Industrial Management & Data Systems

Absorptive capacity and business performance: The mediating effects of innovation and mass customization

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Absorptive capacity and business performance

The mediating effects of innovation and mass customization

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Received 20 September 2017
Revised 12 December 2017
9 February 2018
30 March 2018
Accepted 12 April 2018

Abstract

Purpose – The purpose of this paper is to examine the multiple paths of absorptive capacity's (AC) effect on business performance (BP): direct effect and indirect effects through innovation and mass customization (MC).
Design/methodology/approach – The authors examined the role of innovation and MC capability on the relationship between AC and BP. Data from 278 Chinese firms in four manufacturing industries collected by questionnaire are used to empirically examine the proposed model by Structural equation modeling.
Findings – The results show that AC can directly enhance BP, and indirectly through innovation and MC capability. The study also finds that MC capability has a stronger mediating effect than innovation.
Originality/value – Prior studies have not yet built linkages between AC and BP with both innovation and MC's effects. This study provides empirical evidence of the effects of AC on BP and three paths are discussed including AC's direct effect and indirect effects through innovation and MC to firm's BP. This study provides a new direction for executives to better understand the movement of knowledge along supply chain and in intra-organizational environment, and of the importance of innovation and MC capability since they are essential carriers for BP enhancement.

Keywords Absorptive capacity, Innovation, Business performance, Mass customization capability
Paper type Research paper

1. Introduction

Given that market competition has intensified and the product life cycle has shortened, firms have been increasingly exploring how to improve their innovation and management capability to fulfill ever-sophisticated demands. It is generally believed that in the current knowledge-intensive business environments and competitive markets, a firm's internal and external learning capability is becoming critically important (Zhao *et al.*, 2008; Huang *et al.*, 2008). In addition, many successful practices are associated with mass customization (MC), which companies such as Dell, 3 M and P&G have adopted as one of their important strategies to improve their business performance (BP).

Absorptive capacity (AC), introduced and defined by Cohen and Levinthal (1990) as the ability to acquire, assimilate and then exploit external information for commercial ends has become an essential ability for enterprises to create competitive edges by developing new products or increasing manufacturing flexibility (Patel *et al.*, 2012). AC not only improves the existing knowledge base and encourages new knowledge creation activities that influence entrepreneurial success but also encourages firms to renew their products or key technologies to more efficiently manage their employees and stimulate creativity. Many scholars have studied how AC contributes to BP and have tested the manner in which it contributes to building competitive advantage. Some scholars have argued that new product development

This research is supported by a major program grant of the Natural Science Foundation of China (NSFC) (No. 71090403), the Humanities and Social Science Research Foundation of the Ministry of Education of China (No. 17YJA630061), and the Fundamental Research Funds for the Central Universities.

Industrial Management & Data Systems
Vol. 118 No. 9, 2018
pp. 1787-1803

0263-5577
DOI 10.1108/IMDS-09-2017-0416

through innovation can benefit from AC since it can help a company both acquire and use external information (Kotabe *et al.*, 2011) and intervene to translate external resources into practical benefits (Kostopoulos *et al.*, 2011). Here, innovation is defined as new application of knowledge, ideas, methods and skills that can generate unique capabilities and leverage an organization's competitiveness (Kim *et al.*, 2012). MC, a competitive production mode coined by Pine (1993a, b), Ward and Duray (2000) and Duray *et al.* (2000), is here defined, from an operational capability view, as a manufacturer's ability to offer a high volume of different products reliably to the large customized demands in the market without substantial tradeoffs in cost, delivery or quality (Liu *et al.*, 2006; Huang *et al.*, 2008).

Although the literature on AC has grown rich and has analyzed complex organizational phenomena, attempts to delve deeper into the process that links AC with external knowledge flows to firm performance have been made only recently. However, studies on AC in recent decades have mainly focused on its relationships with organizational learning (Gebauer *et al.*, 2012), innovation (Gebauer *et al.*, 2012), knowledge creation (Camisón and Forés, 2011; Ferreras-Méndez *et al.*, 2015) and firm performance (Lev *et al.*, 2009; Flatten *et al.*, 2011). Relatively few studies have examined an integrated portfolio including AC, practical operations and the end goal of enhancing organizational performance and important questions on the mechanisms through which AC contributes to BP remain unanswered (Kostopoulos *et al.*, 2011). Based on this gap, the current research was designed to explore how AC contributes to BP enhancement directly and indirectly through innovation and MC. The study attempts to address two key questions:

RQ1. What are the effects of AC on BP in the Chinese manufacturing industry?

RQ2. What is the role of innovation and MC in the path by which AC enhances BP along the supply chain?

To achieve this goal, a theoretical model was developed to display the proposed relationships, and a survey was conducted in 278 Chinese manufacturing firms. Specifically, the study was designed to examine the following three different paths: first, AC enhances BP directly; second, AC enhances BP through innovation; finally, AC enhances BP through MC.

