Inzinerine Ekonomika-Engineering Economics, 2021, 32(5), 499–516

The Impact of E-Commerce Sales on Capacity Utilization

Xuechang Zhu[1], Hui Shang[2], Zhen Dai[3], Bin Liu[4,*]

[1]*School of Management, Tianjin University of Technology*
391 Bin Shui Xi Dao Road, Xiqing District, Tianjin City, China
E-mail. zhuxuechang1123@126.com

[2]*School of Economics, Zhejiang Gongshang University*
18, Xuezheng Str., Xiasha University Town, Hangzhou City, China
E-mail. shanghui@mail.zjgsu.edu.cn

[3,4]*China Institute for WTO Studies, University of International Business and Economics*
10, Huixin Dongjie, Chaoyang District, Beijing City, China
E-mail. [3]daizhen@uibe.edu.cn; [4]liubin@uibe.edu.cn (Corresponding author)*

crossref http://dx.doi.org/10.5755/j01.ee.32.5.28508

This study aims to examine the relationship between e-commerce sales and capacity utilization in China, with process innovation being the mediator and product focus being the moderator. A mediated moderation model was developed and tested using data from 804 Chinese manufacturing firms as well as two-stage least squares regression analysis. The results reveal that the relationship between e-commerce sales and capacity utilization is negative; while process innovation mediates this relationship. Furthermore, product focus not only moderates the relationship between e-commerce sales and capacity utilization, but also moderates the relationship between process innovation and capacity utilization. These findings are useful for decision-makers when formulating e-commerce sales strategies and focusing on process innovation that will help them achieve higher capacity utilization. This paper contributes to existing research by validating process innovation as mediator and product focus as moderator between e-commerce sales and capacity utilization.

Keywords: *E-commerce Sales; Process Innovation; Product Focus; Capacity Utilization; Manufacturing Firms; Mediated Moderation Model.*

Introduction

Along with the vigorous development of information and communication technology (ICT), managers of manufacturing firms view e-commerce sales as a significant driver of market expansion. Especially under the impact of COVID-19, the non-contact features of e-commerce sales are increasingly favored by managers. As a result of low entry cost, e-commerce sales are an avenue through which managers seek market competition, establishing links with new trading partners (Eyers & Potter, 2015). In fact, managers always regard e-commerce sales as a marketing tool rather than the opportunity to improve production management (Liu *et al.*, 2015; Wang, 2014). Then, it may be difficult for manufacturing firms to play an active role in e-commerce sales to improve operational performance, especially in terms of capacity utilization. To be specific, the substitution effect of e-commerce sales on offline sales may eventually reduce market share (Duch-Brown *et al.,* 2017; Lorca *et al.,* 2019), resulting in idle capacity and reduced capacity utilization. Meanwhile, with the increasing diversification of consumer demands and the intensification of market competition, the timely delivery of diversified products has become the key to attaining competitive advantage. Obviously, low-level production process management make it tough for manufacturing firms with e-commerce sales to meet consumer demand in a timely manner (Crespo & Bosque, 2010), resulting in demand mismatch and waste of production capacity. Taking into account the importance of capacity utilization for manufacturing firms in emerging market, it is of great significance to explore the impact of e-commerce sales on capacity utilization.

An abundance of prior studies argued the positive impact of ICT on capacity utilization (Nightingale, 2003; Marini & Pannone, 2007). However, recent study alike suggests that ICT is negatively related to capacity utilization (Yeo & Grant, 2019). The mixed results suggest that ICT does not always improve capacity utilization. Meanwhile, the application of ICT has evolved into a more complex e-commerce sales filed. To this end, exploring the impact of e-commerce sales on capacity utilization may help to better understand these mixed results. However, research into e-commerce sales and capacity utilization remains nascent. In addition, despite researchers have made significant progress in understanding the role of process management in impacting capacity utilization (Klarin *et al.,* 2010; LaGanga, 2011), they did not provide clear guidance on how process management mediates the relationship between e-commerce sales and capacity utilization from the perspective of process innovation.

Identifying how e-commerce sales act upon process innovation is particularly important in the emerging market context, where process improvement is not as important as in developed economies. Furthermore, considering the important role of product diversification in meeting customer need, little is known about the moderating effect of product focus on the link between e-commerce sales and capacity utilization. Therefore, the aim of this study is to add to our understanding of capacity utilization by investigating the impact of e-commerce sales on capacity utilization, with a focus on the mediating role of process innovation and the moderating role of product focus. Results of this research are central to the field of operations management and of high practical relevance. However, empirical evidence remains scare.

This study contributes to existing literature in three ways. First, this study broadens our view of the interface between the application of ICT and operational performance by exploring the impact of e-commerce sales on capacity utilization in the context of Chinese manufacturing firms. Our results provide the empirical evidence for the negative relationship between e-commerce sales and capacity utilization, deepening our understanding of why manufacturing firms with e-commerce sales in emerging markets experience low capacity utilization. Second, this study provides a better understanding of how e-commerce sales contribute to capacity utilization from the perspective of process innovation. Our results suggest that process innovation can significantly mediate the relationship between e-commerce sales and capacity utilization. Identifying process innovation as a mediating process may advance understanding of the relationship between the application of ICT and capacity utilization. Finally, this study theorizes and empirically confirms the importance of the context within which e-commerce sales is associated with capacity utilization. We find that product focus not only moderates the relationship between e-commerce sales and process innovation, but also moderates the process innovation-capacity utilization linkage. As a result, we further confirm that process innovation mediates the moderating effect of product focus on the relationship between e-commerce sales and capacity utilization.

This study develops a mediated moderating model to explore the impact of e-commerce sales on capacity utilization. To validate our model, we rely on information collected from the 2012 World Bank Enterprise Survey in China, and conduct an empirical study of 804 Chinese manufacturing firms across multiple industries. To mitigate potential endogenous problems, we apply the instrumental variable (IV) method and employ the two-stage least squares (2SLS) estimator to make the empirical analysis. Empirical results provide detailed insight into the linkages among e-commerce sales, process innovation, product focus, and capacity utilization, thereby contributing to the theory development of ICT-capacity utilization linkage.

The rest of the paper is structured as follows. The background and hypotheses development are provided in Section 2. Then, we present the research methodology in Section 3. In Section 4, we provide empirical results to test our hypotheses. Lastly, we end the paper with our conclusions, limitations, and opportunities for future research in Section 5.

Literature Review

Capacity Utilization

Given the importance of productive capacity in the sustainable development of enterprises, capacity utilization has been one of the central areas in the operations management (OM) literature. Top managers pay significant attention to capacity utilization because of its crucial role in evaluating production expansion and efficiency gains (Adeyemi & Olufemi, 2016). Meanwhile, capacity utilization is also an important factor in projecting potential output and optimizing resource allocation (Jakubovskis, 2017). It is not surprising, therefore, that capacity utilization has always been central to understanding the operating situation of manufacturing firms. Traditionally, capacity utilization is defined as the ratio of actual capacity to potential capacity generated by installed equipment if capacity was fully utilized (Yang *et al.,* 2019).

The vast literature on capacity utilization has identified several main factors. Concretely, it is well known that market demand is an important determinant of capacity utilization. As a result, enterprises accompanied with large market share or market concentration usually enjoy higher capacity utilization (Escobari & Lee, 2014). That is, the greater the market demand, the less idle capacity, which increases capacity utilization. However, as argued by Guan et al. (2009), enterprises prefer to choose idle capacity under high market demand fluctuations. As such, reducing idle capacity can be a good way to increase capacity utilization. In doing so, production flexibility has started suffering valuing. It is argued that enterprises with better production flexibility can immediately modify production possibilities and adjust idle capacity in response to changes in demand, thereby enjoying higher capacity utilization (Alvarez-Lois, 2005). However, this positive impact of production flexibility on capacity utilization depends on demand correlation and the inability to fully utilize capacity (Jakubonskis, 2017). Similarly, researchers have built on theory of constraints of the firm to argue that resource constrains, such as market constrains, labor constrains, or equipment constrains, force managers to think smarter and be more innovative to achieve more with fewer resources by improving capacity utilization (Nyaoga *et al.,* 2015). In addition, to reduce idle capacity and increase capacity utilization, the availability of input production factors such as raw materials cannot be ignored (Akindipe, 2014). Other relative determinants, such as inventory, working capital and labor, are also very important for capacity utilization (Liu *et al.,* 2013; Yang *et al.,* 2019). Meanwhile, lowering the uncertainty of market demand is also an effective way to reduce idle capacity, which helps to improve capacity utilization, but it relies on accurately capturing market information (Salim, 2008; Escobari & Lee, 2014). Therefore, considering the importance of the application of ICT in improving production flexibility and market information collection capabilities (Ali & Kumar, 2011; Gao *et al.,* 2012), it is interesting to explore the role of e-commerce sales in affecting capacity utilization.

E-Commerce Sales

E-commerce sales, as a subset of e-commerce, refer to the sales of goods or services conducted over computer-mediated network. With the rapid development of ICT, e-commerce sales have become increasingly important for manufacturing firms due to providing a useful and convenient platform to better promote and distribute their products. This is because e-commerce sales not only allow consumers to shop anytime and anywhere, but also allow manufacturers to effectively transfer relevant product information to potential buyers (Liu *et al.,* 2013; Hamad *et al.,* 2018). It is also argued that e-commerce sales are a low-cost means of product advertising and marketing (Kim *et al.,* 2016; Alsaad *et al.,* 2019; Zhou, 2020). Furthermore, e-commerce sales play an important role in enabling manufacturers to more accurately capture customer preferences to enhance product differentiation and soften price competition (Wang *et al.,* 2016; Stefko *et al.,* 2019). In this view, increased e-commerce sales may exert a positive impact on performance. Concretely, it is argued that increasing e-commerce sales are closely related to better profitability (Popa *et al.,* 2018; Ibrahim *et al.,* 2019). Similar results hold apply to their impact on innovation (Bogue, 2016; Mu *et al.,* 2021). Meanwhile, from the perspective of cost reduction, it is believed that e-commerce sales can help reduce information search costs and transaction costs (Xuhua *et al.,* 2019), thereby contributing to improve operational efficiency (Liu *et al.,* 2021). In addition, recent research also focuses on the positive impact of e-commerce sales on energy saving and emission reduction (Dost & Maier, 2017; Zhao *et al.,* 2019; Chen & Yan, 2020).

