International Journal of Sustainable Development and Planning
Vol. 15, No. 8, December, 2020, pp. 1285-1296
Journal homepage: http://iieta.org/journals/ijsdp

E-commerce Industry's R&D, Market Operating and Performance: Based on Worldwide Listed Companies' Empirical Analysis

Lin Ding[1], Wenjun Liu[2*], Cuibo Wang[2]

[1] School of Accounting, Zhongnan University of Economics and Law, Wuhan 430073, China
[2] School of Management, South-central University for Nationalities, Wuhan 430074, China

Corresponding Author Email: scun_wenjunliu@126.com

https://doi.org/10.18280/ijsdp.150815

Received: 10 June 2020
Accepted: 25 August 2020

Keywords:
E-commerce, R&D intensity, operating intensity, firms' performance

ABSTRACT

Based on the characteristics of the e-commerce industry, this paper proposes the conception of operating intensity and explores the relationships between R&D intensity, operating intensity and firms' performance. Multiple regression analysis approach is adopted based on the unbalanced panel dataset of global e-commerce listed companies in 49 countries in 2001-2015. Our findings suggest that suitable R&D intensity contributes positively to e-commerce firms' performance, and with a lag. Operating intensity contributes an inverted U shape to e-commerce firms' performance. We also find that interaction between R&D and operating intensity's effects on firms' performance is positively significant in global samples. In Group 7 sample, R&D intensity contributes positively to e-commerce firms' performance, but BRICS sample's is negative. Operating intensity contributes positively to firms' performance both in Group 7 sample and BRICS sample. Marginal utility of operating intensity on firms' performance in Group 7 sample is bigger than in BRICS. The results imply that R&D investment of e-commerce listed companies in BRIC countries has not converted to benefit, however it drags down the firms' performance.

1. INTRODUCTION

Drucker [1] states that enterprise had only two basic functions: marketing and innovation. As for e-commerce industries, the lacking of physical manufacturing processes develops the functions as R&D input and operating input, which respectively stand for "technological and innovative" intensity and "market and management" intensity. The ultimate goal of these two inputs is enhancing firms' performance, protecting investors' interests, realizing long-term and sustainable development of companies and eventually maximizing companies' values.

Technological innovation is the most significant operational section in knowledge intensive industries [2, 3], but market brands and resource channels reflect the market recognition in labor and capital intensive industries [4]. E-commerce industry, however, can be categorized in both knowledge intensive industries and capital intensive industries. Thus, it comes down to the questions of whether e-commerce firms' performance is enhanced more effectively by R&D input or by operating input. Do these two inputs have interactive effect? Are these two inputs mutually simulative to enhance an e-commerce firm's performance, or mutually constraining as to be competitors of firm's internal resources?

Up until now, while plenty of studies have investigated R&D input in high-tech industries, the majority use microscopic data at corporation level, and they follow two main study paths. One is using R&D input as a dependent variable to study the relationship between personal internal factors of senior management (such as age, education, gender) [5], external environmental factors of senior management (such as duration, ownership structure of enterprises, R&D funding source), Founder CEOs [2], corporate government [6], Entrepreneurial orientation [7] and R&D input. The other path is using R&D input as an independent variable and focusing on the relationship between R&D input and company performance [8, 9], the relationship between R&D input and stock price crash risk [10], the relationship between R&D input and productivity growth [11], and the relationship between R&D input and energy consumption [12].

Other studies use both microscopic and macroscopic data. Gorączkowska [3] examines the Polish 951 manufacturing companies in 2012-2014 and finds that nurturing environment and financial environment have important influence on business innovation. Usman [13] examines R&D investment on high tech exports in 1995-2014 of Pakistan and finds that R&D investment is positively related to exports.

However, there are very few studies about R&D input in e-commerce industry. Although e-commerce industry can be categorized into high-tech industries, quite distinctive differences exist between e-commerce industry and other high-tech industries. First, e-commerce industry is subject to "external networks," which means that companies with "large networks" obtain obvious advantages compared to those with "small networks," thus making it a priority to enhance operating input and fight for market share. Second, the main product of e-commerce companies is service, which has the features of both invisible and the marginal costs of almost zero, making it possible for the industry to be actively and effectively innovative. Third, software development (technology) is no longer the main threshold for entering e-commerce industry. Once a new pattern appears, each

company will get involved in e-commerce industry. That is to say, those that are sensitive to the market, continuously create suitable products for customers, and quickly occupy the market can gain the initiative alone.

