Configurational Conditions and Sustained Competitive Advantage: A fsQCA Approach

ABSTRACT

Traditional manufacturing firms in emerging markets such as China are increasingly facing the challenge of digital transformation for Sustained Competitive Advantage (SCA). Underpinned by the resource orchestration theory, this study posits that organisational resources (relational and technological), transformation capability, and organisational characteristics are configurational conditions for SCA. Using fuzzy-set Qualitative Comparative Analysis (fsQCA), this study reveals multiple pathways – configurational resources and capabilities in sets of necessary and sufficient conditions – leading to SCA in a sample of 206 Chinese clothing manufacturing firms. Results suggest that relational resources are a necessary condition that fundamentally drives SCA; small firms can achieve SCA by combining relational resources and transformation capability, while portfolio technological resources are sufficient for large firms. For organisations with higher levels of global market engagement, both relational and portfolio technological resources are essential for achieving SCA. This study enhances understanding of the interdependence of the causal conditions (e.g., organisational resources and capability) in set relations with the outcome of SCA in different firms considering their size and level of global market engagement.

Keywords: Relational and portfolio technological resources; Transformation capability; fsQCA; Sustained competitive advantage; Industry 4.0; Global market engagement

Introduction

Traditional manufacturing is characterised by high energy consumption, low value added, and reliance on cost-based competitiveness (Li et al., 2020). The traditional manufacturing firms, particularly in emerging markets such as China, having once developed their global competitive advantage on the basis of low labour costs (Gereffi et al., 2005), are facing resource and environment constraints and are hence under pressure from the transformation towards advanced manufacturing technologies (Li, 2018; Cao et al., 2019) and green reformation (Li et al., 2020). Traditional manufacturers have long been associated with many proprietary legacy processes that over time have proved to be costly as the processes become inefficient; and these problems are no exception for Chinese manufacturers (Westerweel et al., 2018). The Chinese traditional manufacturers, particularly those with high labour-intensive input, have persistently been threatened by their competitors, such as those in Vietnam and Cambodia who benefit from much lower labour costs, prompting them to think about how to sustain their increasingly challenged competitiveness in the global market (Cao et al., 2019).

Furthermore, the penetration of the Industry 4.0 technologies in China continues to haunt traditional manufacturers (Rosin et al., 2020). Despite the technological advancements offered by Industry 4.0, many Chinese traditional manufacturers find it difficult to create scalable and competitive solutions that are both effective and affordable (Cao et al., 2019). Lack of access to capital remains a perennial problem facing traditional manufacturers, especially small- and medium-sized, preventing them from reaping the benefits from various improvements in the current manufacturing resources, business network, products and marketing aiming towards the digital and smart transformation (Qin et al., 2016; Li et al., 2019; Warner & Wäger, 2019). Although China still retains the world's dominant status in the manufacturing sector (Cao et al., 2019), the signal is clear that traditional manufacturing firms face significant issues pertaining to competitive advantages.

Sustained competitive advantage (SCA) is a significant research issue relevant to traditional manufacturing firms in China (Cao et al., 2014). The issue is also relevant to the world’s other top manufacturing countries, including Germany, India, and the United Kingdom (Richter, 2020), as all face the SCA challenges in their traditional manufacturing sector, particularly with the advent of Industry 4.0, when technology advancement requires digital transformation in the information and communication technologies that support advanced manufacturing.

Extant literature shows that sustaining competitive advantage is always at the centre of the debate, and there appear to be compelling reasons to shape the future research agenda surrounding this issue, especially in the midst of the fourth industrial revolution (Feng et al., 2018; Machado et al., 2020). Numerous studies have thus investigated the SCA issues in traditional manufacturing from the viewpoints of technological transformation and smart systems (Frank et al., 2019), for instance, artificial intelligence (Lee et al., 2018), adoption of automation manufacturing technology (Cao et al., 2019), and strategic choices of manufacturing locations either ‘staying at home’ or offshored (Stentoft & Rajkumar, 2020).

Nonetheless, when it comes to acquiring external capabilities, traditional manufacturing firms tend to be risk averse (Cao et al., 2019). They prefer first to address their fundamental issues but still make optimum use of their internal resources and capabilities, which they have developed over the years. Only once they have gained confidence, do they go on to develop a smart transformation and technological innovation. A recent empirical study suggests that focusing on firm-level capability development is an essential and practical solution for sustainable manufacturing, particularly in developing countries (Raj et al., 2020).

So, what does an optimum use of resources and capabilities entail? Though it sounds straightforward, there seems to be no simple answer to this question due to resource scarcity, causal complexities and other predicaments for firm performance. For instance, compared to large manufacturing firms, traditional small- and medium-sized firms have fewer capital resources or capabilities for innovation, although they are more flexible and adaptable to change. Furthermore, if firm resources are valuable, rare, imperfectly imitable, and non-substitutable (VRIN), then in theory, the firm should sustain its competitive advantage (Barney, 1991; 2001). However, multiple and heterogeneous resources also require multiple capabilities to configure those resources and be able to adapt to external dynamics, leading to achieving superior performance.

The extant literature on resource and capability configuration varies but tends to be dominated by linear regression analysis, which investigates ‘one best solution’ for SCA. Tallon (2007), for instance, explored the configuration of IT resources to prepare for, or react to, changes in order to gain superior performance, using PLS-SEM analysis which examines a moderated mediation model. The issue with the ‘one best solution’ is the difficulty to elaborate on various success stories in the real world as businesses often achieve SCA via multiple pathways. Other literature has explored how to configure resources and capability by employing cluster analysis. For instance, Lindgreen et al. (2013) applied a non-hierarchical K-means clustering analysis to identify four configurations of purchasing/sourcing practices to select the supply base. The four configurations are electronic purchasing, network purchasing, transactional, and integrative relational types. Cluster analysis groups cases according to the similarity of data patterns but does not indicate conditions for prediction or explanation, or causal relationships.

This paper aims to join in the conversation on SCA with a specific focus on firms’ resources and capability in the context of the traditional Chinese clothing manufacturing sector. Drawing on the underpinnings of resource orchestration theory (Sirmon et al., 2011) and the causal complexity in firms (Kauppila, 2015), this study intends to identify the causal conditions of organisational resources, organisational capability, and organisational characteristics (e.g., sizes and levels of global market engagement (GME)) for achieving SCA. Acknowledging the void in the extant literature on the resource and capability configuration, this study conducts a set-theoretic analysis using fuzzy-set Qualitative Comparative Analysis (fsQCA). The fsQCA enables exploration into multiple pathways for the achievement of SCA by Chinese traditional manufacturing firms. Compared with other traditional tools, fsQCA is relatively new; however, it has become increasingly prevalent in strategy and organisational research (Greckhamer et al., 2018). For instance, using fsQCA, Greckhamer and Gur (2019) explored the causal complexity underlying the links between generic strategies and firm performance and found six configurations of strategies for high performance. Similarly, Bouncken et al. (2020) found three pathways to high firm-level value captured in SMEs' coopetition.

This study offers several contributions to the operations and strategic management literature. *First*, this study proposes a framework to understand critical configurational set solutions for manufacturing firms to achieve SCA in the global commodity chain environment (Gereffi, 1999; Gereffi et al., 2005). This framework considers organisational resources, organisational capability, and organisational characteristics and examines their complex dynamics using a configurational approach. *Second*, the study reveals multiple pathways leading to SCA rather than a single best solution offered in most extant literature. The study enhances understanding of the interdependence of the causal conditions in set relations with the outcome of SCA in different firms regarding their size and level of GME.

Theoretical lens

Resource orchestration theory

According to the Resource-based View (RBV) theory, a firm's competitive advantage is attributable to the valuable and rare resources that it currently possesses; firms sustain their competitive advantage provided that the resources are non-tradable or imitated by other firms (Barney, 1991; Barney & Clark, 2007; Chadwick et al., 2015). Furthermore, excellence in a single resource or a few limited resources alone is insufficient to create SCA; it is the exploitation of bundling or complementary resources that enables and enhances positive SCA (Kauppila, 2015). While acknowledging the viewpoint of complementarity, little is known about what could be the multiple and heterogeneous resources and capabilities for achieving SCA in manufacturing firms (Gruber et al., 2010).