Obviously, e-commerce sales seem to offer manufacturers new ways to open up new business opportunities and expand product markets (Savrul *et al.,* 2014). However, this market expansion effect of e-commerce sales does not apply to all situations. Some studies have pointed out that e-commerce sales have a substitution effect on offline sales (Hernant & Rosengren, 2017; Duch-Brown *et al.,* 2017; Lorca *et al.,* 2019).

ICT and Capacity Utilization

As mentioned above, the relationship between e-commerce sales and capacity utilization may be mixed. Interestingly, studies that examine this relationship are missing, creating a gap in the literature. A few existing relative studies focus more on the relationship between ICT and capacity utilization. Concretely, although the positive impact of ICT on capacity utilization has long been formulated, research on the impact of specific types of ICTs has been slow. Contretely, Nightingale (2003) confirmed that enterprises benefiting from IT control systems can achieve increased capacity utilization. Similarly, as noted by Hubbard (2003), on-board computer can reduce demand uncertainty, and improve communication and resource allocation decisions, increasing capacity utilization by 3 % in trucking industry. Furthermore, Marini and Pannone (2007) demonstrated the positive impact of ICT-assisted productions on capacity utilization by using a framework to analyze capital and capacity utilization in production processes. However, Yeo and Grant (2019) regarded the percentage of companies using email to interact with clients and suppliers as ICT indicator, and confirmed the negative impact of ICT on capacity utilization. Although these studies have provided valuable insights, their emphasis on the mixed relationship between ICT and capacity utilization has resulted in a limited understanding of the role of e-commerce sales.

In addition, Considering the correlation between productivity and capacity utilization, research on the relationship between ICT and productivity may provide preliminary evidence for the impact of e-commerce sales on capacity utilization. Concretely, it is argued that the adoption of ICT helps enterprises enjoy a higher labor-productivity (Kılıcaslan *et al.,* 2017). Similarly, Brambilla and Tortarolo (2018) also indicated that the use of ICT contributes to enhance productivity, especially for the initial high-productivity and high-skilled firms. In this vein, e-commerce sales may be positively associated with productivity growth. However, some studies also argued that e-commerce sales have little or no impact on productivity (Kim *et al.,* 2021). Therefore, e-commerce sales may not always promote productivity growth, which may apply equally to capacity utilization.

Research Model and Hypotheses Development

Model Development

Early works in ICT and OM provided equivocal preliminary evidence for investigating the link between e-commerce sales and capacity utilization (Yeo & Grant, 2019). To explain these mixed results, researchers have built on the competitive advantage theory to argue that e-commerce sales can efficiently enable manufacturers to complete transactions at low cost (Hamad *et al.,* 2018; Zhou, 2020). In addition, according to the theory of customer behavior, e-commerce sales can help increase loyalty by capturing customer preference in a timely manner (Tzavlopoulos *et al.,* 2019). Meanwhile, online and offline marketing conflicts based on game theory provides an explanation for the negative impact of e-commerce sales on performance (Duch-Brown *et al.,* 2017; Lorca *et al.,* 2019). To this end, focusing on how the link between e-commerce sales and capacity utilization is necessary, the emerging consensus in the ICT literature is that it is important to evaluate the role of e-commerce sales in changing production process management to impact firm performance.

Manufacturing firms in emerging markets are increasingly adopting e-commerce sales (Phang *et al.,* 2019). In fact, compared with marketing management, manufacturing firms usually do not attach importance to production and operation management. Ignoring production and operation management makes them view e-commerce sales more as a marketing tool rather than a measure to improve production process management. Moreover, declining international demand and increasing demand diversification have made manufacturing firms in emerging market face greater market competition, leading to waste of production capacity. Hence, Low-cost e-commerce sales have become an effective means for manufacturing firms to expand sales channels. However, the ensuing price competition reduce profitability and the motivation for

product process improvement such as process innovation, which may ultimately damage capacity utilization. Research in the OM literature shows that process innovation helps to smooth the production process and solve production problems, leading to more efficient production process management (Harmon, 2010). Thus, exploring the role of process innovation can better understand the impact mechanism of e-commerce sales on capacity utilization.

Furthermore, e-commerce sales may vary depending on product diversification. On the one hand, the diversified needs of consumers pose great challenge for e-commerce sales in emerging market. On the other hand, according to the theory of diversification strategy, although product diversification can enhance the competitive advantage, it puts forward higher requirements for process management (Deligianni *et al.,* 2017). Additionally, drawing on marketing literature, product diversification can alleviate mismatch in demand (Wan *et al.,* 2012). Then, e-commerce sales with high product focus are more likely to encounter the dilemma of unsaleable products, resulting in the waste of production capacity. Therefore, in addition to the role of process innovation in impacting the link between e-commerce sales and capacity utilization, we theorize how product focus affects the relationships among e-commerce sales, process innovation and capacity utilization.

Summarizing, we investigate how e-commerce sales influences capacity utilization and examine the mediating role of process innovation, as well as the moderating role of product focus (Figure 1). we now turn to a detailed discussion of our hypothesis.

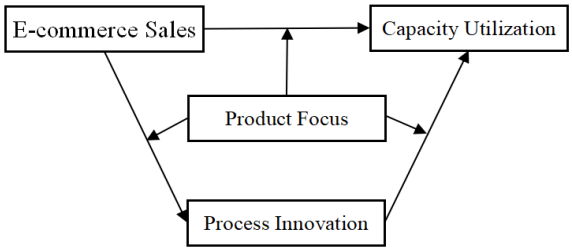

Figure 1. Conceptual Model of the Study

E-commerce Sales and Capacity Utilization

As a low-cost marketing channel, e-commerce sales provide manufacturers and customers with more convenient trading opportunities without time and geographical restrictions (Yasin *et al.,* 2006). Especially in China, the booming of e-commerce has driven most capital-constrained small and medium enterprises (SMEs), to adopt e-commerce sales as the main sales channel. Intuitively, it seems that e-commerce sales can expand new channel for online sales, but this does not mean an increase in total sales. Research on sales diversion confirmed that e-commerce sales can crowd out other offline sales channels (Fan et al., 2018). Then, total sales will decrease when the sales revenue growth from e-commerce sales is less than sales revenue decline caused by the substitution effect, resulting in insufficient capacity utilization. Meanwhile, since manufacturers need to ship products as soon as they get orders through e-commerce sales channels, they always maintain excess inventory to cope with demand shocks. However, given that consumers cannot fully experience products through e-commerce sales, it is hard for manufacturers to accurately capture consumer-specific demand preferences and their changing trends, which can easily lead to slow sales and production disruption under a competitive environment. Therefore, e-commerce sales may even end up losing sales, which may reduce the capacity utilization.

Furthermore, e-commerce sales competition for similar products is often very intense due to the relatively transparent price (Gupta, 2014). Especially in China, similar products are usually subject to competition from different manufacturers. Then, the low-price competition strategy has become the norm for e-commerce sales, which may lead to high fluctuation in demand. In that case, manufacturers have to take idle capacity as a relatively conservative strategy to cope with demand fluctuation (Guan *et al.,* 2009), which ultimately leads to a decline in capacity utilization. Meanwhile, another consequence of low-cost competition caused by e-commerce sales is that manufacturers have to take various ways to reduce costs. Manufacturers may prefer to employ mass production to achieve economies of scale, and then reduce product cost. However, since the cost savings through e-commerce sales cannot meet the consumer's demand in every style, size, and color combination at a much lower cost in the short run, the mismatch in demand may result in a large backlog of products, thereby reducing capacity utilization. In addition, compared with physical stores, customers usually cannot directly judge the quality of products through e-commerce sales. In this vein, taking into account the relatively convenient return system along e-commerce sales, customers generally return goods due to quality or price. If so, no doubt, returns will increase manufacturers' rework, defective products and inventory, which will eventually lead to a decline in capacity utilization. Therefore, we expect a negative impact of e-commerce sales on capacity utilization, and hypothesize:

H1: E-commerce sales are negatively related to capacity utilization.

Mediating Role of Process Innovation

Process innovation refers to the use of new or significantly improved production or delivery methods, including major changes in techniques, equipment and/or software (Mohnen & Hall, 2013). Then, in order to achieve process innovation, manufacturers need to purchase the right equipment or software, which usually costs a lot. Given the large investment required for process innovation, manufacturers that rely on e-commerce sales usually experience lower process innovation incentives due to greater cost pressures. Meanwhile, it is not difficult to understand that manufacturers will face more competitors in the e-commerce sales platform due to lower entry barriers. Taking into account the lack of product innovation for most Chinese manufacturers, the performance of similar products offered by different manufacturers on e-commerce platform does not differ much. In contrast, they pay more attention to price competition and achieve small profits but quick turnover through low-cost strategies. For example, during most Chinese holidays, manufacturers usually adopt a variety of marketing tools to obtain orders, such as low-cost competition, in order to gain greater market share through

e-commerce sales. Therefore, manufacturers that rely on e-commerce sales may be more interested in product marketing. In addition, general manufacturers often pursue process innovations to get orders, so they can deliver quickly after placing an order. Conversely, manufacturers that rely on e-commerce sales typically pre-produce a large number of products for promotion, which is different from the requirements of general manufacturers for product delivery capabilities. As a result, manufacturers that rely on e-commerce sales are more concerned with product marketing than process innovation. In a word, it is proposed that higher e-commerce sales may be associated with lower process innovation in China.

Additionally, process innovation is expected to be central to capacity utilization. As an important branch of enterprise innovation, process innovation is clearly more focused on the improvement of production and delivery processes (Walker, 2014). For example, the introduction of automated equipment can help improve the production assembly capability of firms, thereby reducing unnecessary waiting and waste. Hence, this process innovation is very important to ensure the normal production of personnel and equipment, which helps to improve the capability utilization. In addition, process innovation focuses on improving issues that affect production stability and addressing bottlenecks that affect delivery capabilities. This shows that, process innovation helps to smooth the production process and avoid production disruptions (Gomber *et al.,* 2018), thus increasing the capability utilization of the enterprise. Moreover, it is argued that process innovation is instrumental for the improvement of product quality, such as reducing undesirable products (Kim *et al.,* 2012). Addressing this benefit is particularly relevant in China where e-commerce sales are often filled with low-quality products. Thus, improving product quality with process innovation helps reduce product returns and rework, thereby increasing capacity utilization.

