Entrepreneurial networks, effectuation, and business model innovation of startups: The moderating role of environmental dynamism

1 Introduction

Business model innovation is the reconfiguration of existing business models based on external and internal resources (Foss & Saebi, 2017; Micheli, Berchicci, & Jansen, 2020; Schaltegger, Hansen, & Lüdeke-Freund, 2016; Zhang, Xiao, Wang et al, 2020), and is critical for startups to achieve competitive advantage and sustainability (Massa, Tucci, & Afuah, 2017; McDonald & Eisenhardt, 2020; Snihur & Zott, 2020; Tykkyläinen & Ritala, 2020). Specifically with the presence of COVID-19, dynamic entrepreneurial environment and decision-making processes are aggravated. Therefore, the determinants of startup business model innovation are attracting great attention, especially in the dynamic environments (Ma, & Hu ,2021; Wirtz, Pistoia, Ullrich, & Göttel, 2016; Foss & Saebi, 2017; George & Bock, 2011).

Previous research has revealed that startups, restricted by new entrants' weaknesses, insecure foundations, difficulties in acquiring financing, and questionable legality, greatly depend on entrepreneurs with innovative business models (Zacca, Dayan, & Ahrens,2015; Baker, Grinstein, & Harmancioglu,2015). Therefore, entrepreneurial networks are important resources for startups (Partanen, Kauppila, Sepulveda, & Gabrielsson, 2020; Breuer & Lüdeke-Freund, 2017; Neergaard, 2005; Wassmer, 2010), and may impact business model innovation (Micheli et al., 2020; Zhang et al., 2020).

In addition, entrepreneurial psychology is as an important personal factor in business model innovation (Zhang et al., 2020). Entrepreneurs are startups' main decision makers, and their mindsets and mental states impact business model innovation (Foss & Saebi, 2017; Amoroso, Lim, & Santamaria, 2021). Entrepreneurial networks are an external factor, and along with managerial psychology and personality, help fledgling firms to access diverse

resources and identify opportunities for business model innovation (Zhang et al., 2020). Effectuation or entrepreneurial decision-making and understanding brings together entrepreneurial networks and business model innovation in startups (Long, Wang, & Wang, 2021; Peng, Liu, Jiao, Feng, & Zheng, 2020; Spieth, Schneckenberg, & Ricart, 2014; Venkataraman, Sarasvathy, Dew, & Forster, 2012).

Effectuation is a series of heuristic logic about how entrepreneurs think, make decisions and act in dynamic environments, including individual understanding, thinking models, practices, and behavioral logic (Sarasvathy, 2001; Mitchell, Busenitz, Bird, Gaglio, McMullen, Morse, & Smith, 2007). Business model innovation may be subjectively constructed, and reflects entrepreneurial will and cognition (Martins et al., 2015; Reymen, Berends, Oudehand, & Stultiëns, 2016; Taeuscher, & Abdelkafi, 2017). Entrepreneurial networks are a decision-making starting point for effectuation, and effectuation is a personal factor that triggers business model innovation behavior in firms (Futterer, Schmidt, & Heidenreich, 2018; Reymen, Andries, Berends, Mauer, Stephan, & Van Burg, 2015; Martins et al., 2015). It is reasonable to suggest that effectuation offers insights into the ways through which entrepreneurial networks are transformed into business model innovation (Harms, Alfert, Cheng, & Kraus, 2021; Chesbrough, 2010; Futterer et al, 2018; Velu & Jacob, 2016; Reymen et al., 2016).

However, the existing research separately focuses on impact of entrepreneurial networks and cognition; few studies combine entrepreneurial networks (external) and entrepreneurial cognition and understanding (personal). The relationship between entrepreneurial networks and business model innovation remains in an elusive “black box” (Cai, Anokhin, Yin, & Hatfield, 2016; Partanen et al., 2020), especially in dynamic environments (Ojala, 2016; Cai, Guo, Fei, & Liu, 2017). Therefore, this research examines entrepreneurial networks and effectuation, and explores how entrepreneurial networks impact business model innovation in startups.

The main contributions are first to explore the effects of entrepreneurial networks and effectuation on business model innovation in startups. Second, the research reveals the influence of entrepreneurial networks on business model innovation and tests the mediating effect of effectuation in startups. Third, the boundary condition of effectuation's impact on business model innovation is explored. Against the background of a transforming economy in China, emerging markets and constant institutional reform have accelerated the dynamism of the entrepreneurship environment (Peng et al., 2020). Therefore, it is necessary to test the moderating effect of environmental dynamism as a boundary conditions of effectuation.

2 Literature and hypotheses

2.1 Entrepreneurial networks and business model innovation

Entrepreneurial networks refer to network constructed by entrepreneurs to sustain the production and development of startups. These include entrepreneur individual relationship and startup organizational networks (Witt, 2004). This research was based on the relationship-structure framework, and had a focus on the effects of startup network characteristics including network scale and relationship strength on effectuation.