Built upon the RBV, the resource orchestration theory contends that the causal complexity of SCA comes not only from firm resources and capabilities but also from the configuration of organisational resources, capabilities, and managerial decisions responding to the internal and external competitive environments simultaneously (Kauppila, 2015). Resource orchestration theory addresses the limitation of RBV theory, for instance, by the intervening processes between resources and performance (Sirmon et al., 2011) or by combining organisational resources, capabilities, and managerial decisions simultaneously to produce superior firm performance (Chadwick et al., 2015). This theory has also echoed many previous studies in the information systems field that state information technology (IT) resources alone do not unequivocally facilitate strategic advantage (e.g., Zammuto et al., 2007). Thus, the link between resource and firm performance is most likely to be complex in terms of multi-way interactions among other complementary organisational elements (e.g., culture, policies and rules, and organisational structure) and organisational capabilities (Nevo & Wade, 2010).

The resource orchestration theory provides an excellent anchor to understand the configuration of resources and capabilities (e.g., Liu et al., 2016). For example, Liu et al. (2016) noticed that supply chain integration and IT competency could jointly affect firm performance. Following suggestions from the previous studies, this research sets the configurational approach that focuses on combinations best applies to examining the complicated relationship between SCA and the complex causal conditions, namely, organisational resources (i.e., relational and technological), organisational capability (i.e., transformation capability) and organisational characteristics (i.e., firm size and GME).

Organisational resources: relational and portfolio technological resources

This study examines two types of firms' organisational resources, namely relational resources (RRs) and portfolio technological resources (PTRs), relevant to the research context, i.e., clothing manufacturing firms in China. In the buyer-driven global commodity chain (Gereffi, 1999; Gereffi et al., 2005), manufacturing firms in the emerging markets act as both the exporters and suppliers and their competitive advantage strongly depends on their relationships with global buyers, including global branded marketers and retailers (Gummesson, 2004; Fletcher-Chen et al., 2017). Building and maintaining a long-term relationship with these global customers means having essential RRs for the markets and sales of the manufacturing firms (Kingshott et al., 2018). With the advent of Industry 4.0, the development of a portfolio of technological resources is China's manufacturing locus (Li, 2018) and a strategic roadmap for the future of manufacturing firms (Ghobakhloo, 2018; Ghobakhloo & Azar, 2018). In particular, digital and smart technologies such as 3D printing, automation, cloud, and the Internet of Things (IoT), enables sustainable manufacturing and hence SCA (de Sousa Jabbour et al., 2018; Machado et al., 2020).

RRs, as a type of intangible asset, are heterogeneous and imperfectly mobile, which enable the firm to achieve SCA, according to RBV (Hunt, 2000; Gretzinger & Royer, 2014). RRs are acquired by developing and maintaining positive relationships with the firm's business partners (Morgan & Hunt, 1999; Hunt, 2000). Wittmann et al. (2009) and Kingshott et al. (2018) further explain that RRs, such as trust, commitment, communication, cooperation, and loyalty, are created when a successful relational exchange occurs. These RRs allow firms and their partners to effectively deploy and synthesise their capability to create competitive advantages (Wittmann et al., 2009).

PTRs were first introduced by Srivastava and Gnyawali (2011), referring to the portfolio of technologies possessed by a focal firm. They suggest that the diversity of PTRs enables the focal firm to effectively explore its external partners' diverse technological resources, which is critical for triggering the breakthrough innovation performance of firms. Furthermore, PTRs could enhance firms' ability to sense new opportunities (Zhang & Ozer, 2015). Extended from the previous literature (e.g., Srivastava & Gnyawali, 2011; Zhang & Ozer, 2015), this study defines PTRs as the portfolio of fundamental technological resources held by a manufacturing firm, which enables the firm to transform and sustain its competitive advantage for the ongoing Industry 4.0. PTRs can be leveraged by RRs as complementary resources, which allows the focal firm to develop SCA (Carnes et al., 2017). This is particularly true for Chinese clothing manufacturing firms, which are substantially integrated into the global commodity chain as exporters and suppliers (Gereffi et al., 2005). To gain SCA, they have to learn new technologies in other functional areas from their business partners who are specialised in smart design, digital marketing, and information systems in the global market (de Sousa Jabbour et al., 2018; Li et al., 2019; Machado et al., 2020).

Organisational capability: transformation capability

Organisational capability is defined as the ability to utilise resources and adapt ongoing changes in the business processes and functional activities of the firm (Luo et al., 2012); it is also a significant predictor of competitive advantage in various contexts (Barney,1991; Pavlou & El Sawy, 2010; Chadwick et al., 2015). Scholars have emphasised that responding capability is one of the crucial organisational capabilities for achieving SCA in turbulent business environments (Chiambaretto & Wassmer, 2018).

Transformation capability is a responding capability required by Chinese clothing manufacturers to cope with the ongoing pressure of change towards Industry 4.0 to sustain their competitive advantage (Warner & Wäger, 2019). In recent years, several studies have contributed to a better understanding of the concept in association with Industry 4.0. For example, Castelo-Branco et al. (2019) assessed Industry 4.0 readiness in the manufacturing firms of European Union countries. They found that Industry 4.0 infrastructure (i.e., transformation resources) and big data maturity (i.e., transformation capability) are the two dimensions distinguishing manufacturing firms of different countries in their transformation readiness. Big data maturity in this study refers to the capacity to process digital information generated by the infrastructure in the Industry 4.0 transformation context. Further, Warner and Wäger (2019) explore dynamic capabilities for the digital transformation of incumbent firms in traditional industries, i.e., adopting new digital technologies such as artificial intelligence, blockchain, social media and IoT. The results suggest that transformation capability for smart manufacturing consists of three essential dimensions:

digital ecosystems and external collaboration capability, digitalisation of business models and internal structures, and digital workforce maturity.

Despite the variety of research purposes, existing literature has shown a common interest in the interaction of resources and capabilities and the interactive effect on performance or competitive advantage (e.g., Ferreira et al., 2018). Within the literature, the role of RRs is prominent in contributing to SCA when combined with some capabilities. For instance, Fu (2015) investigates the effect of RRs and knowledge management capability on organisational innovation performance. Shou et al. (2017) examine the mediation effect of innovation capability on the relational resources-performance relationship of Chinese third-party logistics providers. McDermott et al. (2009) suggest that product upgrading capability is dependent on access to a variety of knowledge resources and RRs with a wide range of public-private institutions.

This study joins this stream of literature by investigating the causal conditions of relational resources, portfolio technological resources, and transformation capability for SCA of Chinese clothing manufacturers in the ongoing process towards Industry 4.0.

Organisational characteristics: firm size and global market engagement

Firm size has been widely acknowledged as an essential determinant for converting organisational resources into firm performance (Fiss, 2011; Park et al., 2017). In general, large organisations possess more organisational capabilities obtained from their more abundant resources (Damanpour & Schneider, 2006). Firm size is an essential element of firm characteristics influencing organisational capabilities (Park et al., 2017) and organisational innovation (Cobo-Benita et al., 2016). Thus, in this study, firm size is included as a critical element in the configurations producing SCA.

GME takes various forms, such as joint venture, alliance, or exporting (Görg & Hanley, 2017). GME in this study applies to the form of exports. According to the global commodity chain theorists, the higher the level of engagement in the global market, the greater the competitive advantage the firm gains due to the learning curve (Dicken, 2011). For instance, exporters as own-brand manufacturers, compared to exporters as own equipment manufacturers need a higher level of engagement in the global market for brand development, brand maintenance, and marketing. Through global market access and management, the own-brand manufacturers gain customer relationships and a loyalty market, a source of RRs (Kauppila, 2015). Further, through a higher level of GME, manufacturers learn PTRs from global marketers and branded retailers (Hitt et al., 2000; Camison & Villar-Lopez, 2011). In the end, the own-brand exporters become more competitive in the global market, and the competitive advantage can be sustained in a higher value-added sector. However, not all studies agree with this viewpoint. For instance, based on comparative research carried out in two Brazilian clusters (furniture and footwear industries), Navas-Aleman (2011) finds that domestic and regional commodity chains, rather than global commodity chains, can offer greater transformation opportunities. This study joins in the debate by arguing that the different results regarding the effect of GME might be relevant to the diverse research contexts or the variation in groups of cases. Thus, the firms' GME is included as another key causal conditional element in the configurations for SCA in this study.