Based on these arguments above, we take a step towards understanding the relationships between e-commerce sales, process innovation, and capacity utilization. Summarizing, we propose both direct effects of e-commerce sales and process innovation on capacity utilization and indirect effects of e-commerce sales on capacity utilization through its negative effect on process innovation. Therefore, we posit the following:

H2: Process innovation mediates the relationship between e-commerce sales and capacity utilization.

Moderating Role of Product Focus in the Relationship between E-Commerce Sales and Capacity Utilization

Due to its convenient trading characteristics, e-commerce sales are receiving more and more attention from consumers. With the rapid development of economy, the demand for diversified products is getting bloomed. In doing so, product diversification has become an important trend in e-commerce sales. It is not surprising, therefore, that product focus is expected to be central to the success of e-commerce sales. Product focus, similar to the definition of *specialization rate*, is mainly used to capture the extent to which a enterprise specializes in selling particular products (Hallgren & Olhager, 2006). In general, the higher the enterprise's product focus, the lower the product diversification.

As mentioned above, we proposed the negative relationship between e-commerce sales and capacity utilization in China. That is, on one hand, the substitution effect of e-commerce sales on other sales channels may reduce the overall sales. On the other hand, the return and rework caused by low-quality products in e-commerce sales seriously affect the capacity utilization in China. Note that, e-commerce sales are usually for products that have already been produced, so only products that meet consumer needs can be sold. Thus, increasing product diversity may help avoid mismatches in demand, thereby reducing the uncertainty of e-commerce sales. Therefore, the negative impact of e-commerce sales on capacity utilization is weaker under low product focus.

In addition, the timely feedback characteristics of e-commerce sales may over-amplify product quality defects. For example, all consumers can check the e-commerce seller's reputation and evaluate certain types of products on the e-commerce platform. Obviously, reducing product focus can avoid the risk of a decline in the overall sales of the manufacturers due to the quality defects of a certain product. This is especially important for e-commerce manufacturers. Together, these arguments suggest that low product focus can alleviate the negative impact of e-commerce sales on capacity utilization. Therefore, we posit the following:

H3: Product focus can negatively moderate the relationship between e-commerce sales and capacity utilization.

Moderating Role of Product Focus in the Relationship between E-Commerce Sales and Process Innovation

In China, due to the vicious competition of similar products on the e-commerce platform, the quality of service is of paramount important for consumers' purchasing decisions, such as promptly answering customer questions, fully describing product performance, delivering products quickly, and improving after-sales service. Then, it can be seen that the improvement of service quality is closely related to process innovation. For example, with respect to a particular product, a relatively simple production and service process enables a typical manufacturer with e-commerce to meet the customer's service needs. However, for manufacturers with high product diversification, the delivery requirements of multiple products and small batches lead to more complicated production processes for manufacturers with e-commerce sales. To meet consumer's delivery needs and ensure service quality, manufacturers with e-commerce sales are paying more attention to the positive impact of process innovation on service quality. Give the negative impact of e-commerce sales on process innovation, we propose that low product focus can mitigate this negative impact.

Furthermore, a high product focus allows manufacturers with e-commerce sales to specialize on particular products, with resulting high e-commerce reliance and marketing innovation. Obviously, simple e-commerce sales functions can meet customer needs. Then, with respect to e-commerce sales, manufacturers with high product focus usually value marketing innovation over process innovation. Therefore, the effect of e-commerce sales on process innovation is weaker when product focus is high than low. Following the above, we hypothesize that:

H4: Product focus can negatively moderate the relationship between e-commerce sales and process innovation.

The Mediated Moderation Relationship

It is expected that, the production of a single product is easy to form a mature and stable production processes, which can effectively reduce the defect rate. As the saying goes, practice makes perfect, so high product focus makes manufacturers specialize in one or several products. In that case, relatively skilled workers and well-established production processes enable manufacturers to solve problems in the production process in a timely manner compared to manufacturers with low product focus. In addition, given that process innovation is instrumental for process improvement (Harmon, 2010), manufacturers with high product focus may enjoy a more stable production. As a result, high product focus contributes to avoid production interruptions and increase production stability, thus enhancing the impact of process innovation on capacity utilization. Moreover, as product diversification increases, manufacturers need a higher degree of process innovation to meet production and delivery needs. For example, products that share the same key equipment in different production processes can seriously affect production capacity. If that is the case, low product focus may increase equipment idleness and reduce delivery capacity, weakening the impact of process innovation on capacity utilization. Therefore, the effect of process innovation on capacity utilization is stronger when product focus is high than low.

Combining hypothesis 2, 3, and 4, we further propose a mediated moderation model show in Figure 1. Concretely, the relationship between e-commerce sales and capacity utilization is moderated by product focus; and this moderating effect is due to the mediating effect of process innovation on the e-commerce sales-capacity utilization linkage, and the role of product focus in moderating the relationship between e-commerce sales and process innovation, as well as the relationship between process innovation and capacity utilization. As mentioned above, we hypothesize that:

H5: Process innovation mediates the moderating effect of product focus on the relationship between e-commerce sales and capacity utilization.

Research Methodology

Data Resource

The cross-section data used in this study come from the 2012 World Bank Enterprise Survey in China conducted between December 2011 and February 2013. This is a period when China's e-commerce is booming. Samples were collected using stratified random sampling with replacement, based on face-to-face interviews and questionnaires from business owners and senior managers. Concretely, to prepare a sample for estimation, we focus on the variables listed in Table 1. Then, we dropped some unsatisfactory observations as follows: First, there is missing value in variables. Second, the registration time is not valid. Third, economically insignificant values are removed such as the capacity utilization is less than zero. Finally, all variables are trimmed at the 0.5^{th} and 99.5^{th} centile. In addition, to better capture industry fixed effects used in empirical models, we drop industries with less than 20 samples. The resulting sample contains 804 observations in 11 distinct industries, including Food, Textiles, Garments, Chemicals, Plastics & rubber, Non-metallic mineral products, Basic metals, Fabricated metal products, Machinery and equipment, Electronics, and Transport machines.

Variable Measurement

The measurement of all variables is now described. Concretely, the dependent variable is capacity utilization and the main independent variable is E-commerce sales (*Es*). The mediator variable is process innovation (*Pi*), and the moderator variable is product focus (*Pf*). In addition, the instrumental variable is the percentage of workforce that used computers three years ago (*Computerago*). Meanwhile, control variables consists of two parts, one of which involves factors affecting capacity utilization such as firm size (*Size*), firm age (*Age*), human capital (*Hc*), and the other relates to the variables of e-commerce sales decisions, such as firm size (*Size*), instrument variable (*Computerago*), growth rate of sales (*Growth*), and IT-related expenses (*It*).

To obtain a measure of capacity utilization (*Cu*), we utilize the survey question "*In fiscal year 2011, what was this establishment's output produced as a proportion of the maximum output possible if using all the resources available (capacity utilization)?*" Answers included "*capacity utilization is a%*", and "*Don't know (spontaneous) is -9*". Then, we dropped samples with the answer "*Don't know (spontaneous)*" (the value of this answer is -9), and used *a* to measure capacity utilization. Next, we measure the core independent variable of e-commerce sales (*Es*) according to answers to the question "*In fiscal year 2011, what is the percentage of sales revenue generated through Internet?*" Answers included "*Percentage of sales revenue generated through Internet is b%*", "*No sales generated through Internet is 0*", "*Don't know (spontaneous) is -9*", and "*Not applicable (spontaneous) is -7*". In the same way, we also dropped samples with value less than zero ("*Don't know (spontaneous) is -9*" or "*Not applicable (spontaneous) is -7*"), and used *b* and *0* to measure e-commerce sales. Similarly, we used *c* to capture the mediator, process innovation (*Pi*) through the answer to "*Percentage of product volume associated with new/improved processes is c%*". Then, the moderator, product focus (*Pf*) is also measured by the answer to the question "*Percentage of sales represented by main product is d%*". Note that, in order to avoid the estimation bias caused by the heteroscedasticity of the cross-section data, we performed logarithmic processing on the above four main variables. In addition, according to answer to question "*Three years ago, what percent of this establishment's workforce regularly used computers in their jobs?*", we used the percentage of workforce that used computers three year ago (*Computerago*) as instrument variable. For control variables, firm size (*Size*) is measured by the number of permanent, full-time workers end of last fiscal year entered in logs. Meanwhile, the logarithm of the number of years since the enterprises was set up is used to measure firm age (*Age*). We control for the human capital (*Hc*) through the answer to "P*ercentage of full time permanent workers who completed secondary school*". The growth rate of sales (*Growth*) is measured by calculating the

growth rate of sales revenue for the current year relative to the sales revenue three years ago. Finally, the IT-related expense (*It*) is measure by the ratio of the expense of computers and other information processing equipment to sales. Table 1 provides descriptive statistics and correlations for the data collected.

Table 1

Descriptive Statistics and Correlations

	Variable	1	2	3	4	5	6	7	8	9	10
1	Capacity utilization	1.0000									
2	E-commerce sales	-0.0734*	1.0000								
3	Process innovation	-0.0265	0.3323**	1.0000							
4	Product focus	-0.0022	-0.1838**	-0.1359**	1.0000						
5	Instrumental variable	-0.1785**	0.1188**	-0.1520**	-0.0136	1.0000					
6	Firm size	0.1153**	0.0902*	0.0498	-0.1260**	-0.0188	1.0000				
7	Firm age	0.0489	-0.0233	-0.0163	-0.0265	-0.0364	0.2468**	1.0000			
8	Human capital	-0.0197	0.2061**	0.1263**	-0.1439**	0.2396**	0.1265**	0.0262	1.0000		
9	Sale growth	-0.0434	0.0512	0.0670	-0.0118	-0.0448	0.0272	0.0001	0.0809*	1.0000	
10	IT-related expense	-0.0428	-0.0446	-0.3295**	-0.0186	0.1525*	-0.1167**	-0.0651	0.0242	-0.0478	1.0000
	Mean	4.4678	1.2860	2.6060	4.5685	0.2218	4.5616	2.6237	0.5027	0.3925	0.0179
	Standard deviation	0.1275	1.5191	1.1083	0.0861	0.1825	1.1513	0.3668	0.2733	1.1681	0.0378

*[sample size = 804. *p<0.05, **p<0.01]*

Correcting for Endogeneity

Similar to traditional arguments in the OM literature, the endogenous nature of e-commerce sales needs to be taken seriously (Liu *et al.,* 2013). For example, an endogenous bias that might arise from the fact that enterprises with low capacity utilization may be more concerned with e-commerce sales. Meanwhile, e-commerce sales may be influenced by some omitted variables which also impact capacity utilization. These endogenous problems caused by simultaneity or omitted variables might yield biased parameter estimates if ordinary least squares (OLS) regression is used. In addition, it is important to consider that enterprises may self-select whether to sell through e-commerce. It is believed that enterprises that had e-commerce sales may have enjoyed some underlying resources or capabilities than enterprises that had no e-commerce sales. Furthermore, as mentioned above, one cannot rule out the possibility, however, that enterprises that suffer from low capacity utilization may be more likely to self-select sales through e-commerce. In such a case, examining the effect of e-commerce sales versus non-e-commerce sales choice in a single-equation context may introduce a self-selection bias into our estimation. Moreover, according to the samples, about 54 % of the research samples in this article did not choose to sell through e-commerce. Obviously, ignoring such self-selection problem could bias estimations in investigating the relationship between e-commerce sales and capacity utilization.