Network scale refers to the number of enterprise partners that are directly connected in the entrepreneurial network. This scale can be used to measure the source and scope of funding information that is accessible to the enterprise (Baum, Calabrese, & Silverman, 2000; Hills, Lumpkin, & Singh, 1997). Many studies on entrepreneurship have suggested that the interaction between startups and external organizations such as customers, competitors, suppliers, governments, banks, scientific research institutions, and intermediary institutions can affect organizational market competitiveness and innovation performance (Wassmer, 2010). This interaction can provide external resource support and cost advantages for business model innovation. An extensive network can help startups acquire more information, capital, technology, and knowledge (Zhang & Li, 2010); broaden the horizons of entrepreneurs; and

stimulate their creativity (Leminen, Nyström, Westerlund, & Kortelainen, 2016) so that they can recognize and create business opportunities (Lindgren, Taran, & Boer, 2010). An extensive network can help shorten the time required for information search (Ridzwan, Muhammad, & Rahman, 2016), effectively lowering the acquisition difficulty and cost of heterogeneous resources (Kim & Choi, 2014) and improving the efficiency of business model innovation.

Network strength represents the binary relationship formed by the direct connection of network members. It refers to the degree to which bilateral trading parties understand and trust each other (Forés & Camisón, 2016; Uzzi, 1997; Granovetter, 1978). Many scholars posit that a vigorous network relationship can facilitate the survival and development of startups (Batjargal, 2003). First, a strong relationship usually engenders trust, which can ensure the credibility and quality of resources (Scarbrough, Swan, Amaeshi, & Briggs, 2013). Strong relationships are bonds through which startups acquire high-quality information and tacit knowledge, as they allow convenient transmission of complex information, enable in-depth communication among members (Huang & Wang, 2011), and improve the efficiency of innovation decision-making and action. Second, strong network relationships provide support for members' high-risk entrepreneurial activities such as business model innovation (Dyer & Nobeoka, 2000), which is an experimental process involving constant trial and error (Futterer et al., 2018; Reymen et al., 2015). Thus, a vigorous partnership increases entrepreneur confidence regarding risks and enhances the flexibility of corporate strategies, resulting in the realization of novel business model design. Based on the above analysis, the following hypotheses are proposed:

H_1: Entrepreneurial networks have significant positive impacts on business model innovation.

$H_{1\text{-}1}$: Network scale has a significant positive impact on business model innovation.

$H_{1\text{-}2}$: Network strength has a significant positive impact on business model innovation.

2.2 Effectuation and business model innovation

Effectuation is a heuristic logic that is based on the effectuation process. There is expected to be a positive relationship between effectuation and business model innovation. Velu and Jacob (2016) verified the positive impact of effectuation on business model innovation, and Reymen et al. (2015) found that effectuation promotes changes in six elements of the business model through a case study. Futterer et al. (2018) observed a positive impact of effectuation on business model innovation via an empirical test. This research proposes that the impact of effectuation on business model innovation is mainly reflected in the following ways.

First, emphasis on the validity of the experiment and on the process of trial and error may prompt entrepreneurs to explore diverse business models, acquire market feedback, and recognize new business opportunities (Zhang, Du, Cheng, & Tian, 2019; Lichtenthaler, 2013) presented by unfulfilled consumer demands. Entrepreneurial awareness of the defects of their original business models can improve business model innovation.

Second, the impact of effectuation on business model innovation suggests that entrepreneurs should set resource input parameters within the scope of bearable losses to control risks, and then acquire market feedback about the business model via small-scale trial and error according to the budget and implementation schedule. Enterprises can then immediately terminate losses, particularly those caused by inappropriate investments in an erroneous innovation direction (Wiltbank et al., 2006; Dew et al., 2009), and immediately reallocate financial, human, and material resources (Brettel et al., 2012), thus improving the performance level of innovation projects.

Third, due to the dynamism, ambiguity, and unpredictability of the entrepreneurial environment at the initial stages of a startup, a large amount of information collected by the enterprise at that time may prove to be invalid (Thomke, 1997; Brinckmann, Grichnik, & Kapsa, 2010).). Effectuation that accommodates flexibility and adaptability may better drive enterprise

innovation. If contingencies are emphasized, entrepreneurs can launch innovation projects more rapidly, expend fewer resources, adjust organizational procedures, and capture potential opportunities in changing environments (Naveh, 2007; Zhong, Yu, & Pan, 2019), by modifying and improving the original innovation business model.

Fourth, effectuation emphasizes the acquisition in advance of stakeholder support for and commitment to entrepreneurship activities (Fisher, 2012; Guo, Cai, & Zhang, 2016). If cooperation is emphasized, startups more actively form strategic alliances with stakeholders, and thus realize the sharing of valuable information, become aware of opportunities, access resource integration, while alleviating ambiguity and uncertainty in the innovation process (Chandler et al., 2011； Reymen et al., 2015), and increasing the success rate of startup business model innovation. Based on the above analysis, the following hypothesis is proposed:

H_2: Effectuation has a positive impact on business model innovation.