The study results confirmed the proposed linkages, which have not been discussed previously. More importantly, this research is based on a supply chain view to investigate the role of AC, innovation and MC on BP among the supply chain partners, and this view can help enrich the existing literature by proposing a new way of thinking. In addition, an understanding of the different paths through which AC enhances BP in China can help increase the understanding of how knowledge and dynamic capabilities may influence the BP of manufacturers in other emerging countries.

2. Theoretical background and research hypotheses

Based on a theoretical and practical perspective, we discuss three paths through which AC affects firms' BP (a direct effect and indirect effects through innovation and MC). A theoretical framework is developed to bridge the two important theories of the resource-based view (RBV) and the dynamic capabilities view (DCV).

The RBV as the basis of a company's competitive advantage lies primarily in the application of a series of valuable tangible or intangible resources in the processing of enterprises (Penrose, 1959). To transform short-term competitive advantages into sustainable competitive advantages, these resources must be heterogeneous in nature rather than completely mobile (Barney, 1991). In addition, through consistent and sophisticated bundling activities, the mutual reinforcement of resources can help further distinguish individual capabilities (Teeter and Sandberg, 2016). Dynamic capabilities represent an enterprise's abilities to integrate, build, and reconfigure internal and external competences to address rapidly changing environments (Teece *et al.*, 1997). To overcome the fact that RBV is a static theory, and therefore inadequate to

explain the firm's sustainable competitive advantage, especially in the current changing environment, the concept of DCV was proposed (Barrales-Molina *et al.*, 2014). The main difference between the RBV and DCV is that the RBV emphasizes sustainable competitive advantage, while the DCV focuses on the issue of competitive survival in response to rapidly changing contemporary business conditions. However, we propose that both sustainable advantage and competitive survival are important in the process of supply chain management. In addition, resources are stocks of available factors that are owned or controlled by the organization, and capabilities are an organization's capacity to deploy resources (Amit and Schoemaker, 1993). In a previous research study, Nelson (1982) linked the growth of the concept of dynamic capabilities to the RBV of the firm but did not provide any empirical evidence of this link. In the current study, we bridge the two important theories of RBV and DCV to develop the theoretical model and conduct empirical research.

2.1 Absorptive capacity and business performance

The concept of AC was coined in the field of macroeconomics by Alder (1965), who described it as an economy's ability to utilize and absorb external information and resources. Cohen and Levinthal (1990) first introduced AC into the field of management as a company's ability to acquire, assimilate, and then exploit knowledge or information for commercial ends. Although Zahra and George (2002) further developed the concept and divided it into four distinct dimensions, including acquisition, assimilation, transformation and exploitation, Cohen and Levinthal's (1990) three-dimensional concept has been more widely accepted because it captures the stages of AC, knowledge engagement and continuous learning. Knowledge acquisition mainly refers to a firm's ability to identify and acquire externally generated knowledge that is crucial to operations, such as customer preferences, supplier operations information and new technological developments, through both formal and informal procedures (Zahra and George, 2002). Knowledge assimilation refers to a firm's routines and procedures for analyzing, interpreting and understanding external information and combining such information with existing knowledge (Zahra and George, 2002; Lane *et al.*, 2006). Application refers to routines that allow firms to gain a competitive advantage by incorporating assimilated knowledge into their daily operations (Lane *et al.*, 2006; Zahra and George, 2002). During the application process, people of various backgrounds and interests work together to consider how to improve existing designs for production operations by applying newly assimilated knowledge and making joint decisions.

In recent years, many scholars have explored the relationship between AC and BP. Based on the dynamic capabilities perspective, Liu *et al.* (2013) found that AC is an important source of firm performance; Wales *et al.* (2013) proposed an inverted U-shaped relationship between AC and financial performance; Tzokas *et al.* (2015) highlighted the interactive nature of AC's antecedents and how these antecedents relate to firms' performance and contributed to the understanding of the role of AC as a mechanism for translating external knowledge into tangible benefits. Even if we disregard the procedure through which AC helps a company gain competitive advantage, we can never deny that having a powerful ability to learn from external knowledge enables a company to adjust its strategy based on external changes, to develop products or services that satisfy customers' needs, or to make production plans based on inventory. Thus, powered by AC, firms are more likely to satisfy customers with low costs, high speed and high-quality products. Hereby, we propose the first hypothesis as follows:

H1. As a firm's AC increases, its BP improves.

2.2 Absorptive capacity, innovation and business performance

For many years, researchers in innovation have mainly focused on internal knowledge creation and have ignored the external information exploitation mechanism (Murovec and Prodan, 2009).