Insert Figure 1 about here

Drawn on the above literature review, the research model is depicted in Figure 1. *First*, the criteria for selecting concepts in the model are relevant to the issues that traditional manufacturing firms are increasingly facing, i.e. the challenge of digital transformation for SCA in the Industry

4.0 era (Castelo-Branco et al., 2019). This industry challenge calls for the firms to develop their corresponding transformation capability. *Second*, the selection of strategic resources for SCA should be relevant to the specific research context, i.e. traditional manufacturing firms in emerging markets such as China. The selected strategic resources should inclusively compose two categories: (1) existing strategic resources (i.e. RRs) that firms possess and have been developed through outsourcing manufacturing and exporting with their overseas customers over the history, and (2) new strategic resources (i.e. PTRs) that the firms are developing in responding to the industry 4.0 transformation. *Third*, given the environmental dynamics in the clothing global commodity chain (Gereffi, 1999; Gereffi et al., 2005), GME and firm size are also included as influential conditions. In summary, the causal conditions or combinations of conditions for SCA of the traditional manufacturing firms in this study include resources (RRs and TPRs), transformation capability, and organisational characteristics (firm size and GME).

Methods

Sample and data collection

Radicic et al. (2016) characterised traditional manufacturing by long-established, labour intensive, once the main source and still an important source of employment, retaining a capacity for innovation. Textile and garments manufacturing falls into the category. Through the China Garment Association, 1,890 clothing manufacturing firms were invited for a questionnaire survey. The survey was administered to managers, senior managers, and executives via emails, phone calls, and face-to-face meetings. A sample of 216 completed copies of questionnaires was collected. Appendix A reports the descriptive statistics of the survey. Ten out of 216 observations were identified as outliers and deleted through the data screening process. As a result, a sample of 206 observations is used for the subsequent analysis.

Measures

Four indicators (Appendix B) of process performance measuring SCA were adapted from Van Looy and Shafagatova (2016). The measurement items assess operation performance in delivery time, flexibility, quality, and cost, which aligns with the theoretical underpinnings of RBV theory and reflects the constitutional elements comprising SCA source (Ray et al., 2004).

Relational Resources are reflectively measured by relationship building with external business partners (Wittmann et al., 2009). In line with the global commodity chain theory, the external business partners include a trustable and strong partnership with global customers (Boyd et al., 2010) and a reliable network with suppliers (Shou et al., 2017).

Portfolio Technological Resources. Underpinned by extant literature (Ghobakhloo, 2018; Castelo-Branco et al., 2019; Li et al., 2019), the four items measuring PTRs are generated to cover the required technologies for transforming to ongoing Industry 4.0, i.e., manufacturing technology, digital marketing technology, design technology, and IT.

Transformation Capability is measured by three items: ICT competence of employees, smart manufacturing processes, and a strategic collaborative approach to enhance collaboration and value co-creation among stakeholders. These items measure the competence readiness of manufacturing firms for Industry 4.0 (Schumacher et al., 2016); this readiness also reflects the change in value creation that Industry 4.0 requires manufacturing firms to adopt as their coordinated approach to sustainable performance, for instance, the use of the IoT (Castelo-Branco et al., 2019; Warner & Wäger, 2019). A seven-point Likert scale was used for all scale items (Appendix B).

Organisational Characteristics. These are related to two variables: *global market engagement* and *firm size* (Table 3). The number of employees measures firm size; employee numbers are coded as five-category data (1. ≤50; 2. 51-200; 3. 201-300; 4. 300-500; 5. ≥501). Two self-reported categorical indicators measure GME; one is 'export proportion to total sales' (1. n/a; 2. ≤10%; 3. 11-50%; 4. 51-90%; 5. 91-100%) and the other is 'type of export patterns' (1. n/a; 2. OEA; 3. OEM; 4. ODM; 5. OBM). Both items are coded as five-point scores. The total scores of the two items measure the level of GME of the firm.

Set-theoretic analysis with fsQCA

Measure validation

Normality. Before conducting factor analysis, the normality of each scale was tested (Table 1). Values of skewness and kurtosis are all acceptable (Tabachnick & Fidell, 2007). Results of Kaiser-Meyer-Olkin (KMO) indicate a satisfying measure of sampling adequacy for each construct.

Insert Table 1 about here

Confirmatory Factor Analysis. A confirmatory factor analysis was then conducted using AMOS 25 to assess the loadings, reliability, and validity of the measurement. Results (Table 2) show that the fit indicators of our measurement model with the four constructs are all satisfactory, e.g., GOF (2.788, ρ=0.000), CFI (.876), RMSEA (0.093). All loading estimates, ranging from 0.71 to 0.87, are greater than the threshold value of 0.7, suggesting good measurement convergence validity. CR values ranging from 0.86 to 0.90 are consistent with the corresponding Cronbach's α values, ranging from 0.75 to 0.85. Factor analysis results suggest that all constructs are reliable for further analysis.

Insert Table 2 about here

Discriminant validity was also examined utilising SmartPLS 3. Table 3 displays the test results by referring to the Heterotrait-Monotrait Ratio (HTMT). It indicates that all HTMT ratios support the discriminant validity, i.e., less than the threshold value of 0.90 (Ringle et al., 2015).

Insert Table 3 about here

Calibration

Data calibration is used to prepare for the fuzzy-set analysis (Fiss, 2011). Firstly, Likert scale values and categorical data need to be transformed into fuzzy-set membership scores (Table 4). Likert scale values are related to the four latent variables: relational resources, portfolio technological resources, upgrading capability, and SCA. The latent variables are coded as the average scores of the corresponding measured variables.

Three anchors are defined as full non-membership score (=0.05), full-membership score (=0.95), and the crossover point of maximum ambiguity (=0.50). The membership scores over 0.5 indicate a case of more in than out; those lower than 0.5 indicate a case of more out than in. This study follows Ragin's (2000; 2008) principle that calibration of membership scores in the fuzzy-set must be grounded in theory and the external knowledge of causal conditions. Table 4 displays the summary data and calibration scores.

Insert Table 4 about here

Analysis of necessary conditions

Analysis of causal necessity is a separate process from the analysis of causal sufficiency. Necessary conditions refer to those conditions that have to be present for the outcome of interest to exist (Rihoux & Ragin, 2009). A condition or combination of conditions with the consistency level exceeding the threshold of 0.8 is considered a necessary condition (Ragin, 2000; 2008). The results (Table 5) show three conditions with consistency scores ranging from 0.81 to 0.85, namely, 'Relational resource,' 'Portfolio technological resource,' and 'Transformation capability'. These three are considered to be causal necessity associated with the outcome of SCA. This finding is in line with the extant literature on RBT and the global commodity chain regarding the explanatory factors (e.g., Barney & Clark, 2007) and industrial upgrading for SCA (Gereffi, 1999; Gereffi & Lee, 2016).

Insert Table 5 about here

Analysis of sufficient conditions

Truth table analysis of sufficient conditions is conducted in three steps: construction, reduction, and analysis (Ragin, 2008). The first step is to construct a truth table with 2^k rows, where k is the number of causal conditions. Each row represents a combination of causal conditions in association with the outcome of interest, and the entire table reports all possible combinations or configurational sets of the cases (Ragin, 2008; Fiss, 2011). This study with five conditions makes 32 rows in the truth table.

The second step of the fsQCA is to reduce the truth table to achieve limited complexity by following a neutral and systematic procedure (Ragin, 2000; 2008). Consistency and coverage are two metrics to measure the strength and importance of the relationship between condition(s) and the outcome (Ragin, 2008). This study refers to the suggested principle of coverage that the configurations selected should capture at least 75%-80% of the cases (Ragin, 2008, p. 53). Consistency is defined as how much a given condition or combination of conditions consistently displays the outcome of interest (Ragin, 2006, p. 292). Given the assumption of limited complexity for fsQCA, a certain level of consistency is required to ensure that the identified patterns are in the dataset coherent (Meyer et al., 1993; Ragin, 2008). The perfect consistency score of fuzzy-set relations is 1.0. The suggested consistency threshold in social science, in general, is a minimum of 0.75 (Ragin, 2006; 2008, p. 46) or 0.80 as the accepted degree (Fiss, 2011). This study chooses 0.9 as the threshold for this study, aiming for a higher consistent result.