Furthermore, advanced technology does not necessarily advance the progress of a company. Even if large amounts of R&D capital have been spent to breed high-tech outcomes, the company would still be elbowed out of the market for "doing poor jobs in operating input in e-commerce companies." This case is so common in actual e-commerce industries. Characteristics have affected inputs decisions of R&D input and operating input in e-commerce companies.

Hence, this study explores the relationships between R&D input, operating input and firms' performance. This article is organized as follows. Section 2 reviews prior literature and develops hypotheses of studies, while Section 3 illustrates the research design. Results and robustness tests are reported and discussed in Section 4. Conclusion and innovations are drawn in the final section.

2. PRIOR LITERATURE AND HYPOTHESIS

Whether e-commerce industries can stand firmly in the highly competitive market environment and gain sustainable development largely depend on the inside operational activities of the company itself. Among the company's inside operational activities, R&D input and operating input are necessary for e-commerce firms to keep long-term competitive advantages.

2.1 Relationships between R&D intensity and firms' performance

In the Schumpeterian growth theory, research and innovation are market conducts for entrepreneurs pursuing maximum profits. A company's R&D input directly affects its independent innovative capabilities, which makes it difficult for its products to be copied or replaced [14, 15]. Therefore, research and innovation are the core for the company to improve its performance and eventually surpass its competitors [16-18].

A company's engaging in R&D input, gaining innovative fruits, and obtaining super profit before engaging in a second-round R&D input make up the virtuous circle in its sustainable development [18-20]. The key section in this circle, which also decides the validity of the circle, is whether research and innovation effectively improve corporate performance. Only when the company continuously gains performance improvement brought by innovation can it be increasingly active in engaging in R&D input and can its innovation input be more effective. Hence, the significant sign for a company's innovation becoming successful is its effective enhancement of firms' performance.

However, innovation is a specialized activity that has features such as consuming great amounts of time, requiring large scale investment and being full of uncertainties [21, 22]. From the point of view of a company's internal management (micro-aspect), if R&D intensity is poorly controlled, especially when its matching conditions (including funding, management and personnel) lack sufficient satisfaction, some certain innovation might be an obstacle to the firm's performance. From the point of view of the outside environment (macro-aspect), if a company's innovative outcomes are in a poor intellectual property protection environment, large amounts of innovation funds invested by the company would be of no use at all, and certain innovations might also be an obstacle to the firm's performance.

While many scholars have already found that R&D innovation is positively correlated with firms' performance in other industries, Anwar et al. [23] examine a sample size of 309 nonprofit organizations in Pakistan, and find that process innovation and organization innovation have a positive impact on the organizations' performance. Chege et al. [24] examine 297 companies in Kenya, and find that technology innovation intensity contributes positively to firm performance, but the entrepreneur characteristic affects the firms' innovation level. Other scholars have shown a negative correlation between them. Merkley [25] researches the annual reports of listed companies covering all American industries between 1996 and 2007, and found that narrative numbers exposed by R&D are negatively correlated with performance. Some other scholars also found that R&D activities contribute an inverted U shape to firms' performance. For example, Berchicci [26] uses the dataset of Italian manufacturing listed companies between 1992 and 2004, and he found that external R&D activities contribute an inverted U shape to firms' performance. Some other scholars even found that R&D activities contribute a U shape to firms' performance. For example, Nunes et al. [27] learn that R&D activities contribute a U shape to firms' performance. They examine 463 small and medium-sized enterprises (SMEs) in 1999-2006 in America, and find that R&D intensity restricts the growth of companies at lower levels of R&D intensity and stimulates their growth at higher levels. Thus, it can be concluded that there has not been a certain conclusion about the relationship between R&D input and firms' performance.

Focusing on e-commerce industry, we may easily find from practical observation that those with large levels of market share pay more attention to innovation in different micro-segments. In e-commerce industries, both managers and general staff members agree that R&D input has a close relationship with the company's future potential values. Therefore, suitable R&D input is positively related to e-commerce firms' performance. However, as a production factor, R&D input requires lots of money. If marketing transformation and promotion cannot match innovation, an excess of R&D input may not breed profits and may even bring negative influences to the company. Hence, we predict that R&D input is positively related to firms' performance at first, and then beyond a certain point, R&D input is negatively related to firms' performance. In other words, R&D input contributes an inverted U shape to e-commerce firms' performance.