2.3 Mediating effects of effectuation

Sarasvathy (2001) posits that an entrepreneur will find it difficult to collect adequate information and data for external environment analysis at the initial stage of business development. Entrepreneurs tend to construct an extensive cooperation network for their entries into the market, proceed from a few resources of business model innovation through trial and error, and adhere to logical decision-making principles, including experiments, bearable losses, flexibility, and previous promises (Wiltbank, Dew, Read, & Sarasvathy, 2006; Perry, Chandler, & Markova,2012; Brettel et al., 2012; Reymen et al., 2015; Chandler et al., 2011).

There is a positive relationship between entrepreneurial networks and effectuation (Sarasvathy, 2001; Brettel et al., 2012). The entrepreneur’s current networks usually are the starting point for decision-making, and the construction of an extensive, vigorous relationship networks improve effectuation.

First, a relatively broad network scale can promote startup acquisition of heterogeneous and valuable external resources and knowledge (McIntyre & Srinivasan, 2017; Hansen, 1995); provide new, feasible, and specific methods for growth; and guarantee resource supply for high-risk innovation activities with the cost advantage of the network scale (Almeida & Campello, 2007). Therefore, networks can increase startups' scope of bearable losses and willingness to engage in risk-neutral decision-making (Hu, Wang, Zhang, & Zhang, 2017), enabling them to quickly adjust their business procedures and capabilities to capture business opportunities in changing environments. Under these circumstances, startups may lower risks and improve business models.

Second, business model innovation is an entrepreneurial activity with a high degree of uncertainty. Mu et al. (2009) noted that members with strong utilitarian goals may be unwilling to assume the risks involved in providing entrepreneurs with substantial assistance. Brüderl and Preisendörfer (1998) observed that only network members that trust and support entrepreneurs and startups are likely to provide the necessary financial help, knowledge, and resources that can lower network member perceived risks (Rost, 2011) and improve startups' scope of bearable losses, strategy flexibility, and experiment success rate.

The effects of entrepreneurial network on business model are through effectuation. It is proposed that entrepreneurs adopting effectuation logic are committed to evaluating available resources; pursuing expansion, new methods, and opportunities (Dew, Read, Sarasvathy, & Wiltbank, 2009); and creating shared goals together with stakeholders (Rost, 2011), while flexibly capturing potential opportunities arising from the dynamism, ambiguity, and uncertainty of external environments. Thus, entrepreneurs can effectively integrate resources to maximize business model value. For example, Hu et al. (2017) found the mediating role of effectuation between entrepreneurial networks and startup financing. Peng et al. (2017) observed that effectuation-based resource integration plays a mediating role in the relationship

between entrepreneurial networks and startup performance. Therefore, the following hypotheses are proposed:

H_3: Effectuation plays a mediating role in the relationship between entrepreneurial networks and business model innovation.

$H_{3\text{-}1}$: Effectuation plays a mediating role in the relationship between the network scale and business model innovation.

$H_{3\text{-}2}$: Effectuation plays a mediating role in the relationship between the network strength and business model innovation.

2.4 Moderating role of environmental dynamism

High environmental dynamism, such as rapid market changes and frequent technological updates, has required startups to predict future development trends and acquire critical resources. Under this scenario, effectuation adheres to the decision-making model of action before thinking and emphasizes the interaction with stakeholders via existing methods. This can improve startup efficiency in utilizing entrepreneurship resources and innovating business models through actions and iterative learning (Futterer et al., 2018; Harms & Schiele, 2012; Mthanti, & Urban, 2014).

First, high environmental dynamism can increase startup reliance on experiments and interactive learning for the adjustment and innovation of business models. In a highly dynamic environment, non-continuous technological updates and rapidly changing customer demands make it difficult to recognize and judge the value of business opportunities. This leads to entrepreneurs to apply existing methods and scenarios to recognize opportunities and create value (Chandler et al., 2011). Entrepreneurs adopt an experimental trial and error process to deepen their understanding of the relationship between one’s own behavior and the environment, and utilize ambiguity and uncertainty to create value and innovate business models (Mintzberg & Waters, 1985).

Second, high environmental dynamism is more likely to drive entrepreneurs to assess business model innovation projects in accordance with the principle of bearable losses to better control losses and risks. Dew et al. (2009) points out that when an enterprise is faced with a highly unstable environment, its revenues, sales volume, and other business data are difficult to measure. Even if these data can be assessed, the results may not provide reliable support for critical decision-making. Therefore, entrepreneurs are more likely to flexibly make use of or even create new opportunities for business model innovation with bearable losses as a limitation in a highly dynamic environment (Reymen et al., 2015; Fisher, 2012).

Third, high environmental dynamism reinforces startup willingness to create value via contingency factors. For example, against the background of a transforming economy, the appearance of emerging markets and constant institutional reform have exacerbated the turbulent entrepreneurship environment in China. Hence, it is imperative for startups to develop flexibility and provide rapid response to user demands to survive in the market by capturing the fleeting business opportunities (Yiu, Hoskisson, Bruton, & Lu, 2014; Cai et al., 2016; Ranabahu & Barrett, 2019). For example, Thomke (1997) posited that an innovation team is often confronted with more information in a highly uncertain environment, which calls for constant modification and improvement of the project plan to promote enterprise innovation activities.