To these concerns, we employed the IV/2SLS approach combined with a probit regression to control for the self-selection bias and endogenous problems. First, mirroring Heckman's two-step selection method, we estimated a probit regression in which the likelihood of e-commerce sales choice, denoted by *Esdum*, is regressed on a set of firm-specific variables as follows:

$$Esdum = \alpha_0 + \alpha_1 Size + \alpha_2 Growth + \alpha_3 It + \alpha_4 Computerago + \sum \alpha_j I + \varepsilon \quad (1)$$

Where *Esdum* is a dummy variable that takes the value of 1 when manufacturers have e-commerce sales, 0 otherwise; *Growth* represents the growth rate of sales revenue in the past three years; *It* denotes IT-related expenses; *Size* represents firm size; *Computerago* is the percentage of workforce that used computers three years ago. Then, we applied the estimated inverse-Mill's ratio, denoted by *Lamda*, as a control in our 2SLS estimator as followed.

Next, in order to mitigate potential endogenous problems, we employed the IV/2SLS approach to examine the direct and indirect effects of e-commerce sales on capacity utilization. As argued by Woolridge (2003), the IV must be associated with the e-commerce sales, and uncorrelated with the error term. Concretely, we identify the percentage of workforce that used computers three years ago as the IV. It is well known that e-commerce sales rely on computer-based trading network. Then, the percentage of workforce that used computers is closely related to e-commerce sales. Our argument is that the percentage of workforce that used computers three years ago is closely related to the percentage of workforce that used computers in the current year, but it would not directly impact the capacity utilization of the current year. The 2SLS estimator can be written as follows:

$$\begin{cases} Cu = \beta_0 + \beta_1 \widehat{Es} + \beta_2 Lamda + \beta_3 Controls + \sum \beta_j I + \epsilon \\ Es = \gamma_0 + \gamma_1 Computerago + \gamma_2 Controls + \sum \gamma_j I + \mu \end{cases} \quad (2)$$

Where *Cu* denotes capacity utilization; *Es* represent e-commerce sales; *Computerago* is the instrument variable; *Controls* represents control variables, including firm size (*Size*), firm age (*Age*), and human capital (*Hc*). In addition, industry fixed effects (*I*) are controlled for.

Estimation Results

Testing for Direct and Mediation Effect

Table 2 presents the results of the direct and mediation effect of e-commerce sales on capacity utilization. For completeness, we firstly examined the relationship between e-commerce sales and capacity utilization using OLS estimator in Model 1, showing that the coefficient of the e-commerce sales is significant and negative (β=-0.0255; p<0.01). Results indicate that a high ratio of e-commerce sales decreases capacity utilization. Similar OLS estimation results hold if industry fixed effects are incorporated into Model 2 (β=-0.0288; p<0.01). Next, the coefficient estimates of a 2SLS model is provided in Model 3, suggesting that e-commerce sales can negatively impact capacity utilization (β=-0.1596; p<0.01), in support of H1. The 2SLS estimation results in Model 3, compared with OLS in Model 2, show that the negative effect of e-commerce sales on capacity utilization tends to be under-estimated in the OLS fixed estimation.

Next, we hypothesized in H2 that process innovation mediates the relationship between e-commerce sales and capacity utilization. To test H2, we firstly regressed the e-commerce sales against the mediator, process innovation. Model 4 shows that, the coefficient of e-commerce sales is negative and significant (β=-1.6132; p<0.01). That is, a high ratio of e-commerce sales is not conducive to process innovation. Furthermore, combined with results in Model 3 and Model 4, we examined the mediating effect of process innovation on the relationship between e-commerce sales and capacity utilization. As mentioned above, e-commerce sales are negatively associated with process innovation (Table 2, Model 4), and also have a negative impact on capacity utilization without controlling process innovation (Table 2, Model 3). Then, we regressed both e-commerce sales and process innovation against capacity utilization to investigate the mediating role of process innovation. The results in Model 5 show that the coefficient of e-commerce sales remains negative and significant (β=-0.1359; p<0.01), while the coefficient of process innovation is positive and significant (β=0.0147; p<0.01). That is, the magnitude of the negative effect of e-commerce sales on capacity utilization is reduced after controlling process innovation (the strength of the coefficient for e-commerce sales decreased from -0.1596 to -0.1359). Then, we interpret these results as evidence that process innovation partially mediates the relationship between e-commerce sales and capacity utilization, supporting H2.

With respect to endogenous problems, the Durbin-Wu-Hausman test result are all significant according to results in Model 3 to Model 5 (p=0.0001; p=0.0000; p=0.0001), suggesting that our models have strong endogeneity. Moreover, the Kleibergen-Paap rk LM statistic are all significant (*Chi-sq(1)*=45.059, *P-val*=0.0000; *Chi-sq(1)*=45.059, *P-val*=0.0000; *Chi-sq(1)*=60.732, *P-val*=0.0000), indicating that the IV is not under-identification. Meanwhile, the value of Kleibergen-Paap rk Wald F statistic are all greater than the threshold of Stock-Yogo critical values at 10% maximal IV size (45.209>16.38; 45.209>16.38; 61.161>16.38), rejecting the null hypothesis that our models are weakly identified. Overall, these results suggest that our 2SLS estimation model are well specified and adequately defined. In addition, it should be noted that the coefficients of *Lamda* are all positive and significant, indicating the necessity of controlling self-selection bias.

Table 2

Results of the Direct and Mediation Effects of E-commerce Sales on Capacity Utilization

Variables	Model 1 Capacity utilization	Model 2 Capacity utilization	Model 3 Capacity utilization	Model 4 Process innovation	Model 5 Capacity utilization
Controls					
Firm size (*Size*)	0.0153***	0.0159***	0.0298***	0.2150***	0.0267***
	(0.0041)	(0.0041)	(0.0063)	(0.0697)	(0.0057)
Firm age (*Age*)	0.0068	0.0069	0.0071	-0.0279	0.0075
	(0.0125)	(0.0127)	(0.0140)	(0.1485)	(0.0133)
Human capital (*Hc*)	-0.0024	0.0008	0.0629**	1.1264***	0.0463*
	(0.0169)	(0.0173)	(0.0298)	(0.2968)	(0.0263)
Inverse mill's ratio (*Lamda*)	0.0392***	0.0448***	0.2708***	3.1296***	0.2249***
	(0.0137)	(0.0144)	(0.0679)	(0.7795)	(0.0539)
Direct effects					
E-commerce sales (*Es*)	-0.0255***	-0.0288***	-0.1596***	-1.6132***	-0.1359***
	(0.0072)	(0.0077)	(0.0394)	(0.4420)	(0.0320)
Mediator					
Process innovation (*Pi*)					0.0147***
					(0.0050)

Variables	Model 1 Capacity utilization	Model 2 Capacity utilization	Model 3 Capacity utilization	Model 4 Process innovation	Model 5 Capacity utilization
Industry fixed effects	No	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman test			0.0001	0.0000	0.0001
Kleibergen-Paap rk LM			45.059***	45.059***	60.732***
Kleibergen-Paap rk Wald F			45.209	45.209	61.161
Stock-Yogo critical values					
10 % maximal IV size			16.38	16.38	16.38
15 % maximal IV size			8.96	8.96	8.96
20 % maximal IV size			6.66	6.66	6.66

*[R^2 is not reported in the context of 2SLS/IV since it has little statistical meaning. ***p<0.01, **p<0.05, *p<0.1. Standard errors in parentheses]*

Testing for Mediated Moderation Effect

Mirroring Zhu et al. (2018), we employed multiple regression to examine the mediated moderation effect. Model 1 in Table 3 is the baseline model, which is used to explore the effects of controls variables on capacity utilization. When the moderator (product focus) and the core independent variable (e-commerce sales) were added to Model 2 in Table 3, results show that the coefficient of e-commerce sales is still negative and significant (β=-0.1590; p<0.01). Then, we added the interaction term between e-commerce sales and product focus into Model 3 to explore the moderating effect of product focus. Results in Model 3 indicate that product focus negatively moderates the relationship between e-commerce sales and capacity utilization (β=-0.4692; p<0.1), in support of H3.

To gain more insight into empirical results, we depicted the role of product focus in moderating the impact of e-commerce sales on capacity utilization in Figure 2. Following the methodology in Zhu et al. (2021), we started by splitting the sample into two groups based on product focus: low product focus (one standard deviation below the mean) and high product focus (one standard deviation above the mean). Then, we graphed the e-commerce sales results along the capacity utilization at both low and high level of product focus. As shown in Figure 2, the level of product focus exerts differing effects on the relationship between e-commerce sales and capacity utilization. The negative relationship between e-commerce sales and capacity utilization becomes less negative when product focus is lower than when it is higher. Thus, product focus significantly strengthens the effect of e-commerce sales on capacity utilization.