Finally, this study selects the ‘standard analysis’ option over the ‘specify analysis,’ as suggested in the literature (Thiem, 2014; Baumgartner & Thiem, 2017). Due to the required limited diversity for a neat solution, QCA introduces the Quine-McCluskey algorithm to logically reduce redundancies based on minimal disjunctions in solution models when applying the 'specify analysis' option (Ragin, 2008). Thiem (2014, p. 500) suggests that solution transparency “should always be ensured by either listing all data-fitting models or at least reporting the exact degree of ambiguity that surrounds a chosen mode”. Baumgartner and Thiem (2017, p. 964) further suggest that the minimum disjunctive constraint is not an appropriate way to reduce ambiguities in causal modelling.

The standard analyses report three solutions based on the different treatment of the reminder combinations: the complex, the parsimonious and the intermediate (Ragin, 2008). This study reports the complex solution, where incorporated reminders are justified by the theoretical expectation (Ragin, 2008).

Insert Table 6 about here

The test model can be expressed as a function: SCA = f (Global Market Engagement, Firm Size, Relational Resource, Portfolio Technology Resource, Transformation Capability). The fuzzy-set solution results in four configurational pathways, i.e. C1, C2, C3 and C4, as shown in Table 6, where full circles (●) indicate the presence of a causal condition; larger full circles indicate core conditions (presence); crossed circles (⊕) depicts the absence of a causal condition.

Consistency values of individual set relations, ranging from 0.85 to 0.95, suggest very reliable and consistent results of the pathways. The solution consistency, i.e., 0.88, explaining the significance level of all set relations as a whole, suggests that the causal configurations are sufficient in explaining the outcome of SCA. Coverage explains how much of the outcome is explained by each pathway and by the solution as a whole (Ragin, 2008). The former is 'raw coverage' for each pathway; the latter is 'solution coverage' for all pathways. The results suggest that overall, the four configurational sets captured 75% of SCA in the cases (Table 6). The raw coverages of individual pathways range from 0.23 to 0.67. Unique coverage values range from 0.02 to 0.21, indicating that each configurational set contributes uniquely to explaining the outcome of SCA. The most substantial contribution, 0.21, is from a configurational set of multiple interactive conditions, including relational resource, portfolio technological resource, and transformation capability, explaining the SCA of the firms.

Further, this study seeks to explore a variety of configurations producing SCA based on contingency conditions regarding the organisational specificities. The total sample of 206 cases is categorised into four groups based on the calibrated membership score, i.e., 0.50. For instance, firms with a GME calibrated score of 0.28 are in the low GME group; those with a GME calibrated score of 0.51 are in the high GME group. Similarly, the large firm-size group has calibrated scores of more than 0.50, while those with less than 0.50 calibrated scores are in the small firm-size group.

Results of the truth table analysis are shown in the two-dimension matrix, i.e., Size * GME (Table 7). Coverages of the four solutions range from 0.75 to 0.92; their consistency scores range from 0.79 to 0.85 (Appendix C).

Insert Table 7 about here

Configurational propositions

Underpinned by the resource orchestration theory, this research seeks to investigate multiple pathways and causal configurations of conditions for traditional Chinese manufacturing firms to achieve SCA in the Industry 4.0 era. Causal conditions consider relational resources, portfolio technological resources, transformation capability, GME, and firm size. Specifically, this study investigates the causal necessity and sufficiency leading to SCA. The results suggest that relational resources, portfolio technological resources, and transformation capability are individually the necessary but not sufficient conditions explaining the SCA of the cases. Further examination found that various organisations, e.g., in different firm sizes and levels of GME, can have different solutions to achieve SCA. For instance, SMEs can achieve SCA via GME combined with RRs or via the development of transformation capability combining relational resources. This study has made several contributions, which are new in the current literature.

Based on the results of the fsQCA and considering theoretical underpinnings in organisational orchestration theory, this study develops the following three propositions in the next subsection. *Proposition 1* is based on the results of sufficient conditions analysis. *Propositions 2* and *3* are based on the results of sufficient conditions analysis with the considerations of contingency conditions regarding the organisational specificities.

RRs are the intangible assets that aim to develop trust and commitment between stakeholders for a long-term collaboration for value creation (Wittmann et al., 2009). They have been widely recognised as a critical enabler of achieving competitive advantage (Hunt, 2000) but cannot be generated or maintained by merely investing in capital. Prior research has suggested that RRs can leverage PTRs for obtaining breakthrough innovation (Srivastava & Gnyawali, 2011); thus, extending from their findings, the fsQCA results show that PTRs such as digital marketing and knowledge sharing information systems are complementary to the relational resources.

The results also reveal that transformation capability could be a potential complementarity of relational resources, but it is subject to organisational characteristics. Because transformation capability is more tacit and 'learned by doing' through day-to-day operations and productions, resource-strapped firms may have difficulty transforming collaborative systems, employees' Information and Communication Technology (ICT) competence, or introducing new manufacturing technologies. The practical solutions support these arguments that RRs are presented as a necessary condition in all four configurational solutions to drive SCA; PTRs and transformation capability play a complementary role in achieving SCA, as shown in C1, C3 and C4 (Table 6). In addition, consistent with previous studies in operation and supply chain management (e.g., Fayezi et al., 2015), the organisational context is viewed as a critical contingency factor that can affect organisations in allocating resources. Thus, this study suggests:

> ***Proposition 1****: Relational resource as a necessary condition fundamentally drives organisations to develop SCA. It needs to be designed to effectively achieve SCA depending on portfolio technological resources, transformation capability, and specific organisational contexts in the emerging Industry 4.0.*

Smaller organisations that have relatively insufficient resources may not need to invest in PTRs extensively to achieve SCA. In fact, smaller organisations can quickly learn from their supply chain experiences and create actionable guidelines that can be used to identify promising suppliers and buyers and to develop long-term relationships with them (Wittmann et al., 2009). In addition, compared with larger organisations, smaller organisations have greater advantages in developing transformation capability due to their ability to respond to environmental changes quickly. McDermott and Prajogo (2012) argue that small firms typically have a strong momentum to be innovative, albeit in more incremental ways, so that they can create products with differentiation or unique selling points to compete with larger firms. Particularly in the Chinese clothing industry, small manufacturers maintain their competitive advantage by developing their collaborative systems and adopting smart production processes.

By contrast, large firms are in a better financial and market position (or have monopoly power) to focus on developing exploratory rather than exploitative innovations. Such innovations require idiosyncratic resources that orchestrate tangible and intangible resources from different stakeholders, allowing firms to generate both unique and inimitable resource bundles (Srivastava & Gnyawali, 2011; Linder, 2019). The fsQCA results support the above arguments. Larger firms' capital expenditures are more likely to be focused on creating valuable bundles of RRs and PTRs that help them gain superior SCA, as shown in C1(L*L), C2(L*L), or C1(L*H) (Table 7). At the same time, smaller organisations should consider prioritising efforts to increase their ability to develop RRs and transformation capability, as shown in C1(S*L) or C1(S*H) (Table 7). Put together, this study thus suggests:

Proposition 2*: Small organisations combine RRs and transformation capability to achieve SCA. For large organisations, both RRs and PTRs are essential to achieve SCA while* *transformation capability is not necessary for them to achieve SCA in the emerging Industry 4.0.*

Incremental innovation and adaptation to constant market changes in the emerging Industry 4.0 are dependent on access to a variety of RRs (McDermott et al., 2009; Shou et al., 2017). From the operations management perspective, Bayo-Moriones and Merino-Diaz de Cerio (2003) argued that multinational companies prioritise the physical and technical functions of their organisation, particularly those relating to quality control, production, and manufacturing. Likewise, Sila (2007) found that firms that focus on international markets are more exposed to new ideas and new technologies to overcome intense competitive pressures from their foreign competitors in international markets. Considering the arguments from the global commodity chain and operations management perspectives, this study suggests that international operating firms could develop either RRs or PTRs to achieve SCA, supported by the empirical fsQCA results.