In fact, in the current highly collaborative society, internal innovation is not sufficient to create competitive advantages; thus, firms must engage in external knowledge acquisition, assimilation and exploitation (Cohen and Levinthal, 1990). Specifically, acquiring information from supply chain partners (i.e. suppliers and customers) enables a firm to formulate more ideas about new product designs (Stock *et al.*, 2001) and to identify more technological opportunities (Nieto and Quevedo, 2005). The ability to assimilate knowledge enables staff in a firm to gain a better understanding of external information since sharing external information within the company cannot only imbue them with new knowledge but also inspire them to create new knowledge, which results in innovation (Cohen and Levinthal, 1990). Knowledge exploitation is a critical step in transferring knowledge into practical use since a perfect organizational mechanism is needed to exploit external information for certain uses. Many scholars have argued that AC facilitates a company's learning about new technology from external entities (Stock *et al.*, 2001) and that the new knowledge obtained from external sources helps generate new products directly or stimulate other new ideas that will facilitate innovation (Zahra and George, 2002). In summary, AC promotes a company's speed, frequency and magnitude of innovation (Kostopoulos *et al.*, 2011). Thus, we propose the following hypothesis:

H2. As a firm's AC increases, its innovation capability becomes stronger.

In terms of the impact of innovation on an organization, a positive relationship has been found between firm innovation and firm performance (Mone *et al.*, 1998). Innovation has been considered a key factor for appropriate competition in the market (Clark and Fujimoto, 1990) and a primary source of organizational renewal (Dougherty, 1992). Choices related to innovation also contribute to the overall strategy of capability management and inter-firm cooperation (Yalabik *et al.*, 2012). Thus, innovation is identified as the firm's ability to develop and sustain competitive advantage through the positive relationship between innovation and BP (Yang, 2012). However, Gong *et al.* (2013) found that when riskiness orientation is high, core knowledge employee creativity is negatively related to firm performance. Since innovation plays a key role in providing differentiated products by creating value and setting barriers for competitors (Kim *et al.*, 2012), researchers and practitioners cannot ignore the significance of innovation for business survival and development. Thus, we propose the following hypothesis:

H3. As a firm's innovation capability becomes stronger, its BP improves.

2.3 Absorptive capacity, mass customization capability and business performance

Many researchers have suggested that MC can help satisfy customer needs through specifying and designing the product successfully (Pine, 1993a, b; Ward and Duray, 2000) and have proposed that customers and suppliers are very important in MC (Zhang *et al.*, 2014). However, existing empirical research has mainly focused on the influence of the technical aspects of customer collaboration on MC (Zhang, Lettice, and Zhao, 2015). The definition of MC reflects that MC is a new production prototype that helps identify the goal of combining the value-added effectiveness related to production by increasing cost-efficiency in mass production; thus, MC has major implications for operations management (Åhlström and Westbrook, 1999). This prototype is a great challenge for firms that have adopted it because of increasing uncertainties in the manufacturing environment as well as other strategies related to cost, speed and quality effectiveness (Huang *et al.*, 2007). The test results from Wang *et al.* (2014) proposed that knowledge management has positive effects on MC, and Zhang, Zhao, Lyles, and Guo (2015) showed that AC significantly improves MC. In particular, knowledge sourced from customers and suppliers enhances MC in three ways: directly, indirectly through knowledge application and indirectly through knowledge assimilation and application. Thus, we propose the following hypothesis:

H4. As a firm's AC increases, its MC capability becomes stronger.

However, building MC capability is not an organization's final goal. The conceptual theory needs to be transferred into operational aspects (Flogliatto *et al.*, 2012), which are crucial for a firm to construct an MC system with a long-term, integrative, systematic and strategic view. According to existing research, MC can create efficiency at the operational level and competitive advantages at the strategic level, and increasing manufacturing flexibility based on MC can also help improve firm performance (Camisón and López, 2010). As Zhao *et al.* (2007) suggested, MC practices, including elicitation, design flexibility, advanced manufacturing technologies, and integrated information systems, enhance operational performance in terms of quality and cost. Additionally, the relationships between MC practices and BP are moderated by an organization's competitive strategy and supply chain strategy configurations (Zhao *et al.*, 2008). Thus, from the theoretical perspective, MC has a positive effect on BP. Hence, the following hypothesis is postulated:

H5. As a firm's MC capability becomes stronger, its BP improves.

2.4 The role of innovation and MC capability

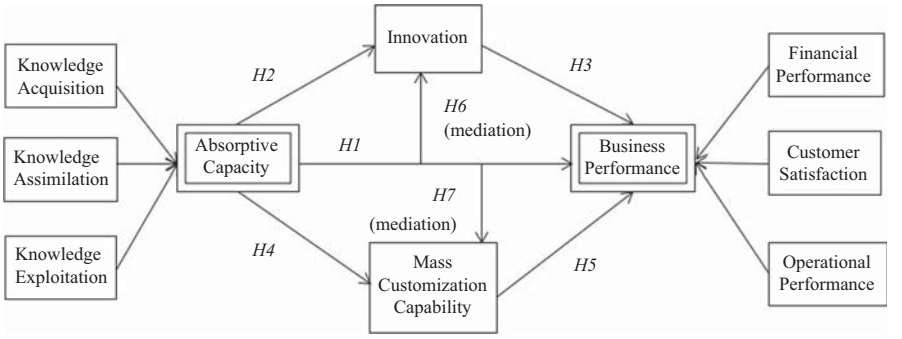
AC, as a dynamic capability, enables a firm not only to acquire and assimilate external information or knowledge but also to create value and to gain and sustain a competitive advantage through the management of external knowledge (Camisón and Forés, 2010). Most studies have shown that AC has a positive relationship with BP (Kostopoulos *et al.*, 2011; Liu *et al.*, 2013). However, this result is not sufficient to argue that AC is fully utilized by firms to maximize returns, and some high-tech absorption cannot be translated into financial performance because of a lack of assimilation ability. Additionally, external knowledge can hardly be applied to production operations due to cultural gaps, managerial issues or implementation problems. As Huang *et al.* (2008) stated, effective process implementation is important when a company intends to improve MC capability through external learning. Therefore, Kostopoulos *et al.* (2011) suggested that innovation mediates the relationship between AC and BP. Thus, we propose the following hypothesis:

H6. The effect of AC on BP is mediated by innovation

AC emphasizes a kind of dynamic ability to realize knowledge learning from both internal and external surroundings, and this ability has gradually gained recognition as a key driver of a firm's competitive advantage (Lichtenthaler, 2009). From the RBV perspective, innovation advantage means that a firm with unique resources or technology is more likely to have a first-mover advantage that can be translated into market share. In addition, for MC implementation to produce a positive result, external information and internal knowledge sharing (Huang *et al.*, 2008) and a related innovative production process are necessary. MC is widely related to innovation by definition since it is completely combined with technological firms, which require remarkable innovation and since innovation enhances the flexibility and responsiveness of a firm that can develop MC (Wang *et al.*, 2016). However, designing and managing an organization that can learn from the external environment efficiently and effectively remain major challenges (Flogliatto *et al.*, 2012). Therefore, an understanding of how firms learn and apply knowledge across the supply chain and of the role of MC in AC for improving BP is necessary. Thus, we propose the following hypothesis:

H7. The effect of AC on BP is mediated by MC capability.

Based on the abovementioned hypotheses, the following theoretical research model (Figure 1) was developed.



Notes: ▭ First-order constructs; ▭ Second-order constructs

Figure 1.
Research model

3. Research design and methodology

3.1 Questionnaire design

The questionnaire was designed based on the concepts explained above, and a seven-point Likert scale (ranging from 1, "significantly disagree," to 7, "significantly agree") was used for all questions, in which companies compared themselves with their competitors. The details of all the scales are listed in the Appendix.

3.1.1 Dependent variable: business performance. BP was measured by three dimensions, including financial performance, customer satisfaction and potential operational performance (product or process improvement). These methods involve both short-term and long-term BP, representing the integrated performance and competitive power of a company.

3.1.2 Independent variables. Absorptive capacity. AC was measured by the three dimensions proposed by Cohen and Levinthal (1990) to fully conceptualize AC: knowledge acquisition, knowledge assimilation and knowledge exploitation. For each dimension, several questions were designed based on dynamic learning across the supply chain and the internal environment, as proposed by Cohen and Levinthal (1990). To measure knowledge acquisition, 12 items were designed to understand firms' frequent communications and information exchanges with suppliers and customers through formal and informal methods. For knowledge assimilation and knowledge application, 10 and 11 items, respectively, were designed.

Innovation. The scales used to measure innovation were mainly taken from previous studies, but a few scales on the characteristics of the manufacturing industry and MC were added. Six items were employed to measure a firm's innovation: new products output (Murovec and Prodan, 2009), market response to product improvement, high-tech content of products, new process output (Murovec and Prodan, 2009), the input-output ratio in new product development and first-class craftsmanship and procedures.

Mass customization capability. To assess MC, four items were taken from Liu *et al.* (2006) and three items were taken from Tu *et al.* (2001). These items were used to understand firms' high-volume, low-cost and quick provision of diversified products.

3.1.3 Control variables. To ensure the robustness of the results, this study includes three control variables: firm size, industry sector and ownership. Firm size affects a firm's ability to process information related to changing resources and to adapt to changing resource conditions and is measured by the number of full-time employees at four different levels. Industry sector may affect the results because different industries may have a different level of innovation, different level of MC and different profit (Duray *et al.*, 2000). For example, the textile and apparel industry in China typically has a lower level of innovation than other industries since this industry is more traditional and its obsolete operation styles are not suitable for the current sophisticated market, while it tends to be easier to realize

technological breakthrough in the electronics and communication equipment industry. Ownership types may influence firms' ability to create competitive advantages (Zhang, Zhao, Lyles, and Guo, 2015). For example, state-owned enterprises are more likely to gain financial and human resources support from the government. The details of the control variables are listed in Table I.

3.2 Sampling and data collection

A random sample of 3,088 Chinese manufacturers in a China Stock Market & Accounting Research Solution database (http://csmar.gtadata.com/) were chosen from four selected industries based in four industry-intensive regions in China, namely, the Pearl River Delta, Central China, the Yangtze River Delta and the Bohai Sea Economic Area. The main methods were mailed surveys followed by telephone calls. Prior to mailing the questionnaires, the target companies were contacted to identify the most suitable informants, who would then agree to participate. The informants were the senior managers in charge of supply chain or production activities because they have systematic knowledge of the whole company, including manufacturing, marketing, purchasing and R&D, that can reflect a company's MC capability, absorptive ability, innovation capability and BP. Multiple informants from each company were asked to complete the questions relevant to their jobs. A total of 600 companies completed the questionnaire, and 278 valid responses were collected, resulting in a valid response rate of 46.3 percent. Data on the companies' ownership, industry and number of employees are shown in Table I. Most of the responses were provided by individuals who held a management position in the firm, and the respondents' average years of experience in the industry was more than four years, indicating that the informants were knowledgeable about the issues under investigation.