Similarly, Model 4 reveals the role of product focus in moderating the effect of e-commerce sales on process innovation. Results in Model 4 showed that the interaction term between e-commerce sales and product focus is negative and significant (β=-8.8236; p<0.01), and provided support for H4, indicating that product focus negatively moderates the relationship between e-commerce sales and process innovation. In the same way, we plotted the relationship between e-commerce sales and process innovation for low versus high product focus in Figure 3. Simple slope tests indicated that for high product focus enterprises, higher levels of e-commerce sales were associated with lower levels of process innovation. However, for low product focus enterprises, the effect of e-commerce sales on capacity utilization was much weaker. That is, when product focus is high, the negative relationship between e-commerce sales and capacity utilization is strengthened. Furthermore, based on these results estimated from Model 3 and 4, Model 5 is used to examine whether process innovation mediates the moderating effect of product focus on the relationship between e-commerce sales and capacity utilization. Results in Model 5 show that product focus negatively moderates the relationship between e-commerce sales and capacity utilization (β=-0.2818; p<0.1), while the absolute magnitude of the coefficient for the interaction term between e-commerce sales and product focus becomes smaller (the coefficient changed from -0.4692 to -0.2818). Meanwhile, results also show that the interaction term between process innovation and product focus is positive and significant (β=0.2336; p<0.05), indicating that product focus can positively moderate the relationship between process innovation and capacity utilization. According to Zhu et al. (2021), these results meet the requirements of identifying a partially mediated moderation, supporting H5. In addition, Figure 4 depicted the role of product focus in moderating the impact of process innovation on capacity utilization. As indicated in Figure 4, high levels of process innovation result in high capacity utilization when product focus is high, whereas process innovation with low product focus yield low capacity utilization. Obviously, process innovation can positively impact capacity utilization at high level of product focus. However, process innovation is negatively correlated with capacity utilization at low level of product focus.

Overall, these results indicate that the mediating effect of process innovation completely accounts for the moderating effect of product focus on the relationship between e-commerce sales and capacity utilization. In other words, the effect of e-commerce sales impacted by product focus on capacity utilization follows the path through process innovation.

Table 3

Results of Regression Analysis for Mediated Moderation

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
	Capacity utilization	**Capacity utilization**	**Capacity utilization**	**Process innovation**	**Capacity utilization**
Controls					
Firm size (*Size*)	0.0128***	0.0295***	0.0326***	0.2603**	0.0256***
	(0.0041)	(0.0064)	(0.0085)	(0.1150)	(0.0061)
Firm age (*Age*)	0.0068	0.0071	0.0079	-0.0140	0.0082
	(0.0127)	(0.0140)	(0.0168)	(0.2228)	(0.0139)
Human capital (*Hc*)	-0.0128	0.0615**	0.0846*	1.5089***	0.0507*
	(0.0169)	(0.0298)	(0.0432)	(0.5495)	(0.0294)
Inverse mill's ratio (*Lamda*)	-0.0049	0.2691***	0.3859***	5.2615***	0.2469***
	(0.0057)	(0.0674)	(0.1181)	(1.6298)	(0.0684)
Direct effects					
E-commerce sales (*Es*)		-0.1590***	-0.2253***	-2.8357***	-0.1494***
		(0.0392)	(0.0680)	(0.9255)	(0.0407)
Mediator					
Process innovation (*Pi*)					0.0130*
					(0.0069)
Moderator					
Product focus (*Pf*)		-0.0349	0.1407	1.9618	-0.5767**
		(0.0771)	(0.1786)	(2.4173)	(0.2649)
Interactions					
Es×Pf			-0.4692*	-8.8236***	-0.2818*
			(0.2397)	(3.3554)	(0.1555)
Pi×Pf					0.2336**
					(0.1043)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman test		0.0001	0.0000	0.0000	0.0004
Kleibergen-Paap rk LM		45.324***	16.010***	16.010***	32.395***
Kleibergen-Paap rk Wald F		45.777	8.610	8.610	17.175
Stock-Yogo critical values					
10% maximal IV size		16.38	7.03	7.03	7.03
15% maximal IV size		8.96	4.58	4.58	4.58
20% maximal IV size		6.66	3.95	3.95	3.95

*[R^2 is not reported in the context of 2SLS/IV since it has little statistical meaning. ***p<0.01, **p<0.05, *p<0.1. Standard errors in parentheses]*

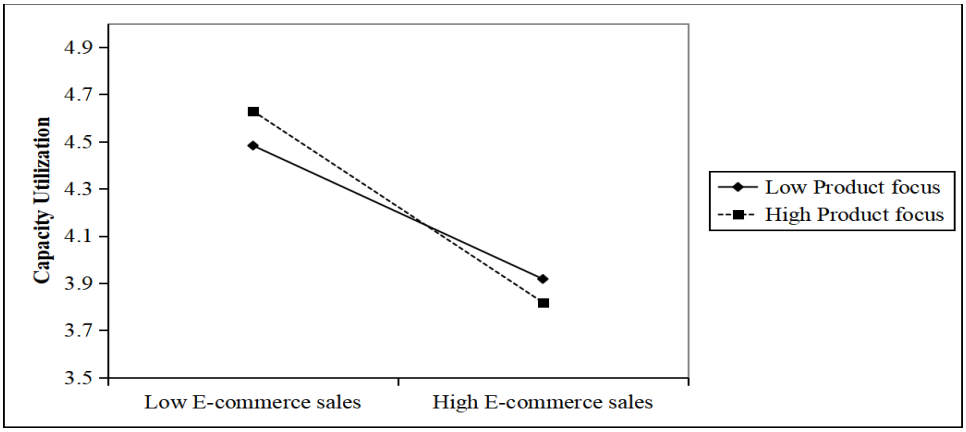

Figure 2. Moderating Effect of Product Focus on Es-Cu Relationship

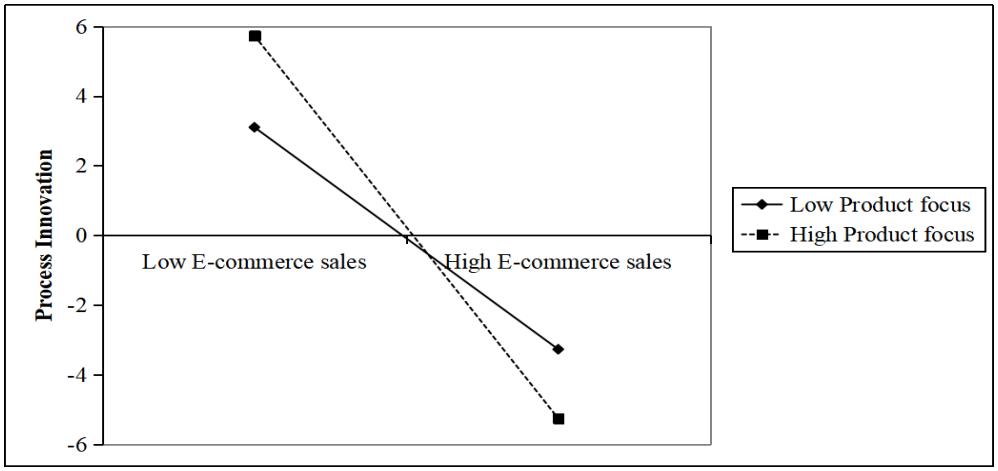

Figure 3. Moderating Effect of Product Focus on Es-Pi Relationship

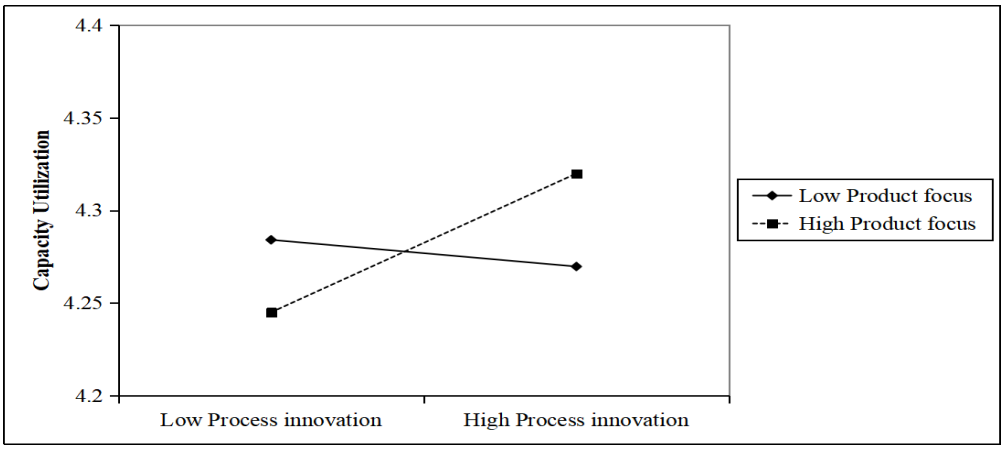

Figure 4. Moderating Effect of Product Focus on Pi-Cu Relationship

Robustness Checks

We performed three separate checks to demonstrate the robustness of our results. Concretely, we mainly repeat the mediation and mediated moderation models of our regression analysis shown in Model 3 to Model 5 in Table 2 and Table 3. The corresponding results support our previous findings and are presented in Table 4 to Table 6.

Firstly, we examine whether the alternative firm size indicator has an undue influence on the estimation results. In addition to the number of employees, we used total sales as the proxy for firm size, and replicated our mediation and mediated moderation analysis. The results of mediation analysis are provided in Model 1 to Model 3 in Table 4, indicating that signs and statistical significance of main variables remain unchanged. Meanwhile, the Model 4 to Model 6 in Table 4 provide the results of the mediated moderation analysis, suggesting that the choice of the proxy for firm size does not affect the previous estimations as all coefficients remain unchanged.

The purpose of the second robustness check is to minimize concerns that our results are susceptible to estimation bias caused by outliers. Although the 1 % outliers samples has been trimmed, we further winsorized all variables at 2.5th and 97.5th percentile, which is a widely used approach to deal with outliers in empirical operations management research. results of mediated and mediated moderation analysis are reported in Model 1 to Model 6 in Table 5 separately. Concluding, the results increase our confidence in the robustness of our results.

Finally, we examine whether our results are sensitive to variations in working time. It is believed that the working time is closely related to capacity utilization. Due to abnormal production or urgent orders, employees may have to work overtime to complete work tasks. However, working overtime may affect the ability of employees to work properly, and reduce the quality and efficiency of their work. To address this problem, we removed samples with a working time of more than 120 hours per week and replicated the mediation and mediated moderation analysis. Results are provided in Model 1 to Model 6 in Table 6 separately, and are consistent with findings before.