Proposition 3*: For organisations that mainly focus on international markets, either relational or portfolio technology resources can help them achieve SCA in the emerging Industry 4.0.*

Discussion

Theoretical contributions

First, this study contributes to organisational configuration theory, particularly the effect of RRs on SCA. The results suggest that RRs are necessary for any solution in order to achieve SCA and even become sufficient in leading to SCA when combined with other resources and capabilities. This finding arguably challenges the traditional view that RRs can achieve at best competitive parity for firms in RBV (Hansen et al., 2004). However, this empirical result further supports the configurational theory approaching organisational performance (Meyer et al., 1993;

Fiss, 2011). Furthermore, this finding is in line with an earlier study using networks theory, suggesting that inter-firm relationships and networks support SCA (Black & Boal, 1994).

Second, the study discovered from evidence in 206 cases that instead of one best way, four pathways or configurations of conditions can lead to SCA in clothing manufacturing firms in China, a representative case with the SCA issue of traditional manufacturing in the global commodity chain. The study enhances the understanding of set relations with the outcome of SCA that differs in firms, e.g., regarding firm size and different levels of GME.

Third, this study makes a methodological contribution by applying a configurational approach to understand the causal complexity of resource orchestration in the SCA of manufacturing firms in the emerging Industry 4.0. The causal complexity is often difficult to understand using commonly employed methods such as regression models. The traditional linear or interaction models of causality seek the one best solution where all causal variables compete against the other variables in explaining and predicting the result. However, in reality, configurational conditions, such as combined resources, can support rather than competing against one another, leading to a commonly desired outcome (Fiss, 2007). In the configurational approach, nonlinear and asymmetric interaction models allow considerable levels of causal complexity in set relations while highlighting commonalities between cases within a set (Ragin, 2000; 2008; Fiss, 2007; 2011). Complex causality allows different configurations of conditions to reach the same final result. Hence, the configurational approach with fsQCA allows identifying various SCA pathways or equifinality (Katz & Kahn, 1978, p. 30).

Managerial implications

This research suggests that to achieve the fullest potential of traditional clothing manufacturers, relational resources, portfolio technological resources, and responsive transformation capability are necessary but insufficient to lead to SCA in the ongoing Industry 4.0. Transforming traditional manufacturing as a responsive strategic choice for manufacturing economies can be seen in other countries such as South Korea and Japan during the periods when they faced external environmental changes and internal economic development. China and other global emerging economies are currently experiencing the same challenges. As a result, triangular outsourcing or relocation of clothing manufacturing to some global lower-cost production centres such as Vietnam, Bangladesh, and Cambodia have become common in the Chinese clothing industry in recent years. However, this practice might only be a knee-jerk reaction to external environmental dynamics rather than a preconceived strategy to achieve and maintain SCA for some clothing firms. The strategic managers in their mindset should also consider implementing transformation capability and GME while taking into account their firm sizes for SCA (Liu & Liang, 2015).

The research results suggest that SCA is attributable to multiple pathways involving combinations of various conditions, e.g., resource orchestration composed of PTRs and RRs (Bathelt et al., 2013) and transformation capability. However, business management might be unconscious of this combination. For example, clothing managers tend to emphasise transforming processes such as brand development, advertising, and marketing while neglecting maintenance and updating of the RRs, such as managing customer relationships, supplier relationships, and employee commitment (Hitt et al., 2000).

Limitations and further work

The authors acknowledge some limitations in this study. The choice of indicators used for this study has taken account of the specificities of the research context of clothing manufacturing firms in China. Given that the value of a specific resource is contingent on its corresponding market context (Barney, 2001), care needs to be taken in generalising the findings to other settings

(Brouthers, 2008). We recommend future research to look at external or institutional contingency factors (Gomes & Dahab, 2010) and other business strategies (Aragon-Correa & Sharma, 2003) to achieve the SCA of the manufacturing industry. This study approaches SCA by focusing on the economic aspect of transformation; however, environmental improvements (Marchi et al., 2013) and lean production practices in Industry 4.0 (Tortorella & Fettermann, 2018) for SCA in the global supply chain have become research concerns. This is yet to be framed and considered in future research.

Conclusions

This research enhances the understanding of the under-researched configurations of various firm resources with organisational capability leading to the SCA of traditional manufacturing firms in the emerging Industry 4.0 era (Liu et al., 2016; Ghobakhloo & Azar, 2018). RRs are essential for firms to achieve SCA. Transformation capability complements RRs for small organisations to achieve SCA; however, both RRs and PTRs are crucial for attaining SCA for large organisations. Further, the highly global operating firms could develop either RRs or PTRs to achieve SCA in the emerging Industry 4.0.

References

Aragon-Correa, A., & Sharma, S. 2003. A contingent resource-based view of proactive corporate environmental strategy. *Academy of Management Review,* 28 (1), 71–88.

Barney, J.B. 2001. Is the resource-based view a useful perspective for strategic management research? Yes. *Academy of Management Review,* 26 (1), 41–56.

Barney, J.B. 1991. Firm resources and sustained competitive advantage. *Journal of Management*, 17 (1), 99–120.

Barney, J.B., & Clark, D.N. 2007. *Resource-Based Theory: Creating and Sustaining Competitive Advantage*. Oxford, UK: Oxford University Press.

Bathelt, H., Munro, A.K., & Spigel, B. 2013. Challenges of transformation: Innovation, re-bundling and traditional manufacturing in Canada's technology triangle. *Regional Studies*, 47 (7), 1111–1130.

Baumgartner, M., & Thiem, A. 2017. Model ambiguities in configurational comparative research. *Sociological Methods & Research*, 46 (4), 954–987.

Bayo-Moriones, A., & Merino-Diaz de Cerio, J. 2003. The status of quality departments: empirical evidence for the Spanish manufacturing industry. *International Journal of Quality and Reliability Management*, 2 (4/5), 569–584**.**

Bititci, U.S., Ackermann, F., Ates, A., Davies, J., Garengo, P., Gibb, S., & Firat, S.U. 2011. Managerial processes: business process that sustains performance. *International Journal of Operations & Production Management*, 31 (8), 851–891.

Black, J.A., & Boal, K.B. 1994. Portfolio resources: traits, configurations and paths to sustainable competitive advantage. *Strategic Management Journal*, 15 (2), 131–148.

Bouncken, R.B, Fredrich, V., & Kraus, S.. 2020. Configurations of firm-level value capture in coopetition. *Long Range Planning*, 53 (1), 101869.

Boyd, B.K., Bergh, D.D., & Ketchen, D.J. 2010. Reconsidering the reputation-performance relationship: a resource-based view. *Journal of Management*, 36 (3), 588–609.

Brouthers, K.D. 2008. Resource-based advantages in an international context. *Journal of Management*, 34 (2), 189–217.

Camison, C., & Villar-Lopez, A. 2011. Non-technical innovation: organisational memory and learning capabilities as antecedent factors with effects on sustained competitive advantage. *Industrial Marketing Management*, 40 (8), 1294–1304.

Cao, D., Berkeley, N., & Finlay, D. 2014. Measuring Sustained Competitive Advantage From Resource-based View: Survey of Chinese Clothing Industry. *Journal of Sustainable Development*, 7(2), 89-102.

Cao, D., Tao, H., Wang, Y., Tarhini, A., & Xia, S. 2019. Acceptance of automation manufacturing technology in China: An examination of perceived norm and organisational efficacy. *Production Planning & Control*, 31 (8), 660–672.

Carnes, C.M., Chirico, F., Hitt, M.A., Huh, D.W., & Pisano, V. 2017. Resource orchestration for innovation: structuring and bundling resources in growth- and maturity-stage firms. *Long Range Planning*, 50 (4), 472–486.

Castelo-Branco, I., Cruz-Jesus, F., & Oliveira, T. 2019. Assessing Industry 4.0 readiness in manufacturing: Evidence for the European Union. *Computers in Industry*, 107, 22–32.

Chadwick, C., Super, J.F., & Kwon, K. 2015. Resource orchestration in practice: CEO emphasis on SHRM, commitment-based HR systems, and firm performance. *Strategic Management Journal*, 36 (3), 360–376.

