This paper was accepted for publication in the British Journal of Management in September 2021.

Effectuation Logic and Early Innovation Success: The Moderating Effect of Customer Co-creation

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Abstract

This research examines whether and how customer co-creation activities moderate the relationship between effectuation logic and performance in the early stage of the innovation process. Effectuation logic is a promising decision-making logic for innovation success, but the tools that help translate this approach into innovation performance are under-researched. Three key dimensions of effectuation logic are examined: means-driven, partnerships and control. The results of a large-scale survey-based study indicate a varied and nuanced role of co-creation as a means to enhance the contribution of effectuation logic to early innovation success. This research helps increase our understanding of the often-abstract principles of effectuation logic by examining its manifestation within the context of innovation and by showing how specific firm practices, here customer co-creation activities, can accentuate the contribution of effectuation logic to early innovation performance.

Keywords

Effectuation logic, Co-creation, Innovation, Survey Method.

Introduction

Effectuation has been proffered as a promising decision-making logic for innovation success (Berends, *et al,* 2014; Brettel, *et al,* 2012; Chandra and Yang, 2011). A logic is an internally consistent collection of ideas or principles that underpin choices that firms make when putting in place managerial actions (Sarasvathy, 2008). Effectuation logic is a compelling lens with which to explain decision-making under uncertainty (McKelvie, *et al*, 2020) and has been applied to a range of management fields (Blauth, *et al*, 2014). It takes the means at hand as the starting point from which different possible ends can be achieved (Sarasvathy, 2001). It seems to flourish in uncertain operating environments that are difficult to predict and is frequently proposed as an alternative to traditional causation decision-making logic (Sarasvathy, 2001). The latter is an approach emphasizing continuity and planning, driven by pre-determined goals and systematic approaches to problem-solving and is typical of traditional models of innovation. In contrast, effectuation logic is consistent with adaptive, emergent (Mintzberg, 1978), and non-predictive managerial approaches (Wiltbank, *et al*, 2006). As such, it can influence the way firms make judgements that characterize the innovation process, such as attitudes to risk, resources, outsiders and unexpected events (Futterer, *et al*, 2018).

However, whilst effectuation is a managerial logic that seems to sit well with decision-making associated with innovation, it does not constitute a clearly defined set of activities. Current research lacks knowledge about specific methods and practices that translate the effectuation mindset into innovation performance. Meanwhile, Coviello and Joseph (2012) argue that effectuation logic can be effective for innovation success in combination with specific practices, notably collaborative activities with customers. This is because a logic that engenders responsiveness and the ability to hastily change plans and alter usual innovation routines and processes is consistent with being open to customers' ideas and suggestions (Coviello and Joseph, 2012; Fuchs and Schreier, 2011). The positive attitude towards partnerships and alliances that characterizes effectuation logic is likely to work well in combination with practices to deliberately engage with customers, particularly in the early stage of innovation, where multiple ideas and novel concepts are generated.

Collaborative practices with customers, in the early stage of innovation, have been shown to contribute to success (Poetz and Schreier, 2012; Dziallas, 2020; Coviello and Joseph, 2012; Da Costa, and Brettel, 2011). For example, they can improve product variety (Al-Zu'bi and Tsinopoulos, 2012) and result in better-performing products, as they are more creative (Nishikawa, *et al*, 2013) and highly valued by customers (Kristensson, *et al*, 2004; Roberts, *et al*, 2005). As an illustration, Muji, a dominant Japanese consumer goods company, stated that sales from products generated from customers' ideas over a three-year period enjoyed sales five times higher than products generated from ideas emanating from professional designers (Nishikawa, *et al,* 2013). Unilever also purposefully chooses knowledgeable customers to work alongside its internal experts to develop new products, thus extending its resources for innovation (Cui and Wu, 2017). Such close collaboration with customers is often referred to as *customer co-creation*, defined as *a collaborative set of activities through which customers actively generate and evaluate new product ideas and concepts* (O'Hern and Rindfleisch, 2010; Gemser and Perks, 2015). This enables customers to consciously and actively take over or participate in innovation activities traditionally executed by the firm (Fuchs and Schreier, 2011; Mahr, *et al*, 2014). Among commonly used customer co-creation practices are crowdsourcing, ideation contests, problem-solving workshops and discussion forums (O'Hern and Rindfleisch, 2010; Piller, *et al,* 2010; Roberts, *et al,* 2005).

Effectuation logic emphasizes leveraging existing means as a starting point to envision a multitude of ends, including unexpected ones. This means-driven mindset, in combination with customer co-creation practices, can help leverage customer knowledge to generate a multiplicity of ideas for final products. Including customers in the innovation process brings about a continuous reframing of goals as novel ideas and concepts emerge that may contradict existing framing of new products. This often results in unanticipated outputs, such as the discovery of changes in customer needs. Indeed, customer co-creation practices purposefully embrace unexpected surprises, means and constraints emanating from collaboration with customers (Futterer, *et al,* 2018).

Effectuation logic determines what losses can be afforded and, by extension, what must be protected. Customer co-creation practices, with their emphasis on experimentation and improvisation (Hmieleski and Corbett, 2008), can potentially help make such determinations. Effectuation logic is rooted in the belief that the future cannot be predicted, but that it can be controlled. By collaborating with customers in the early phase of innovation, firms gain a measure of control, increasing certainty that they will achieve desired outcomes.