3.3 Pre-test and pilot test

Before designing and distributing the questionnaires, several plant visits were arranged to explore and improve the understanding of the research questions in the context of different industries. After the plant visits, the questionnaire was designed, and the survey underwent several rounds of testing to improve its wording, the ease with which it is answered, the appropriateness of the question sequence and consistency in the meaning. The pre-tests also helped validate the scales composed of the survey items. The original questionnaire was developed in English, but as the respondents were native speakers of Mandarin Chinese, we invited several Chinese and foreign experts in the field of supply chain to translate the questionnaire into Chinese and then back-translate it into English to ensure accuracy. The research team then conducted a pilot test with several senior managers on site at six companies in different areas of China. Semi-structured, face-to-face discussions and Q-sort

Ownership	Number	Rate	Industry	Number	Rate	Number of employees	Number	Rate
State owned or held	53	0.910	Textile and apparel	63	0.227	Less than 100	43	0.155
Private owned	128	0.460	Electrical appliance	26	0.940	101–500	85	0.306
Foreign owned	51	0.183	Electronics and communication equipment	118	0.424	501–2,000	54	0.194
Joint venture	41	0.147	Automobile	71	0.255	More than 2,000	96	0.345
Collective owned	5	0.180						
Total	278	1	Total	278	1	Total	278	1

Table I. Company profiles

techniques were also carried out to enhance the content validity and identify problems with the wording and comprehension of the questions. The questionnaire was then modified based on the results of the pilot test.

4. Data analysis and results

Partial least squares (PLS) regression was used for the data analyses because it can estimate the loadings and weights of indicators on constructs, thus assessing construct validity and the causal relationships among constructs in multistage models (Fornell and Bookstein, 1982). Compared with covariance-based structural equation modeling (SEM), PLS regression is more robust and has fewer statistical identification issues. For models with formative constructs and relatively small samples, such as the model in the current research, PLS regression is the most suitable technique (Hair *et al.*, 2011). Thus, SmartPLS 3 software was adopted to assess the proposed model. To determine the approximate model fit, the standardized root mean square residual (SRMR) was calculated. The SRMR value of the estimated model is 0.073, which is below the acceptable threshold of 0.08 proposed by Henseler *et al.* (2014).

4.1 Measurement model

AC and BP were used as second-order constructs. We chose to define a two-stage approach (indicators reuse approach and latent variable score) because the research model is a reflective-formative model. Formative constructs and reflective constructs were examined under different procedures in the assessment of the measurement model. First, the validity and reliability of the formative constructs (e.g. AC and BP) (Petter *et al.*, 2007) were assessed by examining both the item weights and loadings (Cenfetelli and Bassellier, 2009), and reliability was further assessed by examining the possible multicollinearity among indicators (Diamantopoulos *et al.*, 2006). Table II shows that the weights of AC2 were not significant; this result might be due to multicollinearity or to the relatively large number of indicators (Cenfetelli and Bassellier, 2009). Therefore, we examined loadings (bivariate correlations) between indicators and their respective constructs (Cenfetelli and Bassellier, 2009) and found that the loadings of all the items onto AC are above 0.7, which indicates statistical significance. This result indicates that all the items have absolute contributions to AC and supports the adoption of all these indicators (Cenfetelli and Bassellier, 2009) for subsequent model analysis. The results also show that the variance inflation factor values range from 1.521 to 4.844, which are well under the acceptable threshold of 10.00, indicating lower threats of multicollinearity (Hair *et al.*, 1998).

Second, the reliability and validity of the reflective constructs (e.g. innovation and MC capability) were assessed using different procedures. The reliability of the reflective constructs was assessed by using composite reliability (CR) and average variance extracted (AVE). The convergent validity and discriminant validity were assessed by a confirmatory factor analysis (CFA). The CFA resulted in certain modifications to the initial model to achieve a good fit, and some indices were compared with the recommended level to test the dimensionality of the constructs. Table II summarizes the results of the measurement model,

Constructs	Item	Weights	*t*-value	Loadings	*t*-value
Absorptive capacity	AC1	0.553	4.412	0.945	32.090
	AC2	0.165	1.036	0.875	20.141
	AC3	0.361	2.215	0.923	27.808
Business performance	BP1	0.240	2.902	0.826	23.290
	BP2	0.311	3.267	0.871	25.152
	BP3	0.565	7.145	0.940	40.847

Table II.
Item weights and loadings for the formative constructs

including loading coefficients, the relevant *t*-values, CR and fit index. Table III shows that all measures exceed the acceptable thresholds of 0.70 or above for CR and 0.50 or above for AVE (Fornell and Larcker, 1981), with CR ranging from 0.909 to 0.943 and AVE ranging from 0.502 to 0.727, except for the first item (AC1) for AC (discussed earlier). Additionally, we examined the Cronbach's α coefficient to detect the internal consistency of the questionnaires results. All of the figures in Table III exceeded the recommended criterion of 0.70, indicating the adequate reliability of the questionnaire.