Chiambaretto, P., & Wassmer, U. 2018. Resource utilisation as an internal driver of alliance portfolio evolution: The Qatar Airways case (1993-2010). *Long Range Planning*, 52 (1), 51–71.

Cobo-Benita, J.R., Rodríguez-Segura, E., Ortiz-Marcos, I., & Ballesteros-Sánchez, L. 2016. Innovation projects performance: Analysing the impact of organisational characteristics. *Journal of Business Research*, 69 (4), 1357–1360.

Damanpour, F., & Schneider, M. 2006. Phases of the adoption of innovation in organisations: effects of environment, organisation and top managers. *British Journal of Management*, 17 (3), 215–236.

de Sousa Jabbour, A.B.L., Jabbour, C.J.C., Foropon, C., & Godinho Filho, M. 2018. When titans meet – Can industry 4.0 revolutionise the environmentally-sustainable manufacturing wave? The role of critical success factors. *Technological Forecasting & Social Change*, 132, 18–25.

Dicken, P. (2011). Global Shift: Mapping the Changing Contours of the World Economy (6th ed.). London: SAGA Publications Ltd.

Fayezi, S., Zutshi, A., & O'Loughlin, A. 2015. How Australian manufacturing firms perceive and understand the concepts of agility and flexibility in the supply chain. *International Journal of Operations & Production Management*, 35 (2), 246–281.

Feng, L., Zhang, X., & Zhou, K. 2018. Current problems in China's manufacturing and countermeasures for industry 4.0. *EURASIP Journal on Wireless Communications and Networking*, https://doi.org/10.1186/s13638-018-1113-6.

Ferreira, J.J., Fernandes, C.I., & Peris-Ortiz, M. 2018. How agents, resources and capabilities mediate the effect of corporate entrepreneurship on multinational firms' performance. *European Journal of International Management*, 12 (3), 255–277.

Fiss, P.C. 2011. Building better causal theories: A fuzzy set approach to typologies in organisation research. *Academy of Management Journal*, 54 (2), 393–420.

Fiss, P.C. 2007. A set-theoretic approach to organisational configurations. *Academy of Management Review*, 32 (4), 1180–1198.

Fletcher-Chen, C.C.-Y., Al-Husan, F.Z.B., & ALhussan, F.B. 2017. Relational resources for emerging markets' non-technological innovation: Insights from China and Taiwan. *Journal of Business & Industrial Marketing*, 32 (6), 876-888.

Frank, A., Dalenogare, L., & Ayala, N. 2019. Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, 210, 15–26.

Fu, N. 2015. The role of relational resources in the knowledge management capability and innovation of professional service firms. *Human Relations*, 68 (5), 731–764.

Gereffi, G. 1999. International trade and industrial upgrading in the apparel commodity chain. *Journal of International Economics,* 48 (1), 37–70.

Gereffi, G., & Lee, J. 2016. Economic and social upgrading in global value chains and industrial clusters: Why governance matters. *Journal of Business Ethics*, 33 (1), 25–38.

Gereffi, G., Humphrey, J., & Sturgeon, T. 2005. The governance of global value chains. *Review of International Political Economy*, 12 (1), 78–104.

Ghobakhloo, M. 2018. The future of manufacturing industry: A strategic roadmap toward Industry 4.0. *Journal of Manufacturing Technology Management*, 29 (6), 910-936.

Ghobakhloo, M., & Azar, A. 2018. Information technology resources, the organisational capability of lean-agile manufacturing, and business performance. *Information Resources Management Journal*, 31 (2), 47–74.

Gomes, P.J., & Dahab, S. 2010. Bundling resources across supply chain dyads. *International Journal of Operations & Production Management*, 30 (10), 57–74.

Görg, H., & Hanley, A. 2017. Firms' global engagement and management practices. *Economics Letters*, 155, 80–83.

Greckhamer, T., & Gur, F.A. 2019. Disentangling combinations and contingencies of generic strategies: A set-theoretic configurational approach. *Long Range Planning*, 101951. In Press.

Greckhamer, T., Furnari, S., Fiss, P.C., & Aguilera, R.V. 2018. Studying configurations with qualitative comparative analysis: Best practices in strategy and organization research. *Strategic Organization*, 16 (4), 482–495.

Gretzinger, S., & Royer, S. 2014. Relational resources in value adding webs: The case of a Southern Danish firm cluster. *European Management Journal*, 32 (1), 117–131.

Gruber, M., Heinemann, F., Brettel, M., & Hungeling, S. 2010. Configurations of resources and capabilities and their performance implications: an exploratory study on technology ventures. *Strategic Management Journal*, 31 (12), 1337–1356.

Gummesson, E. 2004. Return on relationships (ROR): The value of relationship marketing and CRM in business-to-business contexts. *Journal of Business & Industrial Marketing*, 19 (2), 136–148.

Hansen, M.H., Perry, L.T., & Reese, C.S. 2004. A Bayesian operationalisation of the resource-based view. *Strategic Management Journal*, 25 (7), 1279–1295.

Hitt, M.A., Dacin, M.T., Levitas, E., Arregle, J., & Borza, A. 2000. Partner selection in emerging and developed market contexts: Resource-based and organisational learning perspectives. *Academy of Management Journal*, 43 (3), 449–467.

Hunt, S.D. 2000. *A general theory of competition: Resources, competences, productivity, economic growth*. Thousand Oaks, CA: Sage

Hunt, S.D., Lambe, C.J., & Wittmann, C.M. 2002. A theory and model of business alliance success.

Journal of Relationship Marketing, 1 (1), 17–35.

Katz, D., & Kahn, R.L. 1978. *The social psychology of organisations* (2nd ed.), New York: Wiley.

Kauppila, O. 2015. Alliance management capability and firm performance: Using resource-based theory to look inside the process black box. *Long Range Planning*, 48 (3), 151–167.

Kingshott, R., Sharma, P., & Chung, H. 2018. The impact of relational versus technological resources on e-loyalty: A comparative study between local, national and foreign branded banks. *Industrial Marketing Management*, 72, 48–58.

Lee, J., Davari, H., Singh, J., & Pandhare, V. 2018. Industrial Artificial Intelligence for industry 4.0-based manufacturing systems. *Manufacturing Letters*, 18, 20–23.

Li, F., Zhang, T., Sha, Q., Pei, X., Song, Y., & Li, C. 2020. Green Reformation of Chinese Traditional Manufacturing Industry: Approach and Potential for Cooperation. *Procedia Manufacturing*, 43, 285–292.

Li, H., Wu, Y., Cao, D., & Wang, Y. 2019. Organizational mindfulness towards digital transformation as a prerequisite of information processing capability to achieve market agility. *Journal of Business Research*, https://doi.org/10.1016/j.jbusres.2019.10.036

Li, L. 2018. China's manufacturing locus in 2025: With a comparison of “Made-in-China 2025” and “Industry 4.0”. *Technological Forecasting & Social Change*, 135, 66–74.

Linder, C. 2019. Learning from suppliers: A framework for operation innovation in small and medium sized enterprises. *Production Planning & Control*, 30 (10-12), 827–841.

Lindgreen, A,, Vanhamme, J,, Van Raaij, E.M,, & Johnston, W.J. 2013. Go Configure: The Mix of Purchasing Practices to Choose for Your Supply Base. *California Management Review*, 55 (2), 72–96.

Liu, H., Wei, S., Ke, W., Wei, K.K., & Hua, Z. 2016. The configuration between supply chain integration and information technology competency: A resource orchestration perspective. *Journal of Operations Management*, 44, 13–29.

Liu, Y., & Liang, L. 2015. Evaluating and developing resource-based operations strategy for competitive advantage: An exploratory study of Finnish high-tech manufacturing industries. *International Journal of Production Research*, 53 (4), 1019–1037.

Luo, J., Fan, M., & Zhang, H. 2012. Information technology and organisational capabilities: A longitudinal study of the apparel industry. *Decision Support Systems*, 53 (1), 186–194.

Machado, C., Winroth, M., & Ribeiro Da Silva, E. 2020. Sustainable manufacturing in Industry 4.0: An emerging research agenda. *International Journal of Production Research*, 58 (5), 1462–1484.