Following from the logic discussed above, the question guiding this research is *whether and how customer co-creation activities moderate the relationship between effectuation logic and performance in the early stage of innovation.* Whilst effectuation logic has been shown to offer a promising decision-making logic for innovation success, the methods that translate this approach into innovation performance have received scant attention. We propose that customer co-creation activities in the early stage of innovation positively moderate the relationships between effectuation logic and early innovation performance. We focus on three key dimensions of effectuation logic: means-driven, partnerships and control (Sarasvathy, 2001) and examine whether and how customer co-creation enhances the contribution of these dimensions of effectuation logic to early innovation performance.

This research offers important contributions of value for theory and practice. It extends the theory of effectuation into the innovation discipline by empirically examining the moderating effects of customer co-creation activities on relationships between effectuation logic and early-stage innovation performance. In doing so it advances effectuation research from its origins, that of the entrepreneur and new business start-ups, to the corporate setting. Further, the findings bring forward a varied and nuanced role of customer co-creation as a moderator of effectuation logic. In so doing, the research enables translation of the often-abstract principle of effectuation logic into more concrete terms.

The rest of the article is organized as follows. First, we begin by outlining the theoretical background and developing hypotheses. Second, we explain the method, sampling, survey-based data collection and variables used to test the hypotheses. The results are presented, and the article concludes with a discussion of the findings, managerial contributions, and directions for further research.

Theoretical Framing

Effectuation is an appealing logic when firms need to deal with change and unpredictability (Sarasvathy, 2001, 2008). Such conditions characterize innovation, particularly in its early stages (Brettel *et al*, 2012; Coviello and Joseph, 2012) where there is a high degree of uncertainty as firms carry out largely unstructured and unguided searches for ideas and concepts (Kim and Wilemon, 2002). Envisioning and forecasting is difficult (Eling, *et al*, 2014). Firms need to respond speedily to opportunities and leverage internal and external resources (Reid, *et al,* 2015). Funding is often not yet allocated (Reid and de Bretani, 2004),

and so managers need to capitalise on the resources that exist. Effectuation logic resonates well with these conditions. Effectuation logic posits that the firm begins with an inventory of its means, from which it imagines goals. The goals it chooses to pursue fall within what it can afford to lose. Goal construction and goal achievement are different sides to the same coin. This is at odds with ends-driven logics (such as causation) which have dominated theorizing in the innovation domain and rely on well-ordered actions and planning.

A critical element of effectuation logic is its role in guiding action. In particular, scholars emphasise action in contexts of uncertainty where predictability, pre-existing goals and an independent environment are not available to the decision-maker (Kerr and Coviello, 2019). Translating effectuation logic into action can involve enlisting the help of committed stakeholders to support crafting and morphing original innovation ideas (Sarasvathy, 2008). Effectuation logic entails an iterative process where new product ideas and opportunities are refined through interactions, often with other actors. Indeed, 'who one knows' is important when enacting effectuation logic, which can involve stitching together contingent contacts (Kerr and Coviello, 2019). Customers, in particular, can provide firms with vital resources. Scholars point to the range of customer types engaging in co-creation with innovating firms. These span individuals, business users, lead users (von Hippel, 1976), communities of users (Hienerth and Lettl, 2011; Candi, *et al,* 2018), and mass crowds (Franke, *et al*, 2008).

Research into customer co-creation has blossomed. It has characterized the degree and scope of customer co-creation activities (Hoyer, *et al*, 2010) and explored degrees of collaboration and nature of tasks assigned to customers (Piller, *et al*, 2010). Other work categorizes co-creating customers in terms of their participation (Chang and Taylor, 2016), propensity to contribute (Roberts *et al*, 2017), strategy for selection (Roberts and Darler, 2017), strategic approaches to managing co-creation design (Frow, *et al,* 2015), and management activities (Roberts *et al.,* 2021). Researchers have also delineated the benefits that co-creation brings to the innovating firm, such as new product success (Kristensson, *et al*, 2004; Magnusson, 2009; Poetz and Schreier, 2012), market success (Candi, *et al*, 2016), understanding of customer needs (Roberts, *et al.,* 2005) and enhanced firm reputation (Fuchs and Schreier, 2011). Meanwhile, there are also costs of establishing customer co-creation (Candi, *et al*, 2016; Carbonell, *et al*, 2009; Hoyer, *et al*, 2010), and firms must develop and commit considerable resources to the co-creation process (Gemser and Perks, 2015).

Yet, despite this rich diversity of research on co-creation, there has been limited attention to how customer co-creation activities might accentuate the effects of decision-making logics such as effectuation. This is important to both effectuation and innovation research because dominant deterministic explanations surrounding innovation have been shown to break down under conditions of uncertainty and ambiguity (Engel, *et al*, 2017; Sarasvathy and Dew 2005). Following this line of thinking, the present study contends that customer co-creation activities could enhance the effectiveness of effectuation logic in innovation. A set of hypotheses are developed *vis a vis* how customer co-creation activities positively moderate the contribution of effectuation decision-making logic to early innovation performance. Three dimensions of effectuation logic are considered.

The first effectuation logic dimension, considered in this study, is *means-driven.* As the name implies, this dimension emphasizes the means at hand at a given time. As described by Sarasvathy (2001, p.245) "Causation processes take a particular effect as given and focus on selecting between means to create that effect. Effectuation processes take a set of means as given and focus on selecting between possible effects that can be created with that set of means." Thus, being means-driven implies taking present means as the point of departure for

innovation (Read, *et al*, 2009) with only a broad goal of eventual commercialization (Brettel, *et al*, 2012). Since initial goals are broad and even ill-defined, being means-driven can lead to continuous reframing of activities and goals along the innovation process.

