	n.s.	H1c (+)	No
	Pre-commitments	− 0.07	− 1.13	n.s.	H1d (+)	No
	Causation	− 0.38	− 6.05	< 0.0001	H1e (−)	Yes
Entrepreneurial experience	Experimentation	0.15	2.67	0.004	H2a (+)	Yes
	Flexibility	0.04	0.57	n.s.	H2b (+)	No
	Affordable loss	− 0.02	− 0.36	n.s.	H2c (+)	No
	Pre-commitments	− 0.05	− 0.87	n.s.	H2d (+)	No
	Causation	0.01	0.22	n.s.	H2e (−)	No
Management experience	Experimentation	− 0.13	− 2.43	0.007	H3a (−)	Yes
	Flexibility	0.04	0.60	n.s.	H3b (−)	No
	Affordable loss	0.03	0.54	n.s.	H3c (−)	No
	Pre-commitments	0.07	1.13	n.s.	H3d (−)	No
	Causation	0.14	2.53	0.005	H3e (+)	Yes
Investor influence	Experimentation	0.13	2.51	0.006	H4a (+)	Yes
	Flexibility	0.04	0.70	n.s.	H4b (−)	No
	Affordable loss	− 0.32	− 5.95	< 0.0001	H4c (−)	Yes
	Pre-commitments	0.14	2.60	0.009	H4d (+)	Yes
	Causation	0.20	3.75	< 0.0001	H4e (+)	Yes

structural model in different groups, we establish configural and metric measurement invariance between the groups (Steenkamp and Baumgartner 1998). We compute separate CFAs in both groups and demonstrate the usual measurement properties (see Table 5).

In both groups, the measurement models performed well and exhibited only slight differences from the full data set. First, we established configural invariance as follows: we estimated one CFA model without any constraints between the groups (CFA M0) and found the same signs for all factor loadings. Second, when the factor loadings are constrained to be equal between groups (CFA M1) and model fit does not deteriorate considerably compared to CFA M0 (change in NNFI and CFI < 0.01; Cheung and Rensvold 2002), metric measurement invariance is established (Steenkamp and Baumgartner 1998). In our data, CFA M0 and CFA M1 display sound fit indices (CFA M0: χ^2[d.f.] = 1317[918], $p < 0.001$, χ^2/d.f. = 1.44, RMSEA = 0.03, SRMR = 0.05, NFI = 0.85, NNFI = 0.94, CFI = 0.95; CFA M1: χ^2[d.f.] = 1332[942], $p < 0.001$, χ^2/d.f. = 1.42, RMSEA = 0.03, SRMR = 0.05, NFI = 0.85, NNFI = 0.94, CFI = 0.95). Because NNFI and CFI show no difference, we can confirm metric measurement invariance. We can then use a structural model (SEM M1) in which the factor loadings are constrained to be equal between groups to assess differences in the structural path coefficients. Table 6 displays the results.

Model fit of SEM M1 is again largely satisfactory: χ^2(d.f.) = 1596(1058), $p < 0.001$, χ^2/d.f. = 1.51, RMSEA = 0.03, SRMR = 0.05, NFI = 0.82, NNFI = 0.92, CFI = 0.93. The most notable and significant differences of influence strengths between early and later stage ventures are the associations between entrepreneurial experience and pre-commitments (early stage: $\gamma = -0.17$, $p < 0.05$, later stage: $\gamma = 0.08$, n.s.); entrepreneurial experience and causation (early stage: $\gamma = -0.14$, $p < 0.05$, later stage: $\gamma = 0.17$, n.s.); and management experience and causation (early stage: $\gamma = 0.27$, $p < 0.001$; later stage: $\gamma = 0.01$, n.s.), in line with hypotheses H5d, H5e, and H6e. Overall, entrepreneurial and management experience show significant influences only in the early, but not in the later stages. Interestingly, most other significant influences in the two groups are also more pronounced among early stage ventures, albeit not significantly different from the later stages.

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Table 5 Measurement model statistics in two groups according to venture stage