Marchi, V.D., Maria, E.D., & Micelli, S. 2013. Environmental strategies, upgrading and competitive advantage in global value chains. *Business Strategy and the Environment*, 22 (1), 62–72.

McDermott, G.A., Corredoira, R.A., & Kruse, G. 2009. Public-private institutions as catalysts of upgrading in emerging market societies. *Academy of Management Journal*, 52 (6), 1270–1296.

McDermott, C.M., & Prajogo, D.I. 2012. Service innovation and performance in SMEs. *International Journal of Operations & Production Management*, 32 (2), 216–237.

Meyer, A.D., Tsui, A.S., & Hinings, C.R. 1993. Configurational approaches to organisational analysis. *Academy of Management Journal*, 36 (6), 1175–1195.

Meyer, K.E., & Xin, K.R. 2018. Managing talent in emerging economy multinationals: Integrating strategic management and human resource management. *The International Journal of Human Resource Management*, 29 (11), 1827–1855.

Morgan, R.M., & Hunt, S. 1999. Relationship-based competitive advantage: the role of relationship marketing in marketing strategy. *Journal of Business Research*, 46 (3), 281–290.

Navas-Aleman, L. 2011. The impact of operating in multiple value chains for upgrading: the case of the Brazilian furniture and footwear industries. *World Development*, 39 (8), 1386–1397.

Nevo, S., & Wade, M.R. 2010. The formation and value of IT-enabled resources: Antecedents and consequences of synergistic relationships. *MIS Quarterly*, 34 (1), 163–183.

Park, Y., El Sawy, O.A., & Fiss, P.C. 2017. The role of business intelligence and communication technologies in organisational agility: A configurational approach. *Journal of the association for information systems* 18 (9), 648–686.

Pavlou, P.A., & El Sawy, O.A. 2010. The "third hand": IT-enabled competitive advantage in turbulence through improvisational capabilities. *Information Systems Research*, 21 (3), 443–471.

Qin, J., Liu, Y., & Grosvenor, R. 2016. A Categorical Framework of Manufacturing for Industry 4.0 and Beyond. *Procedia CIRP*, 52, 173–178.

Radicic, D., Pugh, G., Hollanders, H., Wintjes, R., & Fairburn, J. 2016. The impact of innovation support programmes on SME innovation in traditional manufacturing industries: an evaluation for seven EU regions. *Environment and Planning C: Government and Policy*, 34(8), 1425–1452.

Ragin, C.C. 2008. *Redesigning social inquiry: Fuzzy sets and beyond. Chicago*: University of Chicago Press.

Ragin, C.C. 2006. Set relations in social research: evaluating their consistency and coverage. *Political Analysis*, 14 (3), 291–310.

Ragin, C.C. 2000. *Fuzzy-Set Social Science*. Chicago/London: The University of Chicago Press.

Raj, A., Dwivedi, G., Sharma, A., Lopes de Sousa Jabbour, A.B., & Rajak, S. 2020. Barriers to the adoption of industry 4.0 technologies in the manufacturing sector: An inter-country comparative perspective. *International Journal of Production Economics*, June 2020, 224.

Ray, G., Barney, J.B., & Muhanna, W.A. 2004. Capabilities, business processes and competitive advantage: choosing the dependent variable in empirical tests of the resource-based view. *Strategic Management Journal*, 25 (1), 23–37.

Richter, F. 2020. *China is the world's manufacturing superpower*. Feb. 18, 2020, https://www.statista.com/chart/20858/top-10-countries-by-share-of-global-manufacturing-output/

Rihoux, B., & Ragin, C.C. (Eds.) 2009. *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques*. Thousand Oaks, CA: Sage.

Ringle, C.M., Wende, S., & Becker, J.M. 2015. *SmartPLS 3. Boenningstedt: SmartPLS GmbH*. http://www.smartpls.com

Rosin, F., Forget, P., Lamouri, S., & Pellerin, R. 2020. Impacts of Industry 4.0 technologies on Lean principles. *International Journal of Production Research*, 58(6), 1644-1661.

Schumacher, A., Erol, S., & Sihn, W. 2016. A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises. *Procedia CIRP*, 52, 161–166.

Shou, Y., Shao, J., & Chen, A. 2017. Relational resources and performance of Chinese third-party logistics providers: The mediating role of innovation capability. *International Journal of Physical Distribution & Logistics Management*, 47 (9), 864–20.

Sila, I. 2007. Examining the effects of contextual factors on TQM and performance through the lens of organisational theories: an empirical study. *Journal of Operations Management*, 25 (1), 83–109.

Sirmon, D.G., Hitt, M.A., Ireland, R.D., & Gilbert, B.A. 2011. Resource orchestration to create competitive advantage: Breadth, depth, and life cycle effects. *Journal of Management*, 37 (5), 1390–1412.

Srivastava, M., & Gnyawali, D. 2011. When do relational resources matter? Leveraging portfolio technological resources for breakthrough innovation. *Academy of Management Journal*, 54 (4), 797–810.

Stentoft, J., & Rajkumar, C. 2020. The relevance of Industry 4.0 and its relationship with moving manufacturing out, back and staying at home. *International Journal of Production Research*, 58 (10), 2953–2973.

Tabachnick, B.G., & Fidell, L.S. 2007. *Using multivariate statistics.* 4th edn. London: Pearson Education, Inc.

Tallon, P.P. 2007. Inside the adaptive enterprise: An information technology capabilities perspective on business process agility. *Information Technology and Management*, 9 (1), 21–36.

Thiem, A. 2014. Navigating the complexities of qualitative comparative analysis: Case numbers, necessity relations, and model ambiguities. *Evaluation Review*, 38 (6), 487–513.

Tortorella, G., & Fettermann, D. 2018. Implementation of Industry 4.0 and lean production in Brazilian manufacturing companies. *International Journal of Production Research*, 56 (8), 2975–2987.

Van Looy, A., & Shafagatova, A. 2016. Business process performance measurement: A structured literature review of indicators, measures and metrics. *SpringerPlus*, 5 (1), 1–24.

Warner, K.S.R, & Wäger, M. 2019. Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, 52 (3), 326–349.

Westerweel, B., Basten, R.J.I, & Van Houtum, G-J. 2018. Traditional or Additive Manufacturing?

Assessing Component Design Options through Lifecycle Cost Analysis. *European Journal of Operational Research*, 270(2), 570-585.

Wittmann, C.M., Hunt, S.D., & Arnett, D.B. 2009. Explaining alliance success: Competences, resources, relational factors, and resource-advantage theory. *Industrial Marketing Management*, 38 (7), 743–756.

Zammuto, R.F., Griffith, T.L., Majchrzak, A., Dougherty, D.J., & Faraj, S. 2007. Information technology and the changing fabric of organisation. *Organisation Science*, 18 (5), 749–762.

Zhang, G., & Ozer, M. 2015. The formation of status asymmetric ties: a perspective of positive externality and empirical test. *Industry and Innovation*, 22 (7), 625–647.

Tables and figures

Table 1

Assessment of Normality

Construct	KMO*	Indicators	Skewness	Kurtosis
Transformation Capability	.69	UC01	-.67	-.26
		UC02	-.97	.35
		UC03	-.91	.35
Portfolio Technological Resource	.75	PR02	-.58	-.39
		PR01	-.28	-.63
		PR04	-.46	-.41
		PR03	-.09	-.88
Relational Resource	.78	RR01	-.70	-.17
		RR03	-.70	-.50
		RR04	-.47	-.38
		RR02	-.68	-.36
Sustained Competitive Advantage	.86	SCA01	-.72	.55
		SCA02	-.36	-.38
		SCA03	-.36	-.21
		SCA04	-.55	-.34

Table 2

Construct Reliability and Validity: Loadings, AVE, CR, and Cronbach's α

Construct	Indicators	1	2	3	4
1.Portfolio Technological Resource	PTR01	.71			
AVE=0.63	PTR02	.84			
Cronbach's α=0.80	PTR03	.82			
CR=0.87	PTR04	.72			
2.Relational Resource	RR01		.81		
AVE=0.63	RR02		.81		
Cronbach's α=0.80	RR03		.82		
CR=0.87	RR04		.72		
3.Transformation Capability	TC03			.84	
AVE=0.67	TC02			.80	
Cronbach's α=0.75	TC01			.81	
CR=0.86					
4.Sustained Competitive Advantage	SCA01				.87
AVE=0.69	SCA02				.83
Cronbach's α=0.85	SCA03				.81
CR=0.90	SCA04				.81