Customers can act as existing means for the firm. Involving them during the innovation process, e.g., in ideation activities, in co-creation workshops, in evaluation of new product ideas and in discussions, can help generate new insight and resources resulting in ends that were unimagined by the firm; customers can potentially discern and promote opportunities for exploiting existing means to develop new products (Mahr, *et al*, 2014). The appeal of such new products can create a level of pre-commitment likely to increase the odds of success. We therefore hypothesize as follows:

H1. Customer co-creation activities positively moderate the relationship between the means-driven dimension of effectuation logic and early innovation performance.

The *partnerships* dimension of effectuation logic stresses an open mind-set towards stakeholders. Through partnerships, firms can gain access to a rich external repertoire of resources to supplement their internal resource base. This reflects an expanding cycle of resources as stakeholder membership grows (Sarasvathy and Dew, 2005). The formation of partnerships also reduces risk. With a partnership mind-set firms co-create goals by negotiating with stakeholders who are willing to share knowledge, expertise and make pre-commitments to innovation projects. The partnerships dimension of effectuation logic is intuitively consistent with customer co-creation. Furthermore, research (Ogawa and Piller, 2006: Prahalad and Ramaswamy, 2004) suggests that customer co-creation activities are particularly effective within an open culture in which firms' goals, activities, and processes are transparent and collaborative, which is consistent with effectuation logic. Thus, we hypothesize as follows:

H2. Customer co-creation activities positively moderate the relationship between the partnerships dimension of effectuation logic and early innovation performance.

Effectuation logic focuses on *controlling* outcomes rather than predicting them (Kristinsson, *et al,* 2016). Firms with a control mind-set explicitly reject unpredictable future trends and focus on aspects over which they have control (Sarasvathy, 2001; Wiltbank, *et al*, 2006) and hold that "to the extent we can control the future, we do not need to predict it" (Sarasvathy, 2001, p. 252). For example, firms might seek control through gaining buy-in from potential suppliers and customers (Berends, *et al*, 2014). In innovation management, the control aspect of effectuation also relates to deciding which ideas or concepts are allowed to move forward (Sarasvathy, *et al,* 2014). Particularly, this perception of control suggests that once firms identify their available means, as well as accessing their environment through co-creation, they mindfully converge all resources around more relevant product options and carry out experimentation to reduce unfeasible options (Chandler, *et al,* 2012; Coviello and Joseph, 2012). Customer co-creation is associated with experimentation and the results of co-creation activities can help reduce ambiguity (Coviello and Joseph, 2012) and thereby reinforce control. Moreover, the reduced uncertainty and potential customer commitment associated with customer co-creation are consistent with a control stance so that, in combination, the two can lead to enhanced early success (Brettel, *et al*, 2012). Thus we hypothesize as follows:

H3. Customer co-creation activities positively moderate the relationship between the control dimension of effectuation logic and early innovation performance.

A fourth dimension of effectuation logic—*affordable loss*—is frequently part of the effectuation discourse. This decision-making heuristic pre-determines how much loss the

firm can afford and focuses on experimenting with alternatives in which potential losses are affordable (Sarasvathy, 2001). Using affordable loss as a decision-making heuristic lessens the impact of failure by limiting the loss to that which is affordable (Read, *et al*, 2009). The ability to experiment is an essential feature of work in the early stages of innovation, and affordable loss thinking can inspire innovators to be more resourceful (Baker and Nelson, 2005), and hence stimulate creativity. Nonetheless, opportunities may be pursued that are deemed only adequately satisfactory (Dew *et al*, 2009) and stakeholders only invest what they can afford to lose. Thus, learnings from co-creation activities may be considered to be too uncertain, and outside of the scope of what is affordable, so may not be fully utilised and not contribute to early success. Therefore, no hypothesis is made about the affordable loss dimension of effectuation logic.

Methodology

The hypotheses were tested using survey data collected from 205 innovation managers in firms in the United Kingdom and the United States. Qualtrics was employed to collect the data. Research has demonstrated that data collected by panel service providers, such as Qualtrics, is not significantly different from random samples, provided respondents have the knowledge required to respond to the survey questions (Pollard, 2002; Skinner, 2009). Specifically, we targeted innovation managers that satisfied three criteria. First, we required that respondents had worked on at least one innovation project in the previous two years. Second, we required that they had worked on the early stage of innovation. Finally, we required that they had worked with customers in the early stage of innovation. The distribution of the sample firms among industry sectors is summarized in Table 1.

Table 1. Industry sectors represented in sample. 6% response rate.

Industry Sectors	% UK (N=102)	% USA (N=103)	% Total
Food and kindred products	14.5	10.6	12.4
Textile, Apparel, Leather	3.6	8.3	6.2
Metals and Metal products	2.7	6.8	5.0
Computer equipment	22.7	23.5	23.1
Electrical equipment	12.7	5.3	8.7
Transportation equipment	5.5	7.6	6.6
Rubber and Plastic products	1.8	6.1	4.1
Machinery	3.6	5.3	4.5
Furniture	3.6	0.8	2.1
Chemicals and Pharmaceutical Products	5.5	6.1	5.8
Others	23.6	19.7	21.5

Variables

The independent variables were the three dimensions of effectuation logic indicated in the hypotheses. Each of the dimensions was treated as a reflective variable (Perry, *et al*, 2012). We adapted items from existing work (i.e., Sarasvathy, 2001; Brettel, *et al*, 2012; Chandler, *et al*, 2011; Werhahn, *et al*, 2015; Wiltbank, *et al*, 2006). Six researchers, who are experts on effectuation logic, were asked to review an initial collection of 34 items for conceptual match with the three dimensions of effectuation logic and to assess content validity. Based on the

experts' feedback, 15 of the items were dropped and the wording of some of the remaining items was refined for improved clarity. A final total of 19 items measuring three dimensions of effectuation logic were included in the survey, see Table 2.