Fourth, high environmental dynamism enhances the willingness of entrepreneurs to make use of stakeholders' previous commitments. A highly dynamic environment is usually characterized by rapidly changing customer demands, competitors, and technological developments, which means that it is difficult to formulate a well-rounded plan for business model innovation in advance (Brettel et al., 2012). This has forced startups to persuade potential customers to order products in advance, to ensure shareholders commit to funding and risk-sharing (Astley & Zajac, 1991), or to require strategic partners to provide customer

resources for product trial and promotion (Li, X., Li, D., Liu, & Long, 2019). Stakeholder commitments can provide the necessary guarantees for startup development and enable them to increase the diversity of strategies and create new markets. Therefore, the following hypothesis is proposed:

H_4: Environmental dynamism has a positive moderating effect on the relationship between effectuation and business model innovation.

The theoretical model for this research is shown in Figure 1.

[Insert Figure 1]

3. Methods

3.1 Samples and data collection

Based on the findings of Vissa et al. (2009) and Yang et al. (2017), enterprises were selected that were established within the past eight years (founded from January 1, 2012 to December 31, 2019). The data were collected from core members, senior management, or middle managers of the entrepreneurship group. The background information of individuals and enterprises was captured through different questions: Question 4 (What is your position in your company?); Question 6 (What is the name of your company?); Question 7 (How long has the company been established?) to verify whether the respondents conformed to the requirements of this research.

The surveys were conducted from November 2019 to April 2020. The questionnaires were collected through colleagues working in China's Changsha Municipal Federation of Industry and Commerce, and a third-party professional institution, Wjx.cn (https://www.wjx.cn/). In total, 500 questionnaires were delivered. Those with incomplete answers and obvious problems, or that were inconsistent were deleted, and 408 valid questionnaires remained. To ensure the reliability and accuracy of the data, the authenticity of the completed responses was confirmed by visiting the official websites of enterprises and qcc.com (https://www.qcc.com/), and

checking details against the individual and enterprise background information provided by the respondents. The basic characteristics of the respondents are presented in Table 1.

[Insert Table 1]

3.2 Measurements

Scales that have been extensively cited by authoritative research and repeatedly verified by empirical research were used. Five-point Likert scale were used for item measurement.

Dependent variables

Network scale was measured by seven questions asking whether the company had many customers, suppliers, competitors, financial institutions, industrial associations, scientific research institutions, governments, and intermediaries, respectively (Watson, 2007). Network strength was represented by three dimensions, trust, information sharing, and joint solution of problems, based on research by scholars such as Uzzi (1997) and measured using ten questions.

Mediating variable

Effectuation was measured by referring to the scale developed by Chandler et al. (2011), in which the antonymous questions are deleted. Effectuation consisted of four dimensions (experiments, bearable losses, flexibility, and previous promises) and was measured by 11 questions.

Independent variable

Business model innovation was measured by the novel business model scale developed by Zott and Amit (2007), and referred to the research carried out by Chinese scholars such as Guo et al. (2016). Eight items, including whether the company had constantly introduced large numbers of new customers with diverse needs, were used to measure business model innovation.

Moderating variable

Based on dimensions adopted by several scholars, environmental dynamism was divided into two dimensions (i.e., dynamism of the technological and market environments) and measured using eight items (e.g., whether the industry in which the company specializes was undergoing rapid technological change) (Moorman & Miner, 1997; Miller & Friesen, 1978; Dess & Beard, 1984).

Control variables

Control variables were at the individual level, namely, the entrepreneur, and at the organizational level. In terms of the entrepreneur's characteristics, gender, age, educational background, and entrepreneurship experience were selected, all of which have a significant impact on the accumulation of individual social capital as well as on the development and survival of new enterprises. At the organizational level, enterprise scale, years established, and industry type may have a sizeable impact on startup innovation ability and performance, and were thus defined as control variables.

4. Results

4.1 Reliability and validity analysis

Cronbach's α was used to verify the reliability of variables. The results indicated that the Cronbach's α of network scale, network strength, effectuation, business model innovation, and environmental dynamism variables were 0.820, 0.868, 0.821, 0.857, and 0.852, respectively, all of which were greater than 0.8. The CITC (corrected item total correlation) values of all statements were above or close to 0.5. The overall reliability level of the scale was not improved even after any statement was deleted. This suggested high consistency among the variables.

LISREL 8.80 was applied to test the convergent and discriminant validities of the scale (Table 2). The model fitting index of the network scale, network strength, effectuation, business model innovation, and environmental dynamism all were at a favorable level. The factor

loadings of various statements ranged between 0.52 and 0.86. The CR values are 0.825, 0.899, 0.821, 0.883,0.9, and 0.882, respectively, all greater than 0.7, signifying that all scales possessed favorable convergent validity.

[Insert Table 2]

In terms of the discriminant validity test, comparative analysis results of the one-factor to five-factor model are presented in Table 3. The results show that the five-factor model had a favorable fitting effect ($\chi 2/df = 2.28 < 5$; NFI=0.94; NNFI=0.96; CFI=0.97; IFI=0.97; RMSEA =0.056), and the goodness-of-fit is significantly superior to that of the other models. This signifies that the major variables of this study possess acceptable discriminant validity, which can represent five different constructs.