Because R&D input is an indirect way to gain profit, it has some risk. In the best of times, capitalization of R&D expenses will change into intangible assets. Intangible assets eventually become new products (services) on the market. If only the new products (services) have been welcomed by the clients, then the company can gain returns from R&D input. In each section that they are linked, such as if R&D expense could be capitalized, if the board of director could approve the new product (service) production decisions, if the new product (service) could obtain the consumer's praise in the market, there exists much risk on value judgment and valuation. However, in the worst of times, if R&D fails, R&D expense directly goes into the account of the company's expense, and then it will influence current profits and losses and eventually

reduce the company's performance. Under normal circumstances, an e-commerce company tends to be cautious and merely inputs excess R&D. Hence, in practical observation, scholars might be lacking samples with excess of R&D input. This might be why R&D input often contributes positively to e-commerce firms' performance.

In addition, R&D is a long-term activity. Thus its profits are progressive and would not result in immediate economic improvement. Thus, we predict that there is a lag between R&D input and a firm's performance. Hence, we propose:

H1. Suitable R&D intensity is positively related with e-commerce firms' performance, and between the two, there is a certain lag.

2.2 Relationships between operating intensity and firms' performance

In the past, scholars referred to the production of tangible products as "production" or "manufacturing", but they referred to the activities of providing services as "operations". Gradually, the two are collectively called "operations" in practice, then production management has evolved into operations management.

Unlike common technological companies, the core of business in an e-commerce company is its website on the Internet, which serves customers directly. In an e-commerce company, especially for those the core business of which is commercial services, many salespeople and administrative staff work together. In practice, the enterprise divides its operation teams based on business areas. The members of the operation team are responsible for all the issues of this business: including software development, operation and maintenance, customer service, etc. These men are called operators in e-commerce industry. Operators are different from R&D staff.

Therefore, we propose a concept of *operating input*, which is generally referred to as input of resources and personnel in marketing and administrative management. *Operating input* includes not only the monies spent on marketing and brand management to enhance market shares and eventually promote profitability, but also administrative fees invested by the companies to enhance planning, organizing, practicing and controlling levels.

Based on this analysis, we define operating input of e-commerce industry as the sum of management expenses and sales expenses minus R&D expenditure. To our knowledge, there is little similar research up until now.

Nevertheless, management studies related to the content included in the operating input are not in a rare. Long ago in 1963, Cyert and March [28] put forward the conception of *organizational slack*, which includes operating input, R&D expenditure and contents that are valuable but out of the necessity of manufacturing operation such as cash and securities. For a long time, studies about the relationship between organizational slack and firms' performance emerged endlessly. Due to the excessively broad contents included in organizational slack, scholars defined *absorbed slack* within organizational slack. Absorbed slack includes selling, general, and administrative expenditures and is the same as SG&A. Many studies have examined the relationship between SG&A and firms' performance. In 2010, Baumgarten et al. [29] found out that SG&A is positively related with firms' performance in American listed companies between 1980 and 2006. They also pointed out that investigating individual components of SG&A cost would be helpful in further study, and the relationship between segments components of SG&A cost and firms' performance could be examined.

In normal conditions, an e-commerce company produces intangible products. SG&A costs include almost all e-commerce expenses except for financing cost. We decide to separate SG&A cost into several parts. SG&A mainly includes sales expenditures, administrative expenditures, and R&D expenditures. Therefore, in our paper, *operating input* means the rest of SG&A costs minus R&D expenditures. In essence, this paper divides SG&A costs into two parts, R&D input and operating input, that are used to study their respective relationships with e-commerce firms' performance.

Although there are few direct studies about the relationships between e-commerce operating input and firms' performance, an important component of operating input, namely marketing expenditures, has been proved by many scholars in other industries to contribute positively to firms' performance [4, 30].

As for e-commerce companies, from practical observations, it can be easily found out that e-commerce operating input is a direct impetus to breed firms' performance and that suitable operating input should be positively related to firms' performance. However, considering the fast-changing market and quickly updated technology and services in e-commerce industry, an e-commerce company lacking suitable and reasonable R&D input is in danger of being surpassed by rising companies and of losing its initial markets and users. Thus, being an input of production factors, excessive operating input wastes a lot of company resources and fails to breed effective performance. Hence, we predict that operating intensity is positively related with firms' performance at first, and then beyond some scales, it is negatively related with firms' performance, that is, an inverted U-shape.