The moderator variable is co-creation activities undertaken in the early stage of innovation. Since multiple co-creation activities were taken into account, the variable was treated as a 2nd order formative-formative construct (Diamantopoulos and Winklhofer, 2001; Jarvis, *et al*, 2003; Ringle, *et al*, 2012) made up of generation and evaluation activities. 16 items were adapted based on existing literature on co-creation (O'Hern and Rindfleisch, 2010; Piller, *et al*, 2010; Roberts, *et al,* 2005). For the confirmation of these items, thirteen scholars in the field of co-creation were contacted and asked to provide feedback on the appropriateness of each item. They were asked to evaluate each item based on the criteria of wording, timing, logic, and content validity. 15 items scoring above average on these criteria were retained, see Table 2. Since items in a formative indicator should aim to cover the entire scope of the construct, any elimination of items should be undertaken with great care (Bollen and Lennox, 1991; Diamantopoulos and Winklhofer, 2001).

Two separate tests of the research model were undertaken, using two dependent variables reflecting performance in the early stage of innovation, namely product concept creativity and early success. Undertaking two tests of the research model affords a level of validation that could not be achieved based on only one set of tests. Furthermore, testing using two different dependent variables adds nuance to the findings, which deepens our understanding of the phenomena under observation.

Product concept creativity has been proposed as a relevant way of assessing early stage innovation performance (Eling, *et al*, 2014; Im and Workman, 2004; Im, *et al*, 2013; Moorman, 1995). Creativity is generally viewed as encompassing novelty and meaningfulness (Amabile, 1983; Eling, *et al*, 2014; Im, *et al*, 2013). Hence, product concept creativity was formulated as a 2nd order reflective-formative construct made up of 8 items (Im and Workman, 2004), 4 items for novelty and 4 items for meaningfulness.

The early success variable measures the performance potential of concepts developed as a result of activities in the early stage of innovation (Martinsuo and Poskela, 2011). It was formulated as a 2nd order reflective-formative construct with two dimensions, concept competitiveness potential and ability to attract capital. We adopted 5 items proposed by Martinsuo and Poskela (2011) to measure concept competitive potential and 5 items from Reid, *et al* (2015) to measure the ability to attract capital.

Table 2. Variables and survey items. All questions referred to the early stage of a specific innovation project conducted within the last two years. All questions were posed as statements with 7 possible answers ranging from strongly disagree to strongly agree.

Variables	Survey items
Customer co-creation activities	*Generation:*
	We arranged idea contests drawing on the general public or a specific target customer group to make use of their expertise, skills or creativity.
	We arranged crowdsourcing (outsourcing to the crowd by using an online platform such as Innocentive) to develop ideas for new products with customers.
	We engaged in customer communities focusing on generating novel ideas and concepts.
	We held co-creation workshops with customers to develop ideas for new products.
	We applied creative problem-solving techniques to develop ideas for new products with customers.
	We connected to product-related customer discussion forums to gather customers' usage experiences in using the product.
	We utilized idea generation toolkits to let customers participate.
	We held lead user meetings to develop ideas for new products.
	Evaluation:
	We arranged on-line voting/ratings to allow customers to cast a vote for or rate new product ideas.
	We applied idea screening, which let customers evaluate ideas.
	We arranged crowdsourcing to evaluate ideas/concepts for new products with customers.
	We held co-creation workshops with customers to evaluate ideas/concepts for new products.
	We applied creative problem-solving techniques to prioritize developed new ideas/concepts for new products with customers.
	We provided customer toolkits to let customers evaluate new products ideas/concepts.
	We held lead user meetings to evaluate developed ideas/concepts for new products.
Means-driven dimension of effectuation logic	Our innovation project was specified on the basis of the resources that we already have.
	Existing resources formed the starting point for the project.
	The process converged towards a project goal on the basis of existing resources.
	The project outline was predominantly based on existing resources.
	Existing resources significantly impacted the framework of our innovation project.
Partnerships dimension of effectuation logic	We tried to manage the uncertainty of the innovation project through external partnerships.
	We worked with potential partners to jointly shape the future.
	We jointly developed new product ideas with our partners.
	Our focus on the reduction of uncertainty led us to approach potential partners.
	Before implementing the project, we received commitments from our partners.
	In order to reduce uncertainties, we started partnerships.
	We used agreements with partners to reduce uncertainty.
	Commitments from our partners guided the direction of the project.
	We actively combined resources with our partners.
Control dimension of effectuation logic	We attempted to influence trends.
	We attempted to shape the environment we operate in.
	We attempted to co-create future markets.
	We attempted to proactively design our environment with others.