[Insert Table 3]

4.2 Correlation analysis

The Pearson coefficient was used to conduct a correlation analysis of the variables. The values of the variables fell within a reasonable range from 0.4 to 0.75 (Table 4). To eliminate the impact of multicollinearity, the VIFs of all regression models were calculated. The results showed that the VIFs of all variables were under 1.92 (Table 5) and under the benchmark value of 5. Therefore, multicollinearity was not a problem in this research.

[Insert Table 4]

4.3 Regression analysis

Mediating effect of effectuation

Two methods were adopted to verify the mediating effect of effectuation. The mediating effect verification approach proposed by Baron and Kenny (1986) was adopted, and the regression results are shown in Table 5.

First, entrepreneurial network was positively related to effectuation (Model 1: Network model $\beta = 0.247$, $p < 0.001$; network strength $\beta = 0.498$, $p < 0.001$). Second, there was a significant relationship between effectuation and business model innovation (Model 2: Effectuation: $\beta = 0.647$, $p < 0.001$.). Hypothesis 2 was supported. Third, entrepreneurial network and business model innovation were significantly related (Model 3: Network model: $\beta = 0.307$, $p < 0.001$; network strength: $\beta = 0.443$, $p < 0.001$.). Hypothesis 1, Hypotheses 1-1, and Hypotheses 1-2 were all supported. Fourth, after considering network scale, network strength, effectuation, and the regression of business model innovation, Model 4 was obtained. The regression coefficients between network strength and the independent variable, business model innovation, were 0.214 ($p < 0.001$) and 0.256 ($p < 0.001$), respectively. Compared with Model 3, there was a significant decrease in the regression coefficients in Model 4. This signified that effectuation plays a partial mediating role in the relationship between entrepreneurial networks and business model innovation. Therefore, Hypotheses 3, 3-1, and 3-2 were supported.

[Insert Table 5]

Next, based on Preacher and Hayes (2008), the bootstrap test was used to test the mediating effect. Processes that run at a confidence level of 95% are chosen from 5,000 samples generated by bootstrapping. The results showed that the indirect effect of effectuation was 0.826, at a confidence level of 95%, and a confidence interval of [0.0473, 0.1194] (zero not included) (table 6). This suggests a significant mediating effect between entrepreneurial networks and business model innovation ($p < 0.001$).

[Insert Table 6]

Moderating effect of environmental dynamism

The interaction items were entered into the main effect regression model one by one, to examine the impact on the moderating effect of environmental dynamism. The

multicollinearity of the interaction variables was low. The regression results are shown in Model 5 (Table 5).

The interaction item of effectuation and environmental dynamism was added, leading to a significant improvement in the explanatory power of the model ($\Delta R^2 = 0.008$, $p < 0.01$). The standardized regression coefficient of effectuation * environmental dynamism was 0.091, and its significance was less than 0.01 ($p < 0.01$). This indicated that environmental dynamism plays a positive moderating role in the relationship between effectuation and business model innovation. The higher the environmental dynamism, the more significant the positive correlation between effectuation and business model innovation. Therefore, Hypothesis 4 was supported.

Figure 2 presents the impact of the interactive effects of environmental dynamism and effectuation. Based on Cohen et al. (2003), the moderating effect of environmental dynamism on the relationship between environmental dynamism and business model innovation is depicted based on a value higher than the average by one standard deviation, and lower than the average by one standard deviation, respectively.

[Figure 2]

5. Discussions and conclusions

5. 1 Conclusion

This research explored how startup entrepreneurial networks stimulate business model innovation through effectuation in dynamic environment. Based on the empirical analysis of 408 startups in China, the main conclusions were as follows.

Entrepreneurial networks had a significantly positive impact on startup business model innovation. Specifically, expansion of the entrepreneurial networks and strengthening these further facilitates startup business model innovation. Also, the effect of the network strength is more robust. The findings suggest that entrepreneurial networks are significant channels for

acquiring critical resources and provide spillover resource support and cost advantages required for business model innovation. Therefore, maintaining open attitudes facilitates business model innovation and implementation.

Effectuation is a critical mediator that promotes the entrepreneurial network influence on business model innovation. In changing environments, entrepreneurs may reject traditional causal reasoning models, seeking the reallocation of available resources; flexibly adapt with external environmental changes; and apply viable business models through cognitive and action iterations, and via experiment and trial. Effectuation is a critical factor that affects the quality and outcomes of business model innovation. This echoes the idea of fine entrepreneurship developed from the practices in Silicon Valley.

The positive effects of effectuation on business model innovation are stronger in highly dynamic environments. This research noted that the decision-making logic of effectuation has become a practical choice for many enterprises in response to highly dynamic environments. In rapidly transforming economies, entrepreneurs tend to adopt relatively pragmatic attitudes and emphasize learning how to adjust business models via experiments and trial and error. This improves the survival rates of startups in highly dynamic and complex environments through pragmatic, speedy, and innovative actions. This conclusion is consistent with those of scholars such as Futterer et al. (2018) , Harms and Schiele (2012), and Wang et al. (2019).