In addition, heterotrait-monotrait (HTMT) ratio values were assessed to examine discriminant validity. The results presented in Table IV show that the highest value is 0.666, which is below the threshold of 0.85, suggesting discriminant validity between two reflective constructs (Henseler *et al.*, 2015). We tested correlations between latent variables and the square root of the AVE for each construct. The descriptive statistics are shown in Table V, and the results indicate that AC, innovation and MC capability are positively related to BP.

	Cronbach's α	Loadings	Composite reliability	Average variance extracted	Weights
Absorptive capacity					
AC1: Knowledge acquisition	0.895	0.945	0.913	0.470	0.553
AC2: Knowledge assimilation	0.911	0.875	0.926	0.557	0.165
AC3: Knowledge exploitation	0.890	0.923	0.912	0.502	0.361
Innovation	0.904		0.926	0.676	
IN1: New products output		0.806			0.188
IN2: Good market reaction		0.859			0.206
IN3: High-tech content with products		0.801			0.206
IN4: New process output		0.819			0.199
IN5: High input-output ratio in new product development		0.819			0.201
IN6: First-class craftsmanship and procedures		0.826			0.216
Mass customization capability	0.883		0.909	0.587	
MC1: We are highly capable of large-scale product customization		0.744			0.169
MC2: We can easily add significant product variety without increasing costs		0.768			0.209
MC3: We can customize products while maintaining high volume		0.720			0.169
MC4: We can add product variety without sacrificing quality		0.771			0.211
MC5: We can adjust our process design based on customer demand without significantly increasing cost		0.795			0.180
MC6: We can adjust our supply chain design based on customer demand without significantly increasing cost		0.743			0.172
MC7: We can adjust our product design based on customer demand without significantly increasing cost		0.783			0.193
Business performance					
BP1: Financial performance	0.873	0.826	0.914	0.727	0.240
BP2: Customer satisfaction	0.912	0.871	0.932	0.696	0.311
BP3: Potential operational performance	0.932	0.940	0.944	0.651	0.565
Recommended levels	> 0.7	> 0.7	> 0.7	> 0.5	

Table III. Reliability and validity tests of the construct measurement model

4.2 Structural model

A structural model was constructed to test the proposed hypotheses. The results of the model are shown in Figure 2, including the overall explanatory power, the estimated path coefficients, and the *t*-values associated with the paths. The bootstrap re-sampling procedure was used to test the significance of all paths.

The results suggest that a large proportion of the variance in BP (54.8 percent) is explained by the three constructs, and this model also accounts for 28.6 percent of the variance in innovation and 29.9 percent of the variance in MC capability. As the major research interest of the current study is BP, three different paths were examined to explain how AC can enhance BP. The results suggest that AC is absolutely positively related to BP, with a path coefficient of 0.187, thus supporting *H1*; AC has a significant influence on innovation and MC capability ($\beta = 0.535$, $p < 0.001$ and $\beta = 0.547$, $p < 0.001$, respectively), thus supporting *H2* and *H4*; innovation ($\beta = 0.266$, $p < 0.001$) and MC ($\beta = 0.431$, $p < 0.001$) significantly affect BP, thus supporting both *H3* and *H5*.

Table IV.
Heterotrait-monotrait (HTMT) ratio

Construct	AC	IN	MC	BP
AC				
IN	0.535			
MC	0.547	0.499		
BP	0.565	0.581	0.666	

Table V.
Descriptive statistics

	Mean	SD	AC	IN	MC	BP
AC	5.066	0.892	*0.714*			
IN	5.071	1.042	0.529**	*0.822*		
MC	5.132	0.979	0.533**	0.494**	*0.746*	
BP	5.191	0.873	0.557**	0.565**	0.659**	*0.831*

Notes: $n = 278$. The italic numbers in the diagonal row are square roots of the average variance extracted. $p < 0.05$; **$p < 0.01$; ***$p < 0.001$