Construct	Average indicator score		Alpha	Composite reliability	AVE	Latent construct correlations in CFA[a]								
	M	SD				1	2	3	4	5	6	7	8	9
Early-stage ventures ($n = 247$)														
1 Uncertainty	3.74	1.38	0.78	0.79	0.56	0.20								
2 Entrepreneurial experience	4.09	2.20	0.93	0.94	0.83	− 0.13	0.16							
3 Management experience	4.58	2.08	0.95	0.95	0.86	− 0.12	0.40***	0.16						
4 Investor influence	2.62	1.90	0.94	0.94	0.80	0.10	0.02	0.02	0.18					
5 Experimentation	3.65	1.54	0.83	0.83	0.54	0.39***	0.08	− 0.14	0.16*	0.12				
6 Flexibility	5.64	1.04	0.67	0.68	0.42	0.12	0.06	0.05	0.01	0.34**	0.12			
7 Affordable loss	5.31	1.40	0.77	0.78	0.54	− 0.17*	0.04	0.00	− 0.43***	− 0.21*	0.12	0.18		
8 Pre-commitments	4.48	1.45	0.84	0.84	0.57	− 0.06	− 0.10	0.06	0.10	− 0.05	0.31***	0.17*	0.11	
9 Causation	4.75	1.08	0.79	0.82	0.39	− 0.44***	0.05	0.28***	0.18*	− 0.28***	0.07	0.05	0.33***	0.20
Later-stage ventures ($n = 188$)														
1 Uncertainty	3.89	1.42	0.84	0.84	0.64	0.11								
2 Entrepreneurial experience	3.92	2.20	0.91	0.92	0.79	− 0.05	0.09							
3 Management experience	4.49	2.15	0.96	0.96	0.90	− 0.15	0.29	0.09						
4 Investor influence	2.71	1.83	0.92	0.93	0.77	0.10	0.05	− 0.08	0.06					
5 Experimentation	3.52	1.64	0.83	0.83	0.55	0.34***	0.04	− 0.14	0.21*	0.11				
6 Flexibility	5.61	1.10	0.75	0.76	0.52	0.06	0.01	0.01	0.12	0.26*	0.09			
7 Affordable loss	5.09	1.47	0.80	0.81	0.59	− 0.10	− 0.06	0.10	− 0.24**	− 0.07	0.28**	0.08		
8 Pre-commitments	4.32	1.52	0.87	0.87	0.62	− 0.02	0.10	0.05	0.19*	0.12	0.31**	0.09	0.14	
9 Causation	4.76	1.13	0.80	0.83	0.40	− 0.28**	0.18*	0.09	0.13	− 0.14	0.15	0.03	0.38***	0.14

Model fit indices CFA: χ^2 (d.f.) = 682 (459), $p < 0.001$, χ^2/d.f. = 1.49, RMSEA = 0.04, SRMR = 0.05, NFI = 0.86, NNFI = 0.94, CFI = 0.95

*** $p < 0.001$ (two-tailed)

** $p < 0.01$ (two-tailed)

* $p < 0.05$ (two-tailed)

[a] The diagonal displays the highest squared correlation with any other construct

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Table 6 Multigroup analysis for early- and later-stage ventures

Determinant	Decision logic	Early-stage ventures			Later-stage ventures		
		Estimate	Critical ratio	*p* (one-tailed)	Estimate	Critical ratio	*p* (one-tailed)
Uncertainty	Experimentation	0.40	5.10	< 0.0001	0.30	3.54	< 0.0001
	Flexibility	0.12	1.33	n.s.	0.03	0.34	n.s.
	Affordable loss	− 0.14	− 1.80	n.s.	− 0.07	− 0.78	n.s.
	Pre-commitments	− 0.11	− 1.36	n.s.	− 0.04	− 0.41	n.s.
	Causation	− 0.46	− 5.73	< 0.0001	− 0.29	− 3.31	< 0.0001
Entrepreneurial experience	Experimentation	0.20	2.73	0.01	0.09	1.12	n.s.
	Flexibility	0.07	0.82	n.s.	0.01	0.15	n.s.
	Affordable loss	0.04	0.51	n.s.	− 0.09	− 1.02	n.s.
	Pre-commitments[a]	− 0.17	− 2.20	0.02	0.08	0.90	n.s.
	Causation[a]	− 0.14	− 1.90	0.03	0.17	1.93	n.s.
Management experience	Experimentation	− 0.18	− 2.38	0.01	− 0.09	− 1.11	n.s.
	Flexibility	0.03	0.39	n.s.	0.02	0.24	n.s.
	Affordable loss	− 0.02	− 0.31	n.s.	0.10	1.12	n.s.
	Pre-commitments	0.11	1.45	n.s.	0.03	0.39	n.s.
	Causation[a]	0.27	3.68	< 0.0001	0.01	0.13	n.s.
Investor influence	Experimentation	0.12	1.70	0.05	0.16	2.09	0.02
	Flexibility	− 0.01	− 0.17	n.s.	0.10	1.16	n.s.
	Affordable loss	− 0.39	− 5.55	< 0.0001	− 0.22	− 2.69	0.01
	Pre-commitments	0.08	1.11	n.s.	0.19	2.36	0.01
	Causation	0.21	3.06	0.00	0.16	1.96	0.03

[a] Path coefficients significantly different between early and later stages at $p < 0.05$