5.2 Theoretical implications

First, this research explores the effects of entrepreneurial networks (external) and effectuation (personal) on business model innovation in startups, and adds to the antecedents in the research on business model innovation. External and personal factors are critical antecedents of business model innovation. The results are consistent with Zhang et al. (2020), Micheli et al. (2020), and revealed the positive effects of entrepreneurial networks and effectuation on business model innovation.

Second, the “black box” between entrepreneurial networks and business model innovation is discovered and opened, which enriches the understanding on the role of effectuation theory in business model innovation. By applying effectuation theory, how entrepreneurial networks stimulate business model innovation was explored. In contrast to previous research, this investigation found that effectuation leads to the effective utilization of network resources which triggers business model innovation. This research enriches the business model innovation research and illuminates the relationship between external entrepreneurial network and business model innovation through internal decision-making logic, and responds to the call for introducing effectuation into business model innovation (Reymen et al., 2015; Velu & Jacob, 2016; Reymen et al., 2016).

Third, the boundary condition of effectuation was explored. The moderating effect of environmental dynamism in the relationship between effectuation and business model innovation in startups was tested. This expands the research literature on effectuation theory, regarding dynamic business environment as a contingent factor. It proposed that dynamic environments strengthen the effect of effectuation on business model innovation (Futterer et al., 2018; Reymen et al., 2016; Harms and Schiele, 2012; Mthanti et al., 2014).

5.3 Practical implications

First, entrepreneurs in startups should pay attention to building networks. Startups should actively construct extensive entrepreneurial networks with stakeholders such as customers, competitors, suppliers, governments, banks, scientific research institutions, and intermediaries, and focus on maintaining and operating strong relationships. This helps startups address weaknesses as new entrants, overcomes legal obstacles, and promotes the survival and growth of new enterprises, coinciding with the notion of open innovation (Chesbrough & Schwartz, 2007) and innovation via cooperation (Dell'Era & Verganti, 2010). In addition, entrepreneurs

should emphasize network strength and promote trust, information sharing and joint problem solving among participants.

Second, the training of effectuation decision logic in startups is highly desirable. Effectuation is the key decision logic applied to entrepreneurial networks to promote business model innovation. Entrepreneurs are likelier to use effectuation decision-making logic, and flexibly apply effectuation to immediately capture potential opportunities in dynamic situations to foster business model innovation. The successful implementation of business model innovation requires external network resources. Entrepreneurs must utilize critical thinking to interpret, integrate, and allocate network resources to maximize value creation. The positive impact of effectuation on business model innovation is especially strong in dynamic environments.

5.4 Limitations

This study has several limitations. First, the use of cross-sectional data to expound on the relationship between entrepreneurial networks and business model innovation has limitations. In the future, longitudinal research should be carried out to further explore this causal relationship. Second, this study is limited to the exploration of the partial mediation revealed by effectuation. In the future, a dual rational perspective should be adopted to discuss the mediating role of two decision-making logics, effectuation, and causal reasoning, in the relationship between entrepreneurial networks and business model innovation. Third, this research only takes the regulating role of organizational external environmental dynamism into consideration; however, entrepreneurial networks and effectuation are also subject to the impacts of internal factors. Therefore, future research should examine the regulatory role of the impact of regulating variables such as corporate culture and scale, and organizational structure.

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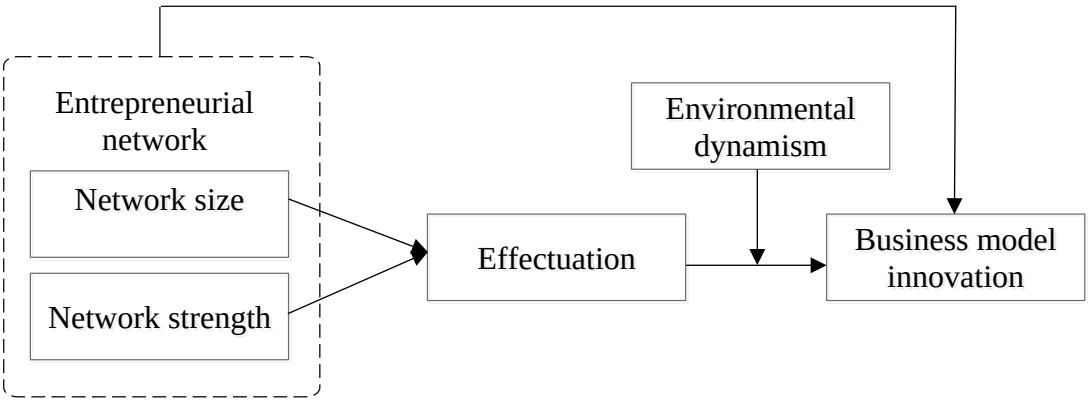

Fig. 1. Theoretical model.