Table 3

Discriminant Validity (Heterotrait-Monotrait Ratio, HTMT)

	1	2	3	4
1 Portfolio Technological Resource	--			
2 Relational Resource	0.88	--		
3 Sustained Competitive Advantage	0.78	0.71	--	
4 Transformation Capability	0.54	0.55	0.55	--

Table 4

Summary Data and Calibration (N=206)

Statistics	SCA	Relational Resource	Portfolio Technological Resource	Transformation Capability	Global Market Engagement	Firm Size
Mean	5.40	5.80	5.23	5.78	6.35	2.83
Std. Dev	.96	.89	1.00	.96	2.33	1.24
Min.	2.60	3.5	2.75	3	2	1
Max.	7	7	7	7	10	5
Calibration value at:						
95%	6.60	6.75	6.25	7.0	9	4
50%	5.40	5.75	5.25	5.67	5.95	2.95
5%	3.20	4.0	3.25	3.67	3.0	1

Table 5

Analysis of Necessary Conditions

Conditions	Consistency	Coverage
Relational Resource	0.83	0.79
Portfolio Technological Resource	0.85	0.82
Transformation capability	0.81	0.77
Firm Size	0.59	0.70
Global Market Engagement	0.74	0.74

Table 6

Configurational Pathways Leading to SCA

Causal Conditions	**C1**	**C2**	**C3**	**C4**
Relational Resource	●	●	●	●
Portfolio Technology Resource	●	⊕	•	●
Transformation Capability	⊕	•	●	•
Firm Size	•	⊕	●	●
Global Market Engagement	•	●	⊕	●
Raw coverage	0.67	0.23	0.34	0.42
Unique coverage	0.21	0.02	0.02	0.03
Consistency	0.91	0.85	0.91	0.95
Overall solution coverage	0.75			
Overall solution consistency	0.88			

Note for Tables 6&7:
C = Configuration.
Full circles (●) indicate presence of a causal condition; larger full circles indicate core conditions (presence). Crossed circles (⊕) depicts absence of a causal condition.

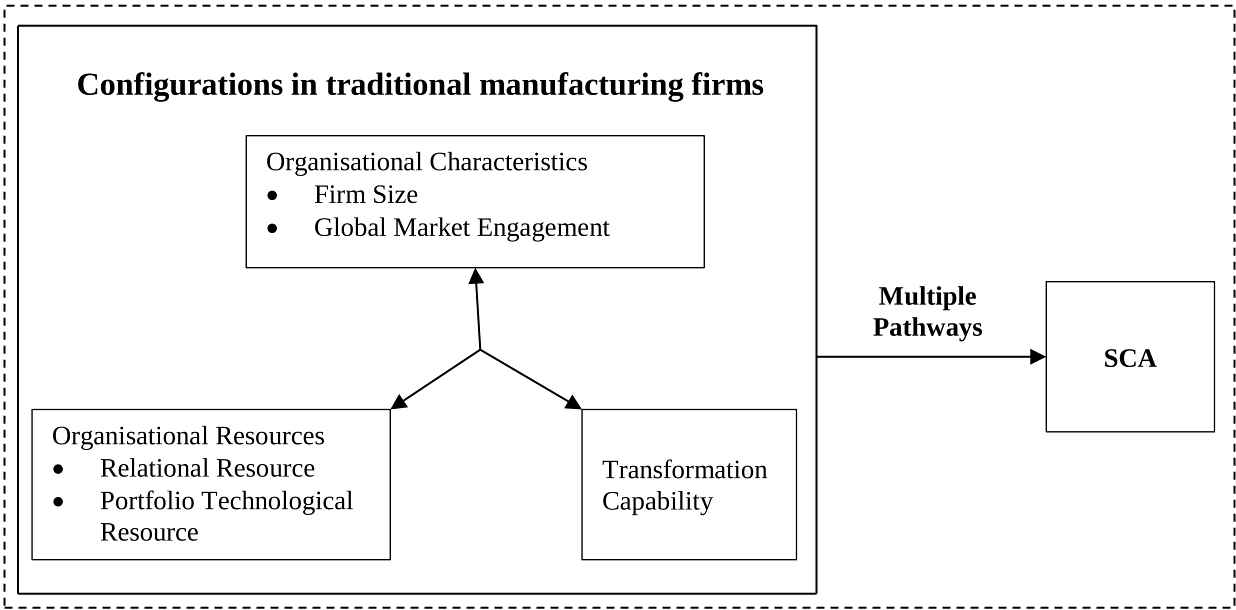
Table 7

Configurations Producing SCA of Contingency Perspective

		Causal conditions	Global Market Engagement: Low		Global Market Engagement: High	
			C1	**C2**	**C1**	**C2**
Firm Size	Large	Relational Resource	⊕	●	●	
		Portfolio Technology Resource	●	●	●	
		Transformation Capability	⊕	⊕	•	
	Small	Relational Resource	●		●	•
		Portfolio Technology Resource	•		•	●
		Transformation Capability	●		●	•

Figure 1

Research Model of Configurations Producing SCA



Appendices

Appendix A. Descriptive statistics of companies and informants (n=206)

Item	Category	Per cent
Employee Number (People)	≤50	11
	51-200	40
	201-300	20
	301-500	13
	≥501	16
Gross Profit Margin from Sales	≤0	0
	0-5%	14
	6-10%	47
	11-20%	31
	≥21	8
Export Proportion to Total Sales	n/a	18
	0-10%	12
	11-50%	22
	51-90%	28
	91-100%	20
Export Pattern	n/a	39
	OEA	14
	OEM	42

	ODM OBM	26 23
Job Position	Supervisor/Manager Senior Manager/Owner/CEO	31 69

Note:
a. For export pattern, the total is more than 100%. This is because the export patterns for some companies are more than one type, e.g., OEA+ODM, or OEM+ODM+OBM.
b. Original Equipment Assembly (OEA), Original Equipment Manufacturer (OEM), Original Design Manufacturer (ODM) and Original Brand Manufacturer (OBM) (Gereffi et al., 2005).

Appendix B. Questionnaire items and descriptive statistics

Measures	Items	Mean/S.D.
Relational Resources (RRs)		
RR01	Our global customers are satisfied with the quality and flexibility of manufacturing and services.	5.26/1.21
RR02	We have established a trustable and strong relationship with our global customers.	5.76/1.17
RR03	We have successfully developed a strategic partnership relationship with our global customers.	5.71/1.06
RR04	We have developed a reliable network with our suppliers.	5.77/1.18
Portfolio Technological Resources (PTRs)		
PTR01	We have developed the required digital marketing technologies for Industry 4.0.	4.60/1.52
PTR02	We have developed the required design technologies for Industry 4.0.	5.19/1.20
PTR03	We have developed the required information technologies for Industry 4.0.	5.38/1.22
PTR04	We have developed the required manufacturing technologies for Industry 4.0.	5.06/1.28
Transformation Capability (TC)		
TC01	We have gradually developed strategically collaborative systems for value co-creation among our stakeholders.	5.67/1.25
TC02	Smart manufacturing processes have gradually been adopted in our firm.	5.88/1.13
TC03	Employees' ICT competencies have gradually been improved in our firm.	5.78/1.16
Sustained Competitive Advantage (SCA)		
SCA1	We deliver orders timely.	5.34/1.22
SCA2	We control manufacturing costs properly.	5.35/1.24
SCA3	Our production and service are flexible to meet particular customer needs.	5.48/1.13
SCA4	Our product quality conforms to the specifications of orders.	5.62/1.12

Appendix C. Solutions quality for four groups of firms (n=206)

	Group 1	Group 2	Group 3	Group 4
	Small-size Low-engagement	Small-size High-engagement	Large-size Low-engagement	Large-size High-engagement
Solution Coverage	0.75	0.89	0.78	0.92
Solution Consistency	0.79	0.81	0.85	0.82
Sample Size (N)	30	76	78	22