Unlike R&D intensity, e-commerce operating intensity is an effective way for companies to directly breed profits. That is to say, e-commerce companies tend to input large amounts of operational resources to generate large profits. Hence, samples of excessive operating intensity are easy to find. Therefore, it is common to conclude that operating intensity contributes an inverted-U shape to firms' performance.

H2: Operating intensity contributes an inverted U shape to firms' performance in e-commerce industry.

Moreover, for e-commerce companies, if matched market transition and promotion are coordinated with internal management, R&D outcomes will effectively advance companies' improvement. On the contrary, lack of coordination between operating intensity and R&D intensity can spark a fight for companies' internal resources between these two intensities, constraining the development of both.

H3: R&D intensity and operating intensity are interactive with firms' performance in e-commerce industry.

3. RESEARCH DESIGN

3.1 Data and sample

Our sample requires data from the database of Osiris worldwide listed companies of Bureau Van Dijk Company and World Development Indicators database of the World Bank. To conduct a cross-national study of the same industry, financial statement data in each country will be compared.

Osiris database provides seven templates of universal financial statements to serve three categories: industrial companies, banks and insurance companies. By using the same template, different listed companies' resources can be compared directly. In this paper, the variable from all kinds of nations is selected from the same place of one financial statement template.

We take global e-commerce listed enterprises during 2001-2015 as the research sample. To get rid of the influences on worldwide e-commerce companies by the bursting bubbles of the American Internet industries between 1998 and 2000, we choose 2001 as the start point. Since 2016, the trade conflict between China and the U.S. has gradually intensified, which has also affected the R&D investment of enterprises, especially China. Therefore, we choose 2015 as the end of data set.

Databases of these samples include both micro-level financial data and macro-level economic data of countries. The data process followed four steps,

First, we select samples using the Global Industry Classification Standard (GICS) of "451010" from the Osiris database of Bureau Van Dijk company. GICS 451010 indicates the Internet software and service industry. We obtained a sample of financial data in 1370 companies in 2001-2015.

Second, because many companies are registered in the Cayman Islands, British Virgin Islands, and Bermuda, their "Real Local Country" is in other countries. The companies registered in the Cayman Islands, British Virgin Islands, and Bermuda are actually not having business in local countries. Because there are "Main Local Country" and "Main Overseas Country or District" variables in the Osiris database, this paper delimits a "Real Local Country" variable, which is used to depict the company's main business location country. If the company belongs to a multinational corporation, then the "Real Local Country" variable is used to depict the country of the parent corporation's main business location. To avoid study bias, we regard a company's "Real Local Country" as its country. Specific steps are as follows: Step 1. We compare two variables ("Main Local Country" and "Main Overseas Country or District") from the Osiris database. If the "Main Local Country" variable is Cayman Islands, British Virgin Islands, or Bermuda, we directly assign the value of "Main Overseas Country or District" variable to be "Real Local Country". If the "Main Overseas Country or District" variable has more than one value, then we open a search engine, do a manual comparison, and find the real business location to be listed as "Real Local Country". Step 2. When the "Main Local Country" excludes Cayman Islands, British Virgin Islands, and Bermuda, (2-1) if the "Main Overseas Country or District" variable's value is missing, we directly assign the values of "Main Local Country" as "Real Local Country"; (2-2) if the "Main Overseas Country or District" variable's value is not absent, then again we open a search engine, do a manual comparison, and find the real business location to be listed as "Real Local Country". Step 3. We build a sketch of "Real Local Country". Then, we hire four postgraduates whose major is e-commerce and divide them equally into 2 groups. Two students in each group individually open search engines. If the students' results are inconsistent, they must report the inconsistent result to us. We double check and search, and ultimately get the final value of "Real Local Country".

Third, we obtain macro-economic data of each nation from the World Bank and merge this data into the previously-acquired dataset. Because data in the World Bank does not contain data of Anguilla and Taiwan, we delete 13 companies in these two areas. However, compared with other 1370 companies, the dataset deleted will not have significant influence on the samples because the 13 eliminated companies are not leading e-commerce companies.

Fourth, we delete observations that for which the variable is missing, unify unit of measurement and adjust percentages into decimal points. To avoid the influence of outliers, we winsorize the major variables. Finally, we obtain 1267 companies' unbalanced penal data from 49 countries in 2001-2015. The observations sum up to 9651.