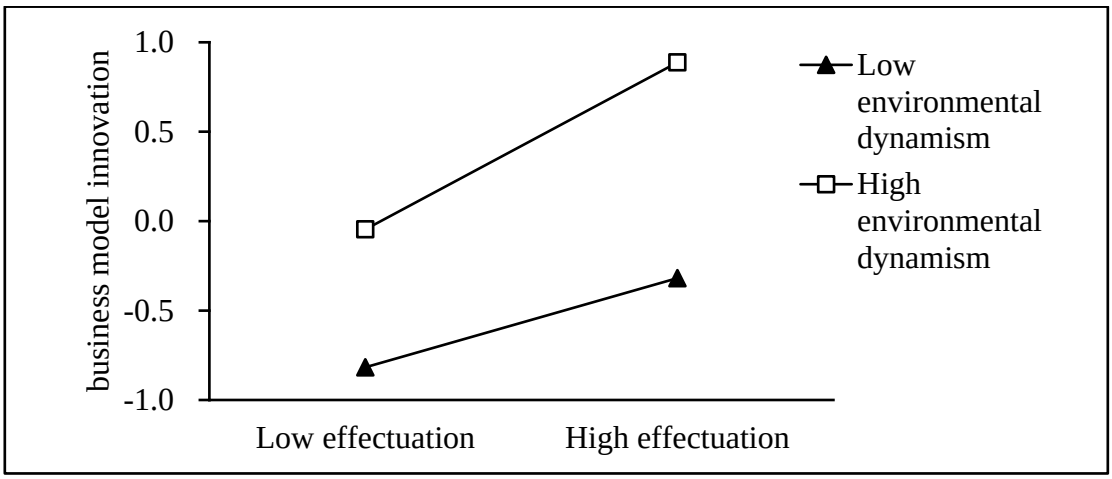

Fig. 2. The moderating effect of dynamic environments.

Table 1.

Characteristics of respondents

Features	Categories	Sample size	Percentage
Gender	Male	239	58.58%
	Female	169	41.42%
Age	< 25	8	1.96%
	25-34	189	46.32%
	35-44	148	36.27%
	45-54	53	12.99%
	≥ 55	10	2.45%
Education	Senior high school or below	21	5.15%
	Junior college	70	17.16%
	Undergraduate	213	52.21%
	Master's	98	24.02%
	Ph.D.	6	1.47%
Position	Chairperson/General Manager	95	23.28%
	Senior management	208	50.98%
	Middle management	105	25.74%
With entrepreneurship experience	Yes	252	61.76%
	No	156	38.24%
Business years established	≤ 1	9	2.21%
	1-3	103	25.25%
	4-5	129	31.62%
	6-8	167	40.93%
Scale (Number of staff)	1-20	56	13.73%
	21-50	95	23.28%
	51-200	135	33.09%
	201-500	61	14.95%
	≥ 501	61	14.95%
Industry	General manufacturing industries	107	26.23%
	Service industries	198	48.53%
	New-and high-tech industries	103	25.25%
Enterprise type	State-owned enterprises	45	11.03%
	Private enterprises	327	80.15%
	Sino-foreign joint ventures, enterprises with Sino-foreign cooperation, and wholly foreign-owned enterprises	17	4.17%
	Collectives	19	4.66%

Table 2.

Validity test of major variables

Variables	Items	Factor loading	Composite reliability (CR)	Fit index
Network size	We cooperate with many customers and suppliers.	0.61	0.825	$\chi 2/df = 1.57 < 5$; NFI=0.98>0.9; NNFI=0.99>0.9; CFI=0.99>0.9; IFI=0.99>0.9; RMSEA =0.038<0.08
	We communicate with many competitors.	0.52		
	We cooperate with many banks.	0.73		
	We cooperate with many industry associations.	0.64		
	We cooperate with many research institutions.	0.60		
	We cooperate with different levels of government department.	0.71		
	We cooperate with more service companies.	0.62		
Network strength	Our participants negotiate fairly with us.	0.64	0.899	$\chi 2/df = 3.56 < 5$; NFI=0.96>0.9; NNFI=0.96>0.9; CFI=0.97>0.9; IFI=0.97>0.9; RMSEA =0.079<0.08
	Our participants keep its word.	0.57		
	Our participants do not mislead us.	0.75		
	Our participants do not take advantage of us even if the opportunity arises.	0.65		
	Our participants warn us of events that may create problems for us.	0.67		
	Our participants share proprietary and sensitive information with us.	0.69		
	Our participants share its plans for the future with us	0.68		
	We are jointly responsible with our participants for getting things done.	0.72		
	We work with our main participants to help solve each other’s problems.	0.69		