Variables	Survey items
	We were always looking for new opportunities.
Product concept creativity	*Novelty:* After the concept evaluation stage, the selected new product concepts… …were really "out of the ordinary." …could be considered as revolutionary. …were stimulating. …showed an unconventional way of solving problems. *Meaningfulness:* After the concept evaluation stage, the selected new product concepts… …were relevant to customers' needs and expectations. …were considered suitable for customers' desires. …were appropriate for customers' needs and expectations. …were useful for customers.
Early success	*Competitive potential of new product concept:* The product will generate a sustainable competitive advantage for our organization The product will offer unique features to customers, compared to competing products. The product will solve important customer problems. The product will boost superior price/performance features, compared to competing products. The product will reach high customer satisfaction. *Ability to attract capital:* The new product concepts contributed to… …the ability to be more attractive to potential alliance partners. …average growth in company employment stemming from involvement. …cash flow. …ability to attract capital. …amount of funding (internal and external) compared to initial request.

A number of control variables were included in analysis. The first of these was firm size, which is likely to be related with a firm's capacity for innovation (Kahn and Candi, 2021) as well as success in engaging customers. Thus, firm size, measured as the number of employees, was included as a control variable. The second control variable was customer base, ranging from industrial customers to end consumers as innovation is likely to differ depending on the type of customer (e.g., Bonner and Walker, 2004). Of the 205 firms in the sample, 35 were business to business firms and 52 were business to consumer firms, the rest (118 firms) had both kinds of customers. The third control variable was innovation type, which has been shown to be influential (e.g., Dewar and Dutton, 1986; Subramaniam and Youndt, 2005). Respondents were asked to categorize the innovation project, based upon which they answered the survey, as radical or incremental. 42% of respondents indicated radical innovation projects and 58% of respondents indicated incremental innovation projects. Prior literature mostly focuses on co-creation in manufacturing sectors (e.g., Gruner and Homburg, 2000), while the importance of co-creation in new service development has also been highlighted (e.g., Alam, 2006; Perks, *et al*, 2012). Therefore, a control variable was included to distinguish innovation projects in manufacturing (coded 1) from innovation projects in services (coded 2).

Data Quality

The measurement model was tested using SmartPLS 3.0 (Ringle, *et al*, 2015). The primary rationale for using PLS is that it is particularly suited when research models include both reflective variables and formative indicators (Hair, *et al*, 2012). First, the measurement model including all first order reflective constructs was tested. Next, evaluation of the convergent validity of reflective constructs was carried out by assessing the outer loadings of the indicators and the average variances extracted (AVE). All AVEs exceeded the recommended minimum of 0.5 (Bagozzi and Yi, 1988). Third, to assess discriminant validity, the Fornell-Larcker criterion was applied (Anderson and Gerbing, 1988). The confidence interval of Heterotrait-Monotrait Ratio (HTMT) was also examined to verify that the confidence interval of the HTMT statistic did not include the value 1 for all combinations of constructs (Hair, *et al*, 2016).

For the formative first order constructs (customer co-creation activities in generation and customer co-creation activities in evaluation), the measurement model was assessed by checking convergent validity using an item measuring the effectiveness of co-creation activities and testing for multi-collinearity (Diamantopoulos and Winklhofer, 2001; Hair, *et al*, 2016). All VIFs were under 5, which indicates that multi-collinearity was not likely a problem (Hair, *et al*, 2016).

Since all data were collected from single respondents, the issue of potential common method bias (CMB) needed to be addressed (Podsakoff *et al.*, 2003). *Ex ante* measures to reduce the risk of CMB included reviews of items by experts external to the project as explained above. Procedural remedies were also implemented, including an attention filter consisting of the statement "please tick 'strongly agree' here" in one of the last blocks of questions in the survey. As recommended by Kock (2015), the possibility of CMB was ascertained by considering multi-collinearity. As mentioned earlier, all VIFs were under the conservative threshold of 5, which, as argued by Kock (2015), provides reasonable confidence that CMB is not a problem.

In the correlation table (Table 3), we see that the highest pairwise correlation is between the variables for the partnerships dimension of effectuation logic and customer co-creation activities (.64). Grewal, *et al* (2004) warn that a high chance of type II error results from high correlations among independent variables (greater than .9), low measure reliability (composite reliability smaller than .7), low R^2, and low sample size. Based on these criteria, we can surmise that our sample was not likely to suffer from unacceptable multi-collinearity since the data set was of sufficient size (N=205), and composite reliabilities were all over .7. Nevertheless, in view of the relatively high pairwise correlations between the dimensions of effectuation logic it was deemed prudent to test each of the hypothesized moderating effects separately.

Table 3. Descriptive statistics and pairwise correlations. N=205.

	Variables	1	2	3	4	5	6	7	8	9	Mean	Std. dev.
1	Co-creation Activities										3.23	1.05
2	Means-driven dimension of effectuation logic	.426**									5.59	0.91
3	Partnerships dimension of effectuation logic	.644**	.395**								5.36	1.25
4	Control dimension of effectuation logic	.464**	.493**	.464**							5.90	0.84
5	Product concept creativity	.480**	.471**	.426**	.644**						5.75	0.75
6	Early success	.519**	.325**	.469**	.407**	.575**					5.11	0.96
7	Firm size	-.118	-.045	-.024	-.040	-.097	-.010				3.49	1.15
8	Customer base	-.080	-.021	-.054	-.076	-.004	-.077	.090			2.08	0.65
9	Innovation type	-.213**	-.067	-.136	-.141*	-.236**	-.110	.003	.170*		1.58	0.50
11	Product vs. Service	-.176*	-.009	-.090	-.195**	-.101	-.106	.131	.047	.132	1.25	0.44

* $p < .05$. ** $p < .01$. *** $p < .001$ (two-tailed)

Results

The hypotheses were tested using SmartPLS 3.0 using the hierarchical component model (HCM) and a two stage approach (please refer to Hair, *et al*, 2016 and Ringle, *et al*, 2012 for details about this procedure). As described above, two tests of the research model were undertaken, one for each of two dependent variables—product concept creativity (Table 4) and early success (Table 5).