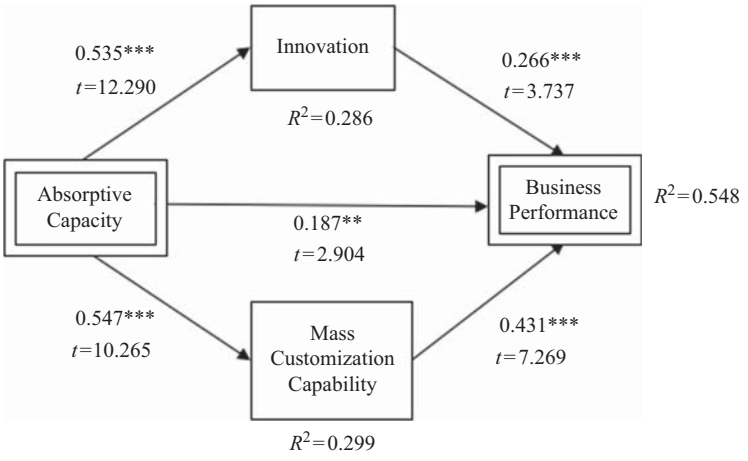


Figure 2.
Results of the PLS analysis

To further examine the mediating effect of innovation and MC capability on the relationship between AC and BP, we followed the procedure and methods proposed by Preacher and Hayes and Zhao *et al.* (2010) to estimate the significance of the two indirect effects in the model and bootstrapped the sampling distributions of the two indirect effects. Table VI shows that the corresponding indirect effect is significant. Thus, mediation is present (Zhao *et al.*, 2010) in the relationship between AC and BP. The results further indicate that innovation and MC capability complementarily mediate the relationship between AC and BP (i.e. "partial mediation" in terms of Baron and Kenny, 1986). Therefore, *H6* and *H7* are supported.

Finally, to identify which path has a stronger mediating effect, the method proposed by Wen *et al.* (2004) was followed to test the relative estimation of mediating effects between AC and BP, which can be measured by the proportion of the mediating effect to the total effect. The relative estimation of MC capability is 41.73 percent ($0.547 \times 0.431/0.565$), which is stronger than the mediating effect of innovation, 25.19 percent ($0.535 \times 0.266/0.565$) (estimated total effect = 0.565).

5. Discussion and conclusions

In summary, the empirical results show that there are three paths through which AC affects BP: AC – BP; AC – innovation – BP, and AC – MC – BP. Innovation and MC can both help make AC more effective and make it easier to achieve the desired benefits, revealing that AC, innovation and MC capability are crucial in helping companies enhance their BP. Furthermore, the empirical results also suggest that MC capability is relatively more important than innovation in transferring AC into realized benefits in Chinese enterprises.

This study contributes to the existing innovation and supply chain management literature in three areas. First, previous research has linked the concept of dynamic capabilities to the RBV but has not provided any empirical evidence of this link (Nelson, 1982). Until now, few empirical studies have been based on an integrative view of RBV and dynamic capabilities to combine AC, innovation and MC capability and examine their contributions to BP; this view is supported by the research results that indicate that manufacturers can improve BP by integrating both internal resources and external resources through AC. Through the dynamic process of supply chain management that enhances BP, the firm can maintain not only its current sustainable competitive advantages but also its competitive survival in response to the changing environment. As García *et al.* confirmed, AC is not a goal in itself but can generate important organizational outcomes when it is developed.

Second, in recent decades, researchers have mainly focused on the relationships between AC and organizational learning and innovation (Kostopoulos *et al.*, 2011; Gebauer *et al.*, 2012), knowledge creation (Camisón and Forés, 2011; Ferreras-Méndez *et al.*, 2015), firm performance (Lev *et al.*, 2009; Flatten *et al.*, 2011 and management ties (Kotabe *et al.*, 2011). Almost no research has explored different paths through which AC enhances BP in Chinese manufacturing industries by examining both innovation and MC. The multiple influences of AC on BP were identified to improve our understanding of the movement of knowledge along the supply chain and in the intra-organizational environment, and the importance of innovation and MC capability were recognized since they are essential to enhancing BP. The current study helps enrich the existing literature and shows researchers the important topic of AC and its

AC → … → BP	Indirect effect	Direct effect	Type of mediation
AC → IN → BP (*H6*)	0.142***	0.187**	Partial
AC → MC → BP (*H7*)	0.236***	0.187**	Partial

Notes: $p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table VI. Significance levels of the direct and indirect effects

relations with various areas based on a fresh perspective on knowledge, strategic resource and dynamic capability. In particular, the result supports the argument that knowledge acquisition and assimilation is a necessary condition to achieve competitive advantage in innovation (Zahra and George, 2002. We further develop the theory through empirical evidence that firms can fully benefit from innovation and transform it into performance outcomes.

Third, MC was recognized as a more impactful factor than innovation in enhancing BP. Although it is widely believed that MC capability is associated with performance, a theoretical foundation for this relationship has been lacking (Liu *et al.*, 2012). In this respect, the empirical assessment of the relationship we estimate here has filled this gap.

This research also offers several insights to practitioners. First, building a learning relationship across the supply chain is very important for the enhancement of BP through innovation and especially for the development of MC capability (Flogliatto *et al.*, 2012; Huang *et al.*, 2008; Pine *et al.*, 1995). Hence, educational and training plans are needed to improve employees' innovative awareness and learning abilities. In addition, Chinese manufacturers should rely on knowledge assimilation and application to adjust manufacturing processes and mass customize products to satisfy the demands of customers. Specifically, entrepreneurs should pay greater attention to MC rather than focusing solely on innovation as a source of competitive advantage. Finally, as China is one of the rapidly developing emerging economies, this recommendation can be provided to manufacturers in other emerging countries.