According to these results of robustness checks, we find robust evidence to strength and support our hypothesis. Concretely, the relationship between e-commerce sales capacity utilization is negative and significant, and is partially mediated by process innovation. Moreover, process innovation mediates the moderating effect of product focus on the linear relationship between e-commerce sales and capacity utilization.

Table 4

Robustness Check Results of Alternative Firm Size Indicator

Variables	Model 1 Capacity utilization	Model 2 Process innovation	Model 3 Capacity utilization	Model 4 Capacity utilization	Model 5 Process innovation	Model 6 Capacity utilization
Controls						
Firm size (*Size*)	0.0175***	0.1361***	0.0156***	0.0182***	0.1466**	0.0141***
	(0.0041)	(0.0426)	(0.0038)	(0.0052)	(0.0683)	(0.0040)
Firm age (*Age*)	0.0111	-0.0208	0.0114	0.0122	-0.0019	0.0124
	(0.0139)	(0.1448)	(0.0132)	(0.0165)	(0.2186)	(0.0138)
Human capital (*Hc*)	0.0648**	1.1276***	0.0486*	0.0865**	1.5223***	0.0532*
	(0.0301)	(0.2992)	(0.0266)	(0.0435)	(0.5573)	(0.0299)
Inverse mill's ratio (*Lamda*)	0.2733***	3.1386***	0.2282***	0.3868***	5.2888***	0.2514***
	(0.0683)	(0.7794)	(0.0546)	(0.1175)	(1.6411)	(0.0692)
Direct effects						
E-commerce sales (*Es*)	-0.1605***	-1.6145***	-0.1374***	-0.2253***	-2.8462***	-0.1515***
	(0.0396)	(0.4413)	(0.0324)	(0.0676)	(0.9305)	(0.0411)
Mediator						
Process innovation (*Pi*)			0.0144***			0.0131*
			(0.0050)			(0.0068)
Moderator						
Product focus (*Pf*)				0.1291	1.9419	-0.5494**
				(0.1770)	(2.4097)	(0.2670)
Interactions						
Es×Pf				-0.4610*	-8.8330***	-0.2782*
				(0.2388)	(3.3612)	(0.1573)
Pi×Pf						0.2206**
						(0.1050)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman test	0.0001	0.0000	0.0001	0.0001	0.0000	0.0004
Kleibergen-Paap rk LM	45.104***	45.104***	60.144***	16.016***	16.016***	32.271***
Kleibergen-Paap rk Wald F	44.675	44.675	59.425	8.551	8.551	16.881
Stock-Yogo critical values						
10% maximal IV size	16.38	16.38	16.38	7.03	7.03	7.03
15% maximal IV size	8.96	8.96	8.96	4.58	4.58	4.58
20% maximal IV size	6.66	6.66	6.66	3.95	3.95	3.95

*[R^2 is not reported in the context of 2SLS/IV since it has little statistical meaning. ***p<0.01, **p<0.05, *p<0.1. Standard errors in parentheses]*

Table 5

Robustness Check Results of Winsorizing Outliers

Variables	Model 1 Capacity utilization	Model 2 Process innovation	Model 3 Capacity utilization	Model 4 Capacity utilization	Model 5 Process innovation	Model 6 Capacity utilization
Controls						
Firm size (*Size*)	0.0265***	0.2336***	0.0226***	0.0285***	0.2772**	0.0211***
	(0.0057)	(0.0734)	(0.0049)	(0.0076)	(0.1215)	(0.0051)
Firm age (*Age*)	0.0039	-0.0330	0.0044	0.0045	-0.0201	0.0047
	(0.0131)	(0.1545)	(0.0122)	(0.0156)	(0.2329)	(0.0125)
Human capital (*Hc*)	0.0555**	1.1383***	0.0364	0.0732**	1.5330***	0.0382

Variables	Model 1 Capacity utilization	Model 2 Process innovation	Model 3 Capacity utilization	Model 4 Capacity utilization	Model 5 Process innovation	Model 6 Capacity utilization
	(0.0259)	(0.3000)	(0.0223)	(0.0371)	(0.5556)	(0.0242)
Inverse mill's ratio (*Lamda*)	0.2576***	3.1516***	0.2049***	0.3533***	5.2987***	0.2134***
	(0.0573)	(0.7834)	(0.0438)	(0.1010)	(1.6424)	(0.0549)
Direct effects						
E-commerce sales (*Es*)	-0.1508***	-1.6265***	-0.1236***	-0.2057***	-2.8578***	-0.1292***
	(0.0333)	(0.4443)	(0.0260)	(0.0581)	(0.9330)	(0.0326)
Mediator						
Process innovation (*Pi*)			0.0167***			0.0136**
			(0.0043)			(0.0058)
Moderator						
Product focus (*Pf*)				0.0936	1.9973	-0.5961***
				(0.1354)	(2.4154)	(0.2174)
Interactions						
Es×Pf				-0.3928**	-8.8348***	-0.2032*
				(0.1917)	(3.3723)	(0.1118)
Pi×Pf						0.2236***
						(0.0788)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Kleibergen-Paap rk LM	44.899***	44.899***	60.604***	15.960***	15.960***	32.536***
Kleibergen-Paap rk Wald F	45.308	45.308	61.389	8.581	8.581	17.254
Stock-Yogo critical values						
10% maximal IV size	16.38	16.38	16.38	7.03	7.03	7.03
15% maximal IV size	8.96	8.96	8.96	4.58	4.58	4.58
20% maximal IV size	6.66	6.66	6.66	3.95	3.95	3.95

*[R^2 is not reported in the context of 2SLS/IV since it has little statistical meaning. ***p<0.01, **p<0.05, *p<0.1. Standard errors in parentheses]*

Table 6

Robustness Check Results of Dropping Working Overtime Samples

Variables	Model 1 Capacity utilization	Model 2 Process innovation	Model 3 Capacity utilization	Model 4 Capacity utilization	Model 5 Process innovation	Model 6 Capacity utilization
Controls						
Firm size (*Size*)	0.0301***	0.2158***	0.0270***	0.0334***	0.2700**	0.0260***
	(0.0065)	(0.0714)	(0.0058)	(0.0089)	(0.1217)	(0.0063)
Firm age (*Age*)	0.0048	-0.0315	0.0053	0.0054	-0.0215	0.0060
	(0.0144)	(0.1531)	(0.0137)	(0.0174)	(0.2335)	(0.0143)
Human capital (*Hc*)	0.0645**	1.1503***	0.0477*	0.0855**	1.5217***	0.0509*
	(0.0296)	(0.2981)	(0.0260)	(0.0434)	(0.5626)	(0.0290)
Inverse mill's ratio (*Lamda*)	0.2722***	3.1981***	0.2256***	0.3938***	5.4565***	0.2480***
	(0.0684)	(0.7885)	(0.0539)	(0.1226)	(1.7102)	(0.0686)
Direct effects						
E-commerce sales (*Es*)	-0.1597***	-1.6403***	-0.1358***	-0.2295***	-2.9417***	-0.1499***
	(0.0396)	(0.4459)	(0.0319)	(0.0706)	(0.9712)	(0.0408)
Mediator						
Process innovation (*Pi*)			0.0146***			0.0133*

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	Capacity utilization	Process innovation	Capacity utilization	Capacity utilization	Process innovation	Capacity utilization
			(0.0051)			(0.0071)
Moderator						
Product focus (*Pf*)				0.1371	1.9863	-0.5895**
				(0.1835)	(2.5191)	(0.2677)
Interactions						
Es×*Pf*				-0.4846*	-9.1314***	-0.2866*
				(0.2496)	(3.5314)	(0.1574)
Pi×*Pf*						0.2364**
						(0.1060)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Durbin-Wu-Hausman test	0.0001	0.0000	0.0001	0.0001	0.0000	0.0004
Kleibergen-Paap rk LM	44.542***	44.542***	60.658***	14.961***	14.961***	31.471***
Kleibergen-Paap rk Wald F	44.870	44.870	61.174	8.084	8.084	16.668
Stock-Yogo critical values						
10 % maximal IV size	16.38	16.38	16.38	7.03	7.03	7.03
15 % maximal IV size	8.96	8.96	8.96	4.58	4.58	4.58
20 % maximal IV size	6.66	6.66	6.66	3.95	3.95	3.95

*[R^2 is not reported in the context of 2SLS/IV since it has little statistical meaning. ***p<0.01, **p<0.05, *p<0.1. Standard errors in parentheses]*

Discussion and Conclusion

This study untangles the relationships between e-commerce sales, product focus, process innovation, and capacity utilization. Summarizing the above results, all hypotheses are confirmed. E-commerce sales are negatively related to capacity utilization (H1). E-commerce sales are also negatively related to process innovation, which partially mediates the path from e-commerce sales to capacity utilization (H2). Additionally, production focus can negatively moderate the relationship between e-commerce sales and capacity utilization (H3), as well as the relationship between e-commerce sales and process innovation (H4). Moreover, product focus can also positively moderate the relationship between process innovation and capacity utilization. Given these results, this study shows that process innovation mediates the moderating effect of product focus on the relationship between e-commerce sales and capacity utilization (H5), thus offering several theoretical and managerial implications that we discuss next.

Theoretical Implications

This study offers some implications for research. Firstly, this study complements prior studies on ICT and extends the literature by focusing on e-commerce sales. The examination of the implications of e-commerce sales with capacity utilization contributes towards further understanding about the cause of low capacity utilization. We explore the impact of e-commerce sales on capacity utilization, thereby empirically supporting and advancing the theoretical development of ICT affecting production management. Earlier research, mostly qualitative, on the ICT has pointed out the positive role in improving capacity utilization (Hubbard, 2003; Marini & Pannone, 2007). However, this study provides empirical evidence for the negative impact of ICT on capacity utilization from the perspective of e-commerce sales. These findings, however, are similarly with recent study indicating that the application of ICT may reduce capacity utilization (Yeo & Grant, 2019). This interesting finding might be explained by the fact that the substitution effect caused by e-commerce sales is greater than its promotion effect on total sales in emerging markets such as China (Liu & Zhang, 2019).