Table 4 shows the findings with product concept creativity as the dependent variable. Step 1 includes only the control variables, and we note that only innovation type is related with the dependent variable at a statistically significant level. The negative coefficient indicates that innovation projects classified as more radical (coded 1 versus 2 for incremental) had more creative product concepts, which is an intuitive finding. In Steps 2a, b and c, the independent variable for each of the dimensions of effectuation logic is added. We note that all dimensions of effectuation logic are related with product concept creativity at statistically significant levels. Thus, we can surmise that, by themselves, these dimensions of effectuation logic can contribute to product concept creativity. In Steps 3a, b, and c, the moderating variable for customer co-creation is added, and we see that this is positively related with product concept creativity at a statistically significant level, which is consistent with existing research indicating the co-creation with customers can lead to more creative outcomes (Read, *et al*, 2009; Roberts, *et al*, 2005).

Turning now to Steps 4a, b, c and d, in which interactions are added to the model, we note that hypotheses 2 and 3 are supported with significant interactions, while hypothesis 1 is not. Thus, the relationships between the partnerships and control dimensions of effectuation logic, respectively, and product concept creativity are positively moderated by customer co-creation activities.

Table 5 shows the results of the second set of tests of the hypotheses, where the dependent variable is early success. Step 1 includes only the control variables, none of which are related with the dependent variable at a statistically significant level. In Steps 2a, b and c, the independent variables for the three dimensions of effectuation logic are added. We note that all three dimensions are related with early success at statistically significant levels, which is consistent with our findings for the product concept creativity variable. Thus, we can surmise that, by themselves, these dimensions of effectuation logic can contribute to early success. In Steps 3a, b, and c, the moderating variable for customer co-creation activities is added, and we see that this is positively related with early success, which is consistent with existing research indicating the co-creation with customers can lead to improved early success (Read, *et al*, 2009). Turning now to Steps 4a, b and c, which add interactions to the model, we note that hypotheses 2 and 3 are supported with statistically significant interactions, while hypothesis 1 is not. Thus, customer co-creation positively moderates the relationship between the partnerships and control dimensions of effectuation logic, respectively, and early success; the more customer co-creation, the stronger the relationships.

Table 4: Results of path analysis to test the research model with **product concept creativity** as the dependent variable.

	Step 1	Step 2a	Step 3a	Step 4a	Step 2b	Step 3b	Step 4b	Step 2c	Step 3c	Step 4c
Control variables:										
Firm size	-.056	-.066	-.020	-.022	-.069	-.022	-.028	-.055	-.031	-.030
Customer base	.014	.051	.059	.059	.042	.057	.048	.091	.088	.075
Innovation type	-.323***	-.235**	-.214***	-.217***	-.264***	-.218***	-.209***	-.180**	-.184**	-.206***
Product vs. service	-.146	-.086	-.046	-.052	-.096	-.045	-.084	-.052	-.037	-.054
Means-driven dimension of effectuation logic		.456***	.189	.200*	.					
Partnerships dimension of effectuation logic					.419***	.132	.282**			
Control dimension of effectuation logic								.643***	.469***	.531***
Customer co-creation activities			.469***	.446***		.468***	.397*		.288**	.244*
(H1) Means-driven X Customer co-creation activities				.069						
(H2) Partnerships X Customer co-creation activities							.211**			
(H3) Control X Customer Co-creation Activities										.146**
R^2	.142	.295	.435	.439	.303	.424	.468	.475	.514	.536

* $p < .05$. ** $p < .01$. *** $p < .001$ (two-tailed)

Table 5: Results of path analysis to test the research model with **early success** as the dependent variable.

	Step 1	Step 2a	Step 3a	Step 4a	Step 2b	Step 3b	Step 4b	Step 2c	Step 3c	Step 4c
Control variables:										
Firm size	-.006	-.006	.054	.054	.001	.049	.044	.015	.033	.034
Customer base	-.063	-.055	-.041	-.041	-.049	-.037	-.043	-.018	-.017	-.028
Innovation type	-.100	-.078	-.002	-.002	-.042	.009	.015	-.050	-.025	-.043
Product vs. service	-.087	-.048	-.014	-.015	-.055	-.012	-.036	-.044	-.026	-.040
Means-driven dimension of effectuation logic		.453***	.179	.181						
Partnerships dimension of effectuation logic					.475***	.209**	.305***			
Control dimension of effectuation logic								.719***	.630***	.679***
Customer Co-Creation Activities			.484***	.482***		.440***	.395***		.177*	.142
(H1) Means-driven X Customer co-creation activities				.009						
(H2) Partnerships X Customer co-creation activities							.136*			
(H3) Control X Customer Co-creation Activities										.120*
R^2	.027	.226	.346	.346	.247	.354	.373	.532	.548	.563

* $p < .05$. ** $p < .01$. *** $p < .001$ (two-tailed)

Robustness testing

Although it seemed most prudent to test the hypotheses for each dimension of effectuation logic separately, as discussed above, we conducted a second set of tests of the research model in which we followed these steps: First, control variables included. Second, all three dimensions of effectuation logic included. Third, moderator variable for customer co-creation added. Fourth, each of the three interactions added. The results of testing using this method were consistent with the results reported above, thus lending credence to the robustness of our findings.