3.2 Model and variables

To test the relationship between R&D intensity, operating intensity and companies' performance, this paper proposes two models.

$$\begin{aligned} \mathrm{ROA}_{i,t} = {} & \alpha + \beta_1 R\&D_{i,t-1} + \beta_2 Operating_{i,t} \\ & + \beta_3 Operating_{i,t}^2 + \beta_4 Size_{i,t} \\ & + \beta_5 Leverage_{i,t} \\ & + \beta_6 SalesGrowth_{i,t} \\ & + \beta_7 CapitalIntensity_{i,t} \\ & + \beta_8 lnGDP_t + \beta_9 lnIP\_receipt_t \\ & + dum\_RealCountry \\ & + dum\_year + \varepsilon_{i,t} \end{aligned} \tag{1}$$

$$\begin{aligned} & \mathrm{ROA}_{i,t} \\ & = \alpha + \beta_1 R\&D_{i,t-1} + \beta_2 Operating_{i,t} \\ & + \beta_3 Operating_{i,t}^2 + \beta_4 R\&D_{i,t-1} * Opreating_{i,t} \\ & + \beta_5 Size_{i,t} + \beta_6 Leverage_{i,t} + \beta_7 SalesGrowth_{i,t} \\ & + \beta_8 CapitalIntensity_{i,t} + \beta_9 lnGDP_t \\ & + \beta_{10} lnIP\_receipt_t + dum\_RealCountry \\ & + dum\_year + \varepsilon_{i,t} \end{aligned} \tag{2}$$

We use model (1) to test H1 and H2. On the basis of model (1), we add the cross terms of R&D intensity and operating intensity into model (2), and use model (2) to test H3.

In these models, "Return on Assets" (ROA) reflects a company's performance in the e-commerce industry. ROA is the proportion of annual total profits divided by year-end total assets. ROA reflects the return on investment of e-commerce companies. ROA means the total return of all assets providers. ROA is not affected by capital sources. Many scholars used to apply ROA to measure companies' operational performance [31].

R&D intensity is defined as the ratio of R&D expenditure scaled by sales of the current year, which is consistent with the measurement index previously used by many scholars [32]. To analyze the hysteretic nature between R&D intensity and performance, this paper tests first-order lag, second-order lag and third-order lag of R&D intensity on companies' performance. The results show that the first-order lag of R&D intensity shows stable rule. Meanwhile, many scholars all use first-order lag of R&D intensity as explanatory variables. Thus, we choose first-order lag of R&D intensity and put it into models (1) and (2). In calculation, we choose R&D expenditure variable from the memo line of income statement in Osiris database.

Operating intensity is defined as the ratio of SG&A expenditures except for R&D expenditure scaled by sales of the current year. The Osiris database uses "Other Operating Items" to measure SG&A expenditures. Therefore, we obtain

the balance of other operating items minus R&D expenditure of the current year, and then we obtain operational intensity as the ratio of balance scaled by sales of the current year.

From the data from the microscopic level, this paper controlled company size, sales growth ratio, asset-liability ratio and capital intensive ratio.

From the data from the macro-economic environment, this paper controlled GDP and receipt fees for intellectual property of each country. Even if e-commerce companies declare the business is outside the limitation of territories and can be operated worldwide, most of their main business is constrained within the scope of the country of registration because of diversities of languages, consuming habits and network speed. At present, most e-commerce companies' main business is still limited to the located country. The performance of e-commerce companies is closely related to the macro-economic environment of the countries where the main businesses are located. Many scholars usually take GDP as an important indicator to measure the overall economic situation of a country, and involve it as a control variable to mark the macro-economic environment. A country's protection of intellectual property is also of great significance to the results of e-commerce R&D intensity. If the country fails to protect the R&D results gained by companies' large investment, the R&D intensity would be of little use. In addition, use of logarithms of variables helps decrease abnormal distributions of residuals [33]. Therefore, this paper uses (GDP) and (intellectual property receipt) as two main control variables at the macro level. Moreover, there is a significant difference of companies' behavior in "Real Local Country". We control "Real Local Country" dummies and year dummies.

Table 1 shows definitions of dependent variables, explaining variables and control variables in models (1) and (2).