Secondly, the results of this study clarify why and how process innovation matter in the relationship between e-commerce sales and capacity utilization. That is, some of the impact of e-commerce sales on capacity utilization takes place through the process innovation. This expands the body of literature addressing the mechanisms through which ICT impacts capacity utilization. Recent OM research argued that process management is critical to capacity utilization (Klarin *et al.,* 2010; LaGanga, 2011). The positive effect of process innovation on capacity utilization echoes this argument. Concretely, this study supports this argument but qualifies it by finding that process innovation accounts for the influence of product focus in the e-commerce sales-capacity utilization linkage. Results suggest that this positive effect may increase under high product focus, but decrease under low product focus. This result may be interpreted as the fact that process innovation in multi-product enterprises is more difficult. Hence, enterprises with high product focus are more likely to realize process innovation, and then enjoy high capacity utilization. In addition, the negative relationship between e-commerce sales and process innovation may partly be explained by the fact that enterprises may view e-commerce sales more as a marketing strategy, while ignoring the improvement of operational management such as process innovation.

Finally, this study extends the scope of product focus research in the context of e-commerce sales. Product focus has been widely used as a moderator in the OM literature. However, this role has not been examined in the context of e-commerce sales for capacity utilization. The empirical results show a complex moderating effect of product focus on the "e-commerce sales-process innovation-capacity utilization" relationship. Concretely, the overall moderating effect shows that manufacturing firms with high product focus may experience lower capacity utilization across all levels of e-commerce sales. This results partly support the view that mismatch in demand reduce capacity utilization (Wan *et al.,* 2012). That is, product diversification can reduce the mismatch between e-commerce sales and consumer demand, thereby avoiding product backlogs and improving capacity utilization. Moreover, the moderation relationship becomes more complicated when considering the indirect effects of e-commerce sales on capacity utilization. The negative moderating role of product focus in the e-commerce sales-process innovation linkage underscores the importance of e-commerce sales as a marketing strategy. In other words, e-commerce enterprises with high product focus usually lack motivation for process innovation due to the relatively simple production process. As mentioned above, the results of this study provide a more comprehensive understanding of the relationships among e-commerce sales, process innovation, product focus, and capacity utilization, and thus aid theory building.

Managerial Implications

This study offers some managerial implications for managers in emerging markets to carry out e-commerce sales. Managers should appreciate the importance of e-commerce sales when responding to a firm's capacity utilization. Our study reveals that e-commerce sales are negatively related to capacity utilization. This particular finding seems prudent for managers to recognize that e-commerce sales may be detrimental to capacity utilization. They need to be cautious about the substitution effect of e-commerce sales on offline sales. Meanwhile, the negative moderating results suggest that managers should focus on increasing the product diversity of e-commerce sales to improve capacity utilization.

This study also reminds managers that they should understand the importance of process innovation. The mediated moderation results suggest that process innovation not only matter in the relationship between e-commerce sales and capacity utilization, but also realize product focus's impact on the effect of e-commerce sales. Thus, managers who encourage e-commerce sales as an end in itself but neglect process innovation may not enjoy high capacity utilization. More importantly, since the effect of e-commerce sales is realized through process innovation mechanisms, our result also calls on managers to improve the production and delivery process innovation management to ensure the effect of e-commerce sales under lower product focus. Accordingly, managers of e-commerce sales enterprises should pay more attention to process innovation to improve capacity utilization, and increase product diversity to reduce capacity waste.

Limitations and Future Research

Like all research, ours is not without limitations. The following research direction are meant to be illustrative. First, this study tests the hypotheses based on Chinese manufacturing samples. Although China has many of the same features as other countries in terms of operational management and market conditions, it also has a certain degree of uniqueness. Future studies should pay more attention to other countries to extend the generalizability of our findings. Second, the data were cross-sectional. It is possible that the lower capacity utilization may not only be the impact of current e-commerce sales. The empirical results presented here are more reflected in the impact of the dependence on e-commerce sales on capacity utilization. Research using longitudinal data is needed to confirm the impact of e-commerce sales trends on capacity utilization. Finally, this study provides a negative impact of e-commerce sales on capacity utilization, and several plausible explanations were put forth. Future research could offer a better understanding of these results through qualitative interviews with e-commerce sales managers. Further, a more detailed examination of the mediating mechanism, such as the importance of marketing, could offer additional insights into the complex relationship between e-commerce sales and capacity utilization.

Acknowledgement

This work has been funded by the Humanities and Social Science Fund of Ministry of Education of China [grant numbers 20YJC630244]; the National Natural Science Foundation of China [grant numbers 71973025]; the National Natural Science Foundation of China [grant numbers 72003174].

References

Adeyemi, P. A., & Olufemi, O. B. (2016). The determinants of capacity utilization in the Nigerian manufacturing sector. *Journal of Economics and Sustainable Development*, 7(5), 20–31. http://doi.org/29301-32095-1-PB

Akindipe, O. S. (2014). The role of raw material management in production operations. *International Journal of Managing Value and Supply Chains*, 5(3), 37–44. http://doi.org/10.5121/ijmvsc.2014.5303

Ali, J., & Kumar, S. (2011). Information and communication technologies (ICTs) and farmers' decision-making across the agricultural supply chain. *International Journal of Information Management*, 31(2), 149–159. http://doi.org/10.1016/j.ijinfomgt.2010.07.008

Alsaad, A., Mohamad, R., & Ismail, N. A. (2019). The contingent role of dependency in predicting the intention to adopt B2B e-commerce. *Information Technology for Development*, 25(4), 686–714. http://doi.org/10.1080/02681102.2018.1476830

Alvarez-Lois, P. P. (2005). Production inflexibilities and the cost channel of monetary policy. Economic Inquiry, 43(1), 170–193. https://doi.org/10.1093/ei/cbi012

Bogue, R. (2016). Growth in e-commerce boosts innovation in the warehouse robot market. *Industrial Robot: An International Journal*, 43(6), 583–587. http://doi.org/10.1108/IR-07-2016-0194

Brambilla, I., & Tortarolo, D. (2018). Investment in ICT, productivity, and labor demand: the case of Argentina. *World Bank Policy Research Working Paper*, No. 8325. http://doi.org/10.1596/1813-9450-8325

Chen, W., & Yan, W. (2020). Impact of internet electronic commerce on SO^2 pollution: evidence from China. *Environmental Science and Pollution Research*, 27(20), 25801–25812. http://doi.org/10.1007/s11356-020-09027-1

Crespo, A. H., & Bosque, I. R. (2010). The influence of the commercial features of the Internet on the adoption of e-commerce by consumers. *Electronic Commerce Research and Applications*, 9(6), 562–575. http://doi.org/10.1016/j.elerap.2010.04.006

Deligianni, I., Voudouris, I., & Lioukas, S. (2017). Do effectuation processes shape the relationship between product diversification and performance in new ventures?. *Entrepreneurship Theory and Practice*, 41(3), 349–377. http://doi.org/10.1111/etap.12210

Dost, F., & Maier, E. (2018). E-Commerce effects on energy consumption: A multi-year ecosystem-level assessment. *Journal of Industrial Ecology*, 22(4), 799–812. http://doi.org/10.1111/jiec.12639

Duch-Brown, N., Grzybowski, L., Romahn, A., & Verboven, F. (2017). The impact of online sales on consumers and firms. Evidence from consumer electronics. *International Journal of Industrial Organization*, 52, 30–62. http://doi.org/10.1016/j.ijindorg.2017.01.009

Escobari, D., & Lee, J. (2014). Demand uncertainty and capacity utilization in airlines. *Empirical Economics*, 47(1), 1–19. http://doi.org/10.1007/s00181-013-0725-2

Eyers, D.R., & Potter, A.T. (2015). E-commerce channels for additive manufacturing: an exploratory study, *Journal of Manufacturing Technology Management*, 26(3), 390–411. http://doi.org/10.1108/JMTM-08-2013-0102

Fan, J., Tang, L., Zhu, W., & Zou, B. (2018). The alibaba effect: Spatial consumption inequality and the welfare gains from e-commerce. *Journal of International Economics*, 114, 203–220. http://doi.org/10.2139/ssrn.2707293

Gao, J., Zhang, C., Wang, K., & Ba, S. (2012). Understanding online purchase decision making: The effects of unconscious thought, information quality, and information quantity. *Decision Support Systems*, 53(4), 772–781. http://doi.org/10.1016/j.dss.2012.05.011

Gomber, P., Kauffman, R. J., Parker, C., & Weber, B. W. (2018). On the fintech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services. *Journal of Management Information Systems*, 35(1), 220–265. http://doi.org/10.1080/07421222.2018.1440766

Guan, Z., Kumbhakar, S. C., Myers, R. J., & Lansink, A. O. (2009). Measuring excess capital capacity in agricultural production. *American Journal of Agricultural Economics*, 91(3), 765–776. http://doi.org/10.1111/j.1467-8276.2009.01271.x

Gupta, A. (2014). E-Commerce: Role of E-Commerce in today's business. *International Journal of Computing and Corporate Research*, 4(1), 1–8.