Discussion and Conclusions

Unprecedented events and elevated levels of uncertainty have characterised recent times. In such conditions, it is more important than ever for innovators and researchers to explore new modes of managing innovation, and indeed it is incumbent upon them to do so. Effectuation logic is widely in evidence in periods of crisis as firms are forced to solve serious problems using means at hand (e.g., Huckman, 2020). Moreover, it has been suggested that entrepreneurial approaches, such as effectuation logic, might provide new opportunities and enhance innovation performance (Brettel, *et al,* 2012; Chandra and Yang, 2011, Kerr and Coviello, 2019). Our research proposes that the innovation management discourse should take into account an alternative decision-making logic, namely effectuation logic. However, translating this logic into action, and understanding the tools and activities required to do so, have received little attention to date.

This study goes some way to addressing this gap by examining how customer co-creation activities might heighten the effectiveness of three dimensions of effectuation logic—means-driven, partnerships and control—in the early stages of innovation. Overall, the findings demonstrate that co-creation activities strengthen the relationship between effectuation logic and early innovation performance. By dissecting effectuation logic into component dimensions and by conducting two separate tests of our research model, the empirical results produce notable fine-grained findings.

In the first test of the research model, the results show that the relationships between the partnerships and control dimensions of effectuation logic, respectively, and product concept creativity are positively moderated by customer co-creation activities. In the second test, relationships between the partnerships and control dimensions of effectuation logic, respectively, and early innovation success are found to be strengthened by customer co-creation activities. Hereinafter, we discuss the detailed results relating to each of the dimensions of effectuation logic considered.

First, the findings indicate that, by itself, the means-driven dimension of effectuation logic contributes to product concept creativity and early success. Indeed, intuitively, starting with one's own means, such as knowledge, expertise, networks, along with a firms' physical resources, to imagine and select between possible new product outcomes, appears advantageous. However, the findings show that the contribution of the means-driven dimension to both dependent variables is positive, regardless of the level of co-creation activities that may be undertaken. In the initial stages of the innovation process, if innovators take a set of means as given and have already decided and selected among possible effects, i.e. new products that can be created with those means, input gained through customer co-creation is not likely to enhance the outcomes of these decisions.

The findings demonstrate that co-creation activities enhance the relationships between the partnerships dimension of effectuation and both concept creativity and early success. This is

in line with research that shows that being open-minded towards outsiders (partnerships dimension) and actively seeking collaboration (customer co-creation) supports and enhances the creative process (Piller, *et al*, 2010; Roberts and Darler, 2017). Building on partnerships, customer co-creation activities support access to a rich external repertoire of resources that can supplement internal resources and improve early success. For instance, in an innovation context, firms can leverage the expertise of both broad-based consumer representatives and specialized professionals with expert knowledge. In so doing, they can increase the number of innovative ideas as well as technical knowledge for specific tasks.

In terms of this set of results related to early success, it appears that establishing early relationships with partners helps reduce uncertainty and this provides confidence to, and attracts, investors. Investors are interested in the firms' ability to be attractive to alliance partners and the potential growth stemming from such involvement. The commitment of external stakeholders is also attractive (Sarasvathy, 2001) and particularly valuable in the early stages of innovation. The results suggests that firms that engage in customer co-creation reinforce the uncertainty reduction that characterizes the partnerships dimension of effectuation, thus making them more attractive to investors.

The early stage of innovation is characterized by uncertainty and is a critical juncture where decisions are made about whether to reject or accept and further invest in an idea. The market is often ill-defined and prediction is difficult. The control dimension of effectuation logic implies a mind-set that must deal with such an uncertain future but is set within the here and now. In contrast to the planned approaches that epitomise innovation approaches, effectuation commences with the identification of means, which reflects an emphasis on future events that can be controlled rather than predicted (Kristinsson *et al*, 2016). This perception of control suggests that once firms assess their available resources, they will be more willing to experiment, e.g., through customer co-creation. The very act of embarking on co-creation activities may be seen as seeking control of future events and markets. Unanticipated events are considered sources of opportunity. Customer co-creation helps create fertile grounds for new ideas to flourish and contingencies to occur (Brettel*, et al,* 2012). In so doing firms are able to limit infeasible options and converge resources around those product options that are more promising (Coviello and Joseph, 2012).

Conventional models of innovation and co-creation activities have been based on causal decision-making and are deterministic. In contrast, our research depicts innovation and co-creation activities under effectuation logic as a more emergent and stochastic process. Co-creation activities can have a beneficial effect but should not be regarded as a universal panacea; having an effectuation logic mindset to guide innovation management decisions can work well on its own. Thus, we concur with Paluch *et al,* (2020) who discuss new agile-hybrid approaches to innovation and highlight the need to find the appropriate innovation approach for a given context.

Research Implications

This research offers a number of important contributions to theory and practice. First, it extends effectuation theory into the realm of innovation management by examining the moderating effects of co-creation on relationships between effectuation and outcomes of early stage innovation. It extends effectuation research from its original focus on the individual entrepreneur and new business start-ups to the corporate setting. Through this empirical study we thus help translate the abstract principles of effectuation logic into more tangible ways of working and offer a more nuanced understanding than existing work. By examining the moderating effects of co-creation activities and finding that their moderating

effects vary, we highlight the importance of taking the context and characteristics of each situation into account when making decisions about augmenting an innovation strategy with co-creation activities.