Table 1. Definitions of variables

Name of variables	Symbols of variables	Definitions of variables
Return on assets	ROA	Profit before tax/ total assets
R&D intensity	R&D	R&D expenditures/sales
Operating intensity	Operating	(Sales fee + management fee + other operating fee – R&D expenditures) / sales
Size	Size	ln(total assets)
Asset-liability ratio	Leverage	total liabilities / total assets
Sales growth ratio	Sales Growth	(Current-period sales- prior-period sales) /prior-period sales
Capital intensity ratio	Capital Intensity	total assets / turnover
GDP	lnGDP	ln (GDP)
Intellectual property receipt	ln IP_ receipt	ln (intellectual property receipt)

3.3 Descriptive Statistics

Table 2 shows the arithmetical means of variables of 1267 sample companies from 49 countries (or regions) finally entered into regressions. Panel A shows the mean of the sample company variables, while panel B shows the median of the sample company variables. In Table 2, two groups are distinguished, Group 7 (G7) for developed countries and BRICS 5 (B5) for emerging markets.

Table 2. Panel A Mean value of variables of sample companies divided in accordance with their "Real Local Country" in 2001-2015

Real Local Country (Number of Company)	ROA	R&D	Operating	Size	Leverage	Sales Growth	Capital intensity	lnGDP	ln IP_ receipt
US (490)	0.23	0.25	1.88	9.16	3.01	0.42	3.95	30.28	25.24
Japan (127)	0.15	0.01	0.46	10.84	0.54	0.21	1.46	29.24	23.95
Germany (34)	0.19	0.06	1.18	10.18	0.53	0.23	3.55	28.76	22.64
UK (72)	0.26	0.08	1.54	9.40	0.92	0.39	2.94	28.55	23.45
France (43)	0.16	0.01	0.61	10.14	0.55	0.33	2.47	28.50	23.09
Italy (7)	0.12	0.00	0.47	11.61	0.58	0.28	4.59	28.23	21.81
Canada (82)	0.30	0.16	2.36	7.70	2.78	0.30	3.43	27.98	21.99
G7 (855)	**0.22**	**0.15**	**1.52**	**9.35**	**2.24**	**0.37**	**3.37**	**29.62**	**24.37**
Russia (4)	0.14	0.00	0.30	12.44	0.37	-0.02	2.66	28.25	20.26
China (109)	0.17	0.11	0.88	10.83	0.75	0.47	3.24	29.42	20.15
Brazil (3)	0.26	0.00	0.51	10.24	1.07	0.16	1.40	27.79	19.13
India (17)	0.11	0.02	1.73	8.91	0.70	0.34	8.74	27.89	18.98
South Africa (5)	0.22	0.00	0.61	9.24	1.01	0.34	1.04	26.38	18.09
B5 (138)	**0.17**	**0.07**	**1.02**	**10.47**	**0.75**	**0.43**	**3.92**	**28.98**	**19.85**
Argentina (1)	0.18	0.10	0.62	12.43	0.46	0.66	1.33	26.45	18.46
Australia (80)	0.29	0.06	3.48	8.20	1.73	0.49	7.02	27.59	20.36
Barbados (1)	0.45	0.00	0.66	7.33	1.91	-0.04	0.55	22.08	14.16
Bangladesh (2)	0.11	0.00	0.28	9.05	0.24	0.22	3.88	25.27	12.34
Belgium (4)	0.13	0.02	0.27	10.47	0.60	0.26	0.99	26.76	21.25
Bulgaria (1)	0.05	0.00	0.53	8.52	0.14	-0.08	2.53	24.71	17.02
Switzerland (3)	0.19	0.19	2.25	9.88	0.30	0.06	5.06	26.86	22.74
Cyprus (2)	0.15	0.00	1.47	8.88	1.66	-0.29	3.50	23.89	16.72
Denmark (5)	0.25	0.00	0.52	9.22	0.49	0.51	1.56	26.48	21.55
Spain (5)	0.12	0.04	0.72	11.33	0.58	0.07	2.79	27.74	21.16