	Our participants work with us to overcome difficulties.	0.79		
Effectuation	We experimented with different products and/or business models.	0.64	0.883	$\chi 2/ df = 1.33 < 2$；NFI=0.98>0.9；NNFI=0.99>0；CFI=0.99>0.9；IFI=0.99>0.9；RMSEA=0.028<0.08
	The product/service that we now provide is substantially different than we first imagined.	0.70		
	We were careful not to commit more resources than we could afford to lose.	0.62		
	We were careful not to risk more money than we were willing to lose with our initial idea.	0.74		
	We were careful not to risk so much money that the company would be in real trouble financially if things didn't work out.	0.63		
	We allowed the business to evolve as opportunities emerged.	0.62		
	We adapted what we were doing to the resources we had.	0.56		
	We were flexible and took advantage of opportunities as they arose.	0.66		
	We avoided courses of action that restricted our flexibility and adaptability.	0.61		
	We used a substantial number of agreements with customers, suppliers and other organizations and people to reduce the amount of uncertainty.	0.55		
	We used pre-commitments from customers and suppliers as often as possible.	0.67		
Business model innovation	The business model brings together new participants.	0.73	0.900	$\chi 2/df = 2.01 < 5$；NFI=0.98>0.9；NNFI=0.99>0.9；CFI=0.99>0.9；IFI=0.99>0.9；RMSEA =0.051<0.08
	The business model gives access to an unprecedented variety and number of participants.	0.68		
	The business model links participants to transactions in novel ways.	0.68		
	Incentives offered to participants in transactions are novel.	0.65		
	The focal firm has continuously introduced innovations in its business model.	0.76		

	There are other important aspects of the business model that make it novel.	0.68		
	The firm claim to be a pioneer with its business model.	0.77		
	Overall, the company's business model is novel.	0.86		
Environmental dynamism	The technology in our industry is changing rapidly.	0.69	0.882	$\chi 2/df=3.10<5$;NFI=0.97>0.9; NNFI=0.97>0.9;CFI=0.98>0.9; IFI=0.98>0.9; RMSEA =0.072<0.08
	Technological changes provide big opportunities in our industry.	0.74		
	A large number of new products have been made possible through technological breakthroughs in our industry.	0.73		
	Technological development has an important impact on our industry.	0.64		
	Customer preferences change rapidly.	0.72		
	Our customers tend to look for new products all the time.	0.66		
	There are new customers in the market to buy your products.	0.67		
	New customers tend to have product-related needs that are different from those of our existing customers.	0.59		
	The needs of new customers have a greater impact on the business area in which the enterprise engages in.	0.62		

Table 3.

Discrimination validity analysis of major variables

Models	χ^2/ df	RMSEA	NFI	NNFI	CFI	IFI
One-factor model	3746.71/945=3.96	0.085	0.90	0.92	0.92	0.92
Two-factor model	3572.90/944=3.78	0.083	0.90	0.92	0.93	0.93
Three-factor model	3404.35/942=3.61	0.080	0.91	0.93	0.93	0.93
Four-factor model	2706.76/939=2.88	0.068	0.93	0.95	0.95	0.95
Five-factor model	2131.54/935=2.28	0.056	0.94	0.96	0.97	0.97

Table 4.

Correlation of variables.

Variables	Mean	Standard deviation	1	2	3	4	5
1. Network scale	3.8410	0.68709	1				
2. Network strength	4.0814	0.55970	0.545**	1			
3. Effectuation	4.1745	0.45301	0.528**	0.638**	1		
4. Business model innovation	3.9240	0.60952	0.573**	0.618**	0.658**	1	
5. Environmental dynamism	3.9975	0.57000	0.470**	0.557**	0.593**	0.744**	1

Note: ** indicates the significance level is defined at $p<0.01$ (two-tailed test); * indicates the Significance level is defined at $p < 0.05$ (two-tailed test).

Table 5.

Hierarchical regression analysis

Variables		Dependent variables			
	Effectuation	Business model innovation			
	Model 1	Model 2	Model 3	Model 4	Model 5
1 Gender	0.074*	-0.032	0.024	-0.003	-0.042
2 Individual's age	0.035	-0.035	-0.011	-0.024	0.000
3 Education	-0.066^{+}	0.005	-0.023	0.002	-0.005
4 Entrepreneurship experience	-0.050	0.000	-0.031	-0.012	-0.030
5 Enterprise age	0.013	0.022	0.017	0.012	-0.014
6 Enterprise scale	0.007	0.122**	0.071	0.068*	0.096**
7 Industry	-0.005	0.038	0.046	0.048	-0.013
8 Ownership	-0.045	0.047	0.015	0.032	0.024
9 Network scale	0.247***		0.307***	0.214***	0.335***
10 Network strength	0.498***		0.443***	0.256***	
11 Effectuation		0.647***		0.376***	
12 Causation					
13 Environmental dynamism					0.517***

14 Effectuation * Environmental dynamism					0.091**
R^2	0.470	0.454	0.470	0.545	0.641
Adj. R^2	0.457	0.442	0.457	0.532	0.631
ΔR^2	0.421	0.398	0.414	0.075	0.008
ΔF	157.876***	290.663***	155.043***	65.276***	8.328**
F	35.271***	36.833***	35.202***	43.117***	64.302***
Maximum VIF	1.499	1.433	1.579	1.920	1.691

Table 6.

Bootstrap verification of mediating effect

Effect types	Effect value	Boot standard error	Boot 95% CI		Relative effect
			Lower limit	Upper limit	
Total effect	0.2725	0.407	0.1924	0.3526	
Immediate effect	0.1899	0.391	0.1130	0.2669	69.69%
Indirect effect	0.0826	0.184	0.0473	0.1194	30.31%