Secondly, our research starts to build a connection between effectuation theory and co-creation. In doing so the findings contribute to co-creation research, which seeks to understand how to leverage the benefits of customer co-creation. Firms may commit considerable resources to co-creation efforts (Gemser and Perks, 2012) and face high risks and costs (Hoyer *et al,* 2010), yet, to date, little is known about how organizations can best support co-creation endeavours (Roberts, *et al,* 2021). Thomke and von Hippel (2002, p.78) suggest that "turning customers into innovators requires no less than a radical change in management mind-set". Our research adds to this discourse by demonstrating how an effectuation mindset works in combination with co-creation.

Thirdly, scholars seek to understand why firms adopt agility and responsiveness and change their usual innovation routines and open their practices to leverage co-creation opportunities (Fuchs and Schreier, 2011; Coviello and Joseph, 2012). While our inquiry was around the moderating role of co-creation on the contribution of effectuation logic to performance, the statistical findings can also be interpreted to confirm that the partnerships and control dimensions of effectuation logic can strengthen the effectiveness of co-creation. Furthermore, since we found correlations between the dimensions of effectuation logic and customer co-creation, it is possible that effectuation logic helps spur co-creation activities or that the two are mutually reinforcing.

Finally, despite the growth in both effectuation studies and co-creation research, guidance on how to put decision-making logics into practice is lacking. Thus, the findings of this study contribute to this nascent sub-field of effectuation decision-making logic research and set the foundations for future research.

Managerial Implications

This study offers interesting implications for managers working on early stage innovation as it provides a finer grained understanding of effectuation logic than is usual. How managers think about business influences how they frame problems and how they choose among different options and activities. Reflecting on the possibility of adopting effectuation logic as an alternative to more traditional thinking may be advantageous, particularly in times of uncertainty. In this light firms should review their decision-making practices, which are often predominately causal, and assess where the opportunities and organizational barriers might lie in adopting effectuation logic. They need the remit and ability to remain flexible, and be open to serendipitous events, new opportunities and new knowledge.

Our research highlights how co-creation activities combined with effectuation logic may be beneficial particularly if managers want to enhance creativity. Meanwhile, our results indicate that a move towards using means-driven effectuation logic can be valuable for innovation without the use of co-creation activities. Thus, managers should evaluate their means, and be reflective about their expertise and that of their networks. They need to be willing to cultivate expedient relationships and embark on experiments that use the resources that they have.

Co-creation activities are growing in popularity and our research examines the moderating effect of co-creation activities on the dimensions of effectuation. Our results highlight the advantages of forming partnerships and of combining this with customer co-creation. However, in a multi-stakeholder environment, partners are often not strategically selected but

select themselves. Therefore, firms need to develop mechanisms to attract partners and motivate and encourage participation and multiple stakeholders to co-create. For example, managers could invest in social media-based mechanisms to nurture and disseminate a reputation for customer co-creation. LEGO, for instance, encourages and facilitates customers in their communities to start their own ventures, which in turn plays an active role in raising customer awareness of the firm and engenders a positive reputation.

The results further suggest that co-creation activities enhance the effectiveness of effectuation logic when managers focus their efforts on aspects over which they have control, e.g., through gaining pre-commitments from potential customers. Managers could also find ways to control ambiguities and uncertainties inherent in co-creating product ideas and concepts. For example, they could invite core customers into their innovation teams or set up virtual platforms for early product design. By developing close working arrangements with customers, control can be enhanced. Finally, firms might consider developing separate pathways for customer co-creation teams, which may be multi-functional and co-located. This could allow quick and largely independent decision-making, unencumbered from usual functional, hierarchical and structured processes. In so doing, co-creation teams can focus on the known and find ways to control the here and now, rather than direct their activities towards planning an unknown future. Finally as a focus on non-predictive techniques and high levels of experimentation may not be attractive to investors and stakeholders, managers may also need to consider further calculated methods to appease such stakeholders.

Directions for future research

Our work is tempered by some limitations, which highlight opportunities for future research. Firstly, the research model tested in this study is limited and could be extended. Environmental factors, such as levels of uncertainty, could be added into the model. The boundary conditions for co-creation and an examination of incremental versus radical innovation may also be of value. Additionally, the dimensions of effectuation logic might have dynamic relationships among them, as hinted at in effectuation process models (Read, *et al.*, 2009; Sarasvathy and Dew, 2005). Such potential relationships warrant further investigation.

Further research could examine effectuation logic in combination with other firm practices, such as collaborative activities with a wider set of stakeholders. This would further augment our understanding of the way effectuation logic can be translated into performance and garner broader knowledge about what types of practices can help this. Future research could also fruitfully explore how different co-creation activities, e.g. ideation contests, crowdsourcing, toolkits and co-creation workshops may affect performance in the context of effectuation.

This research uses cross-sectional data collected at a single point in time, but future research could take a longitudinal approach as advocated by Perks and Roberts (2013). Specifically, given that longitudinal study is concerned with sequential events and flow of activities within processes they might be of value to explore changes in effectuation-co-creation relationships over time and explain the causes of such changes in detail.

Finally, our work could lay the groundwork for future research to develop mid-range theory providing a theoretical bridge between our empirical findings and effectuation theory and co-creation.

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