5 Discussion

5.1 Antecedents of effectuation logics and causation

This article responds to calls to embed effectuation and causation into a broader nomological network (Arend et al. 2015; Harms and Schiele 2012; Perry et al. 2012). It identifies and tests four antecedents of the focal constructs in a new venture context. First, the founder's *perceived uncertainty* drives their experimentation, but not the other effectual logics, and reduces causation, in line with prior evidence (Chandler et al. 2011). Flexibility and affordable loss are not associated with uncertainty in Chandler et al.'s (2011) study either, while pre-commitments were even negatively associated with uncertainty in the latter study. The influence of perceived uncertainty persists over venture stages, indicating that this link to experimentation and causation is of general relevance beyond the scope of venture creation. Thus, all actors, not just experienced entrepreneurs, engage in some degree of effectuation in the face of uncertainty (Arend et al. 2015; Engel et al. 2014).

Second, *entrepreneurial experience* increases experimentation, reduces causation, and reduces pre-commitments in the early venture stage. This result reconfirms the founders' prior experience as a key antecedent of effectuation (Sarasvathy 2001). Similarly, prior entrepreneurial experience constitutes one of the most frequently investigated drivers in entrepreneurship research (e.g., McMullen and Shepherd 2006). However, in our sample, experienced founders in early-stage ventures showed a reduced reliance on pre-commitments, which may reflect their heightened sense of self-efficacy (Forbes 2005), such that they are confident enough to muddle through the early venture stage and seek opportunities to connect with outside partners later. Our results also suggest that the effects of prior entrepreneurial experience fade as the venture matures.

Third, our qualitative study establishes *management experience* as a potential driver of effectuation and

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causation, for which our quantitative study finds partial support. Whereas experienced entrepreneurs engage in experimentation and rely to a lesser extent on causation, experienced managers favor the opposite approach. The result is in line with recent evidence showing that many career paths and experiences can affect a founder's preference for effectuation or causation (Engel et al. 2017). Similar to entrepreneurial experience, the effect of prior managerial experience fades as the venture matures. Taking both results together points to a general notion of diminishing influences of prior experiences on entrepreneurial decision-making over time (e.g., Brinckmann et al. 2010; Reuber 1997). For practitioners and investors, findings from both entrepreneurial and managerial experience suggest that the dominant decision-making styles in a founder team, based on each founder's prior experience, matter mostly at the initial venture stage.

By contrast, *investor influence* is related to effectuation and causation in the early and later stages of a venture. According to our theorizing and analysis, it increases causation, experimentation, and pre-commitments, and it reduces application of the affordable loss principle. Thus, the novel antecedent of investor influence displays the broadest array of effects on effectuation and causation. Investors not only increase causation by demanding a "narrower scope of decision making," (Reymen et al. 2015), they also provide access to a network of contacts (increasing pre-commitments), promise regular rounds of expectable funds (reducing affordable loss), and encourage active experimentation. To the extent that investor influence can be actively changed, this antecedent promises a practically relevant driver of effectuation logics. As many start-ups fall under investor influence when being funded or when striving for funds, this antecedent furthermore affects many settings of effectuation research; future studies should at least control for this. Finally, the differences in effectuation and causation resulting from outside influence suggest that studying effectuation theory in corporate settings (Blauth et al. 2014; Brettel et al. 2012; Johansson and McKelvie 2012; Werhahn et al. 2015) provides different results compared to new venture settings.

Taken together, the four proposed antecedents identify broad and differentiated impacts on effectuation and causation. Only the effectual logic of flexibility was not significantly affected by any of our tested antecedents. Therefore, identifying drivers of flexibility promises opportunities for future researchers to strengthen the nomological network of effectuation and causation. Similarly, identifying drivers of affordable loss and pre-commitments in addition to investor influence may be a fruitful future research endeavor. Furthermore, the two types of prior experience (entrepreneurial and management), that is, the entrepreneurs' human capital and therefore personal factors, demonstrate only early-stage effects and fewer significant paths in the structural models compared with perceived uncertainty and investor influence, or situational context factors. Hence, situational antecedents might play a greater role in explaining the application of effectual or causal decision logics than personal factors do, which mirrors a classic debate in the behavioral sciences (e.g., Kenrick and Funder 1988; Webster 2009). It would be worthwhile for research to explore this supposition further.

5.2 Implications for effectuation theory and measurement

Both the qualitative and the quantitative studies in the present research support a multifaceted understanding of effectuation. It is not a polar opposite of causation, but rather complementary to it, in line with both early (Chandler et al. 2011) and more recent empirical evidence (Reymen et al. 2015; Werhahn et al. 2015). Furthermore, beyond Chandler et al.'s work, we find that antecedent influences on the effectuation logics and causation are not uniform. As the links between investor influence and the effectuation logics demonstrate, those links do not even necessarily move in the same direction: investor influence increases experimentation and pre-commitments, but it decreases affordable loss; and investor influence simultaneously increases causation. These results have two critical implications for effectuation research: (1) effectuation studies are comparable only if they treat effectuation as a multifaceted concept that encompasses all relevant logics and (2) research on effectuation consequences and other potential antecedents should investigate effectuation logics separately, not as a uniform singular construct.