In addition to the above contributions, this research has several limitations. First, this research studied only the overall effects of AC on BP through innovation and MC. However, there are several dimensions or components of AC, including knowledge acquisition, assimilation and exploitation and each dimension may play a different role in these different influential paths. Second, some contingent factors such as region, power and social capital may have an influence on the enterprises and the relationship between AC and BP. Future studies can explore the influence of the institutional environment on AC and BP. Last but not least, this study focuses only on China, and we cannot ascertain whether the findings are generalizable to other countries. To make the theory more commonly adaptive, more data from various emerging economies are needed.

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Appendix. Measurement items

Absorptive capacity

AC1: Knowledge acquisition

Q1: Our employees often go to visit our customers

Q2: We have procedures and methods to obtain real-time customers' operation information (such as production plan, inventory level)

Q3: We have direct contacts with our customers through networks (e.g. EDI, PDS, e-mail, instant communication software)

Q4: We regularly have special meetings with our customers (such as focus groups, brainstorming sessions) to find the products or services needed in the future

Q5: We always investigate our customers to evaluate the quality of our products or services

Q6: We have formal practices and standard operating procedures to guide communications between staff and customers

Q7: Our employees often go to visit our suppliers

Q8: We always investigate our suppliers to get suggestions to improve our products or services

Q9: We regularly have special meetings with our suppliers (such as focus groups, brainstorming sessions) to discuss how to develop products or services that may be needed in the future

Q10: We have procedures and methods to obtain real-time suppliers' operation information (such as production plan, inventory level)

Q11: We have formal practices and standard operating procedures to guide communications between employees and suppliers

Q12: We have direct contacts with our suppliers through networks (e.g. EDI, PDS, e-mail, instant communication software)

AC2: Knowledge assimilation

Q1: The company internally uses a networking collaborative office system

Q2: We often organize study groups to discuss the influence of new knowledge on the enterprise

Q3: We have a special mechanism to solve the opinion conflicts resulting from employees' different understandings and explanations of new knowledge

Q4: We have a special program to guide employees to share knowledge and practical experience

Q5: We have a special program to train the staff mastering new knowledge

Q6: We have official policies and procedures to guide information release among the enterprise's internal departments

Q7: We have special procedures and practices to help staff digest new knowledge and combine it with the existing knowledge

Q8: We often organize cross-department meetings to discuss and gain new knowledge

Q9: We have an internal knowledge management platform (such as discussion BBS, information release platform, or database)

Q10: We use cross-functional teams to deal with new knowledge and make decisions about products and process design

AC3: Knowledge application

Q1: Our employees often put forward suggestions to improve our products and processes based on new knowledge

Q2: We regularly assess our investment and resource allocation decisions based on new knowledge

Q3: We have a programmed mechanism to help to find new business opportunities from new knowledge

Q4: We regularly evaluate and adjust our long-term forecasts based on the market trend and technological development and other new knowledge

Q5: We have a systematic program that applies new technology to develop new products

Q6: We have a systematic program that applies new technology to improve and/or develop processes

Q7: We have been thinking about how to use new knowledge to improve existing operational efficiency and effectiveness

Q8: We have special organizations responsible for improving our ability to apply new knowledge (such as a technology center, R&D center)

Q9: We don't have a computer-based decision support system
Q10: We always consider how to use new knowledge in a better way
Q11: We have special practices and structured programs to store and record new knowledge

Business performance
BP1: Financial performance
Q1: Return on investment (ROI)
Q2: Return on sales (ROS)
Q3: The market share
Q4: Inventory turnover
BP2: Customer satisfaction
Q1: The quality of the products
Q2: The customer service level
Q3: Pre-sale service of the product
Q4: After-sale service of the product
Q5: Speed of delivery
Q6: The reliability of the delivery date
BP3: Potential operational performance
Q1: The ability to adapt to the production volume change
Q2: The ability to offer a variety of product portfolios
Q3: The ability to provide new products rapidly
Q4: The ability to improve existing products/services gradually
Q5: The ability to change existing products/services completely
Q6: The ability to improve the existing process flow gradually
Q7: The ability to change the existing process flow completely
Q8: The ability to design and develop new products/services based on new technology
Q9: The ability to enhance competitive advantages through innovation

Innovation
IN1: Compared to competitors, we introduce more new products
IN2: Improvements to our new products result in very good market reactions
IN3: Our new products have high technology content
IN4: Compared to competitors, we introduce more new production operation modes
IN5: In the development of new products, our input-output efficiency is very high
IN6: We have first-class craftsmanship and processes

Mass customization capability
MC1: We are highly capable of large-scale product customization
MC2: We can easily add significant product variety without increasing costs
MC3: We can customize products while maintaining high volume
MC4: We can add product variety without sacrificing quality
MC5: We can adjust our process design based on customer demand without significantly increasing cost
MC6: We can adjust our supply chain design based on customer demand without significantly increasing cost
MC7: We can adjust our product design based on customer demand without significantly increasing cost

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