Real Local Country (Number of Company)	ROA	R&D	Operating	Size	Leverage	Sales Growth	Capital intensity	lnGDP	ln IP_ receipt
Finland (3)	0.24	0.01	0.85	10.01	0.85	0.18	0.97	26.06	20.82
Hong Kong (6)	0.15	0.05	0.96	10.83	0.47	0.12	4.91	26.11	19.74
Croatia (1)	0.01	0.00	0.49	10.83	0.16	-	13.48	24.78	17.00
Hungary (2)	0.26	0.00	1.79	8.29	0.51	1.26	4.10	25.60	21.37
Indonesia (3)	0.07	0.00	1.17	10.25	0.47	0.30	5.85	27.00	17.82
Ireland (2)	0.12	0.11	0.44	11.59	0.35	0.06	1.73	26.05	21.43
Israel (17)	0.19	0.21	1.03	9.86	0.68	0.26	2.19	26.03	20.47
Jordan (1)	0.13	0.00	0.52	9.33	0.81	0.39	1.22	23.41	-
Kenya (1)	0.09	0.00	0.49	10.13	0.44	0.12	1.24	24.39	17.33
Korea (29)	0.13	0.04	0.45	11.27	0.32	0.15	1.94	27.77	21.98
Luxembourg (2)	0.17	0.00	1.71	10.23	0.35	0.81	5.26	24.74	20.35
Myanmar (1)	-	-	-	5.39	4.00	-	-	24.88	16.96
Malta (1)	0.48	0.00	0.41	9.36	0.60	1.76	1.33	23.05	19.63
Malaysia (9)	0.17	0.01	1.59	9.36	0.34	0.46	4.90	26.08	18.13
Nigeria (2)	0.14	0.00	0.85	10.05	0.34	0.37	4.32	26.48	-
Netherlands (12)	0.14	0.10	1.02	10.88	0.48	0.12	2.42	27.33	23.58
Norway (7)	0.17	0.01	0.89	11.02	0.51	0.32	1.55	26.50	19.34
New Zealand (6)	0.20	0.20	2.31	8.58	1.33	0.94	2.53	25.79	19.32
Panama (1)	-	-	-	12.65	-	-	-	24.19	15.99
Philippines (7)	0.17	0.01	0.96	8.26	1.86	0.16	8.39	25.81	15.28
Poland (20)	0.14	0.00	1.03	8.68	0.49	0.23	5.06	26.91	19.42
Sweden (22)	0.23	0.01	1.53	8.97	0.47	0.52	2.86	26.89	22.42
Singapore (7)	0.27	0.00	2.62	8.81	0.86	0.48	8.08	25.96	20.54
Thailand (5)	0.18	0.00	0.51	9.73	0.41	0.07	1.30	26.30	17.42
Tunisia (1)	0.06	0.00	0.33	8.67	0.31	0.10	1.80	24.54	17.03
Vietnam (1)	0.06	0.00	0.17	11.26	0.68	1.02	9.44	25.50	-
Zimbabwe (1)	0.08	0.00	0.33	10.34	0.62	0.03	1.02	23.18	14.50
Total (1267)	0.21	0.12	1.53	9.47	1.79	0.37	3.65	28.94	22.98

Table 2. Panel B Median value of variables of sample companies divided in accordance with their "Real Local Country" in 2001-2015