Moreover, we note that only experimentation and causation were influenced by all antecedents; pre-commitments and affordable loss were related only to investor influence, and flexibility was not significantly affected by any antecedent. This finding suggests that experimentation is a theoretical core of effectuation and the other logics are more distant complements. Smolka et al. (2016) support this argument by demonstrating

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that only experimentation complements causation in a synergetic effect, and the other effectual logics do not significantly interact with causation. Which role flexibility, affordable loss, and pre-commitments play in a more comprehensive nomological network, notably including consequences and eventually more determinants of effectuation, is a question for future research. For example, investors and their funded entrepreneurs encounter fewer conflicts if those beneficiaries balance a causation logic with an effectuation logic of affordable loss (Appelhoff et al. 2016).

Similar to Smolka et al. (2016), we find that Chandler et al.'s (2011) measurement scale for effectuation logics and causation captures the facets of effectuation and causation well and is more suitable than polar alternatives, because both our qualitative and quantitative study showed that both logics can co-occur. Still, the scale needs improvement. We slightly improved the measurement of pre-commitments by introducing two additional items of measurement. However, we did not find indications for additional effectuation logics as formative facets in the interviews. Another recently proposed effectuation scale suggests control orientation as a fifth (and dominant) facet of effectuation (Werhahn et al. 2015). Future research should embed such potential novel effectuation logics in a nomological network of known antecedents.

5.3 Limitations

Despite the richness of the present findings, we note some limitations, notably concerning research design and measurement issues. A minor design issue may be our focus on determinants of effectuation and causation, leaving out important consequences of the focal constructs. The presented nomological network is, therefore, necessarily incomplete. A more substantial limitation of our research stems from endogeneity concerns (e.g., Antonakis et al. 2010; Perry et al. 2012). We used a single-informant, single-wave, correlational statistical design, trading off its associated weaknesses (Antonakis et al. 2010) against the benefits of a large sample, which allowed for SEM and multigroup analyses. Although our statistical analysis for common method variance and bias suggests no such issue, we cannot rule out other causes of potential endogeneity. The present results thus must be interpreted in light of the chosen research design. We note that one cause of endogeneity, reverse causality, seems implausible according to theoretical reasoning: entrepreneurial and management experience are accounts of the past. Furthermore, investors who fund a range of ventures would be unlikely to adapt their degree of influence depending on the predominant decision logics applied by founders of a single venture. Finally, it makes no theoretical sense to anticipate that more experimentation would lead to higher perceived uncertainty, because experimentation enhances learning. If the effectuation logics influenced perceived uncertainty, we would expect a negative influence, which we did not find in our data. In summary, we are confident that reverse causality is not plausible.

Nevertheless, future research should consider linking effectuation and causation to consequences, for which unbiased downstream data might be more readily available (multiple source design). For example, when assessing effectuation and causation impacts on time-delayed, new ventures, firm-level performance indicators, or venture-specific measurements, another possible source of endogeneity would be controlled for.

Finally, we demonstrate that effectuation and causation measurements must still be improved. We acknowledge that the measurement models of flexibility and causation may have conformed to first-generation validation methods (e.g., alpha and EFA), but they slightly failed the usual thresholds employed in CFA. Therefore, we cannot rule out that the null findings for flexibility may also be due to the measurement instrument. Future researchers should also consider whether Chandler et al.'s (2011) causation scale is in essence a formative and not a reflective measurement model.

6 Conclusion

The present article contributes to effectuation research, which is at an intermediate theory stage (Perry et al. 2012). It employs both qualitative and quantitative analyses to broaden and strengthen effectuation and causation within a nomological network (Arend et al. 2015; Edmondson and McManus 2007). All data originate from an innovative venture creation context to allow an analysis of effectuation in its originally described environment (Sarasvathy 2001). Four antecedents of effectuation and causation emerged, which are as follows: perceived uncertainty, entrepreneurial experience, management experience, and investor influence. The newly discovered antecedents also have practical relevance, in that actors in the venturing process can

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willfully alter them, which addresses Arend et al.'s (2015) criticism of previously missing relevant drivers.

Effectuation logics and causation emerged as multifaceted constructs rather than polar opposites, individually driven by the different antecedents. However, the driving influence of prior entrepreneurial (and management) experience—an original determinant of effectuation (Sarasvathy 2001)—fades over time. Still, the use of effectual logics remains continuously affected by perceived uncertainty, as well as influenced by external investors, an aspect that could become more relevant as the venture matures and evolves into a corporation.

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