Hallgren, M., & Olhager, J. (2006). Differentiating manufacturing focus. *International Journal of Production Research*, 44(18-19), 3863–3878. http://doi.org/10.1080/00207540600702290

Hamad, H., Elbeltagi, I., & El-Gohary, H. (2018). An empirical investigation of business-to-business e-commerce adoption and its impact on SMEs competitive advantage: The case of Egyptian manufacturing SMEs. *Strategic Change*, 27(3), 209–229. http://doi.org/10.1002/jsc.2196

Harmon, P. (2010). The scope and evolution of business process management. In *Handbook on business process management* 1 (pp. 37/81). Springer, Berlin, Heidelberg. http://doi.org/10.1007/978-3-642-45100-3_3

Hernant, M., & Rosengren, S. (2017). Now what? Evaluating the sales effects of introducing an online store. *Journal of Retailing and Consumer Services*, 39, 305–313. http://doi.org/10.1016/j.jretconser.2017.08.010

Hubbard, T. N. (2003). Information, decisions, and productivity: On-board computers and capacity utilization in trucking. *American Economic Review*, 93(4), 1328–1353. http://doi.org/10.2139/ssrn.283879

Ibrahim, W., Turyakira, P., & Katumba, P. M. (2019). E-Commerce adoption and growth of SMEs in Uganda. *International Journal of Business and Management*, 14(1), 46–54. http://doi.org/10.5539/ijbm.v14n1p46

Jakubovskis, A. (2017). Flexible production resources and capacity utilization rates: A robust optimization perspective. *International Journal of Production Economics*, 189, 77-85. http://doi.org/10.1016/j.ijpe.2017.03.011

Kilicaslan, Y., Sickles, R. C., Kayis, A. A., & Gurel, Y. U. (2017). Impact of ICT on the productivity of the firm: evidence from Turkish manufacturing. *Journal of Productivity Analysis*, 47(3), 277–289. http://doi.org/10.1007/s11123-017-0497-3

Kim, D. Y., Kumar, V., & Kumar, U. (2012). Relationship between quality management practices and innovation. *Journal of Operations Management*, 30(4), 295–315. http://doi.org/10.1016/j.jom.2012.02.003

Kim, J. G., Lee, S. W., & Choi, D. O. (2016). Relevance analysis online advertisement and e-commerce sales. *Journal of the Korea Entertainment Industry Association*, 10(2), 27–35. http://doi.org/10.21184/jkeia.2016.04.10.2.27

Kim, J., Park, J. C., & Komarek, T. (2021). The impact of Mobile ICT on national productivity in developed and developing countries. *Information & Management*, 58(3), 103442. http://doi.org/10.1016/j.im.2021.103442

Klarin, M., Milanovic, D. D., Misita, M., Spasojevic-Brkic, V., & Jovovic, A. (2010). A method to assess capacity utilization in short cycle functional layouts. Proceedings of the Institution of Mechanical Engineers, *Part E: Journal of Process Mechanical Engineering*, 224(1), 49–58. http://doi.org/10.1243/09544089JPME280

LaGanga, L. R. (2011). Lean service operations: Reflections and new directions for capacity expansion in outpatient clinics. *Journal of Operations Management*, 29(5), 422–433. http://doi.org/10.1016/j.jom.2010.12.005

Liu, T. K., Chen, J. R., Huang, C. C., & Yang, C. H. (2013). E-commerce, R&D, and productivity: Firm-level evidence from Taiwan. *Information Economics and Policy*, 25(4), 272–283. http://doi.org/10.1016/j.infoecopol.2013.07.001

Liu, Y., Li, H., Peng, G., Lv, B., & Zhang, C. (2015). Online purchaser segmentation and promotion strategy selection: evidence from Chinese E-commerce market. *Annals of Operations Research*, 233(1), 263–279. http://doi.org/10.1007/s10479-013-1443-z

Liu, X.D., & Zhang, S. (2019). Home-based E-commerce and Physical Retailing: Crowding out or Spillover Effect?. *Consumer Economics*, 35(5), 43–52.

Liu, W., Zhang, J., Wei, S., & Wang, D. (2021). Factors influencing organisational efficiency in a smart-logistics ecological chain under e-commerce platform leadership. *International Journal of Logistics Research and Applications*, 24(4), 364–391. http://doi.org/10.1080/13675567.2020.1758643

Lorca, P., De Andres, J., & Garcia-Diez, J. (2019). Impact of E-Commerce Sales on Profitability and Revenue. The Case of the Manufacturing Industry. *Engineering Economics*, 30(5), 544–555. http://doi.org/10.5755/j01.ee.30.5.21254

Marini, G., & Pannone, A. (2007). Capital and capacity utilization revisited: A theory for ICT-assisted production systems. *Structural Change and Economic Dynamics*, 18(2), 231-248. http://doi.org/10.1016/j.strueco.2007.01.001

Mohnen, P., & Hall, B. H. (2013). Innovation and productivity: An update. Eurasian *Business Review*, 3(1), 47–65. http://doi.org/10.14208/BF03353817

Mu, Z., Zheng, Y., & Sun, H. (2021). Cooperative Green Technology Innovation of an E-Commerce Sales Channel in a Two-Stage Supply Chain. *Sustainability*, 13(13), 74–99. http://doi.org/10.3390/su13137499

Nightingale, P., Brady, T., Davies, A., & Hall, J. (2003). Capacity utilization revisited: software, control and the growth of large technical systems. *Industrial and Corporate Change*, 12(3), 477–517. http://doi.org/10.1093/icc/12.3.477

Nyaoga, R. B., Wang, M., & Magutu, P. O. (2015). Testing the relationship between constraints management and capacity utilization of tea processing firms: Evidence from Kenya. *Future Business Journal*, 1(1/2), 35–50. http://doi.org/10.1016/j.fbj.2015.10.001

Phang, D. CW., Wang, K., Wang, Q., Kauffman, R. J., & Naldi, M. (2019). How to derive causal insights for digital commerce in China? A research commentary on computational social science methods, *Electronic Commerce Research and Applications*, 35, 1–16. http://doi.org/10.1016/j.elerap.2019.100837

Popa, S., Soto-Acosta, P., & Perez-Gonzalez, D. (2018). An investigation of the effect of electronic business on financial performance of Spanish manufacturing SMEs. *Technological Forecasting and Social Change*, 136, 355–362. http://doi.org/10.1016/j.techfore.2016.08.012

Salim, R. A. (2008). Differentials at firm level productive capacity realization in Bangladesh food manufacturing: an empirical analysis. *Applied Economics*, 40(24), 3111–3126. http://doi.org/10.1080/00036840600994088

Savrul, M., Incekara, A., & Sener, S. (2014). The potential of e-commerce for SMEs in a globalizing business environment. *Procedia-Social and Behavioral Sciences*, 150, 35–45. http://doi.org/10.1016/j.sbspro.2014.09.005

Stefko, R., Bacik, R., Fedorko, R., Olearova, M., & Rigelsky, M. (2019). Analysis of consumer preferences related to the use of digital devices in the e-commerce dimension. *Entrepreneurship and Sustainability Issues*, 7(1), 25-33. http://doi.org/10.9770/jesi.2019.7.1(2)

Tzavlopoulos, I., Gotzamani, K., Andronikidis, A., & Vassiliadis, C. (2019). Determining the impact of e-commerce quality on customers' perceived risk, satisfaction, value and loyalty. *International Journal of Quality and Service Sciences*, 11(4), 576–587. http://doi.org/10.1108/IJQSS-03-2019-0047

Walker, R. M. (2014). Internal and external antecedents of process innovation: A review and extension. *Public Management Review*, 16(1), 21–44. http://doi.org/10.1080/14719037.2013.771698

Wan, X., Evers, P. T., & Dresner, M. E. (2012). Too much of a good thing: The impact of product variety on operations and sales performance. *Journal of Operations Management*, 30(4), 316–324. http://doi.org/10.1016/j.jom.2011.12.002

Wang, J. (2014). Opportunities and challenges of international e-commerce in the pilot areas of China. *International Journal of Marketing Studies*, 6(6), 141–149. http://doi.org/10.5539/ijms.v6n6p141

Wang, S., Cavusoglu, H., & Deng, Z. (2016). Early mover advantage in e-commerce platforms with low entry barriers: The role of customer relationship management capabilities. *Information & Management, 53(2)*, 197–206. http://doi.org/10.1016/j.im.2015.09.011

Wooldridge, J. M. (2003). Further results on instrumental variables estimation of average treatment effects in the correlated random coefficient model. *Economics letters*, 79(2), 185–191. http://doi.org/10.1016/S0165-1765(02)00318-X

Xuhua, H., Elikem, O. C., Akaba, S., & Worwui-Brown, D. (2019). Effects of business-to-business e-commerce adoption on competitive advantage of small and medium-sized manufacturing enterprises. *Economics & sociology*, 12(1), 80–366. http://doi.org/10.14254/2071-789X.2019/12-1/4

Yang, G. L., Fukuyama, H., & Song, Y. Y. (2019). Estimating capacity utilization of Chinese manufacturing industries. *Socio-Economic Planning Sciences*, 67, 94–110. http://doi.org/10.1016/j.seps.2018.10.004

Yasin, M. M., Czuchry, A. J., Gonzales, M., & Bayes, P. E. (2006). E-commerce implementation challenges: small to medium-sized versus large organisations. *International Journal of Business Information Systems, 1(3)*, 256–275. http://doi.org/10.1504/IJBIS.2006.008599

Yeo, B., & Grant, D. (2019). Exploring the effects of ICTs, workforce, and gender on capacity utilization. *Information Technology for Development*, 25(1), 122–150. http://doi.org/10.1080/02681102.2017.1383876

Zhao, Y. B., Wu, G. Z., Gong, Y. X., Yang, M. Z., & Ni, H. G. (2019). Environmental benefits of electronic commerce over the conventional retail trade? A case study in Shenzhen, China. *Science of The Total Environment*, 679, 378–386. http://doi.org/10.1016/j.scitotenv.2019.05.081

Zhou, L. (2020). Product advertising recommendation in e-commerce based on deep learning and distributed expression. *Electronic Commerce Research*, 20(2), 321–342. http://doi.org/10.1007/s10660-020-09411-6

Zhu, X., Yuan, Q., & Zhang, W. (2018). Inventory leanness, risk taking, environmental complexity, and productivity: A mediated moderation model. *Journal of Manufacturing Technology Management*, 29(7), 1211–1232. http://doi.org/10.11 08/JMTM-03-2018-0082

Zhu, X., Wang, J., Liu, B., & Di, X. (2021), Inventory stickiness, environmental dynamism, financial constraints and survival of new SMEs in China, *Journal of Manufacturing Technology Management*, 32(2), 400–422. http://doi.org/10.11 08/JMTM-11-2019-0401

Authors' Biographies

Xuechang Zhu is a lecturer at the School of Management at the Tianjin University of Technology, China. He holds a PhD in Management from Tianjin University, China. His present research interest includes e-commerce and operations performance.

Hui Shang is a lecturer at the School of Economics at the Zhejiang Gongshang University, China. She holds a PhD in Economics from University of International Business and Economics, China. Her present research interest includes e-commerce and operations performance.

Zhen Dai is an Associate Professor at the China Institute for WTO Studies at University of International Business and Economics, China. She holds a PhD in Economics from the School of International Trade and Economics, University of International Business and Economics, China. Her major is international trade. Her present research interests are in the field of economic security and international trade.

Bin Liu is a Professor at the China Institute for WTO Studies at University of International Business and Economics, China. He holds a PhD in Economics from the College of Economics, Nankai University, China. His major is international trade. His present teaching and research interests are in the field of e-commerce and international trade. He is the corresponding author.

The article has been reviewed.

Received in February 2021; accepted in December 2021.