Real Local Country (Number of Company)	ROA	R&D	Operating	Size	Leverage	Sales Growth	Capital intensity	lnGDP	ln IP_ receipt
US (490)	0.13	0.15	0.57	9.67	0.55	0.16	1.33	30.30	25.31
Japan (127)	0.11	0.00	0.38	10.78	0.35	0.11	0.95	29.21	24.01
Germany (34)	0.10	0.00	0.62	10.25	0.43	0.07	1.17	28.86	22.70
UK (72)	0.16	0.00	0.69	9.37	0.40	0.16	1.30	28.60	23.51
France (43)	0.10	0.00	0.53	9.95	0.53	0.13	1.12	28.61	23.27
Italy (7)	0.05	0.00	0.36	11.76	0.63	0.05	1.56	28.25	21.89
Canada (82)	0.21	0.00	0.76	7.68	0.56	0.10	0.99	28.07	22.00
G7 (855)	**0.13**	**0.05**	**0.55**	**9.79**	**0.48**	**0.14**	**1.20**	**30.07**	**24.76**
Russia (4)	0.12	0.00	0.26	14.40	0.33	-0.06	1.26	28.36	20.32
China (109)	0.12	0.04	0.41	11.14	0.33	0.25	1.90	29.66	20.43
Brazil (3)	0.15	0.00	0.43	8.97	0.87	0.08	1.30	27.97	19.06
India (17)	0.06	0.00	0.73	8.85	0.28	0.06	2.88	27.91	19.07
South Africa (5)	0.11	0.00	0.46	8.66	0.31	0.09	0.96	26.43	18.18
B5 (138)	**0.11**	**0.00**	**0.49**	**10.72**	**0.33**	**0.20**	**1.84**	**29.26**	**20.31**
Argentina (1)	0.19	0.08	0.43	12.51	0.40	0.38	1.25	26.57	18.47
Australia (80)	0.22	0.00	1.08	8.34	0.35	0.11	1.63	27.68	20.48
Barbados (1)	0.38	0.00	0.58	7.17	2.08	-0.06	0.46	22.08	14.35
Bangladesh (2)	0.07	0.00	0.22	9.15	0.19	0.11	3.69	25.24	12.70
Belgium (4)	0.13	0.00	0.24	10.80	0.68	0.17	1.00	26.84	21.20
Bulgaria (1)	0.05	0.00	0.51	8.57	0.08	-0.15	2.41	24.73	17.02
Switzerland (3)	0.09	0.00	0.75	10.24	0.27	0.01	1.48	26.89	22.74
Cyprus (2)	0.09	0.00	0.82	8.65	0.94	-0.24	1.57	23.90	16.72
Denmark (5)	0.18	0.00	0.50	9.66	0.48	0.22	1.25	26.50	21.53
Spain (5)	0.09	0.00	0.57	10.09	0.62	0.06	1.50	27.81	21.20
Finland (3)	0.13	0.00	0.84	10.17	0.67	0.08	0.90	26.14	20.55
Hong Kong (6)	0.07	0.00	0.76	10.84	0.31	0.04	3.52	26.11	19.76
Croatia (1)	0.01	0.00	0.49	10.83	0.16	-	13.48	24.78	17.00
Hungary (2)	0.26	0.00	1.76	8.26	0.36	1.26	4.19	25.60	21.44
Indonesia (3)	0.04	0.00	0.33	10.24	0.43	0.11	2.00	27.01	17.81
Ireland (2)	0.06	0.10	0.38	10.90	0.24	0.06	1.54	26.16	21.18
Israel (17)	0.12	0.17	0.54	9.72	0.42	0.08	1.36	26.10	20.56
Jordan (1)	0.07	0.00	0.39	9.35	0.83	0.35	1.25	23.35	-
Kenya (1)	0.09	0.00	0.49	10.22	0.48	0.08	1.18	24.37	17.30

Real Local Country (Number of Company)	ROA	R&D	Operating	Size	Leverage	Sales Growth	Capital intensity	lnGDP	ln IP_ receipt
Korea (29)	0.08	0.01	0.33	11.00	0.26	0.06	1.52	27.82	22.08
Luxembourg (2)	0.15	0.00	0.55	10.98	0.33	0.00	1.28	24.74	20.15
Myanmar (1)	-	-	-	5.39	4.00	-	-	24.88	16.96
Malta (1)	0.48	0.00	0.41	9.36	0.60	1.76	1.33	23.05	19.63
Malaysia (9)	0.12	0.00	0.43	9.38	0.23	0.19	1.68	26.16	18.34
Nigeria (2)	0.09	0.00	0.45	10.23	0.32	0.14	3.61	26.74	-
Netherlands (12)	0.11	0.00	0.60	10.52	0.34	0.06	1.37	27.44	24.01
Norway (7)	0.11	0.00	0.86	10.77	0.54	0.38	1.39	26.51	19.30
New Zealand (6)	0.12	0.00	1.27	9.34	0.56	0.19	0.83	25.89	19.53
Panama (1)	-	-	-	12.74	-	-	-	24.17	15.91
Philippines (7)	0.06	0.00	0.53	8.66	0.30	0.02	5.81	25.88	15.40
Poland (20)	0.07	0.00	0.28	8.47	0.46	0.00	1.17	26.99	19.65
Sweden (22)	0.16	0.00	0.73	8.67	0.47	0.14	1.30	26.93	22.48
Singapore (7)	0.15	0.00	0.75	8.30	0.41	0.15	1.27	25.98	20.55
Thailand (5)	0.14	0.00	0.44	9.92	0.33	0.07	1.16	26.38	17.83
Tunisia (1)	0.06	0.00	0.34	8.71	0.33	0.10	1.82	24.54	17.03
Vietnam (1)	0.05	0.00	0.04	11.49	0.70	-0.02	4.65	25.48	-
Zimbabwe (1)	0.03	0.00	0.34	10.31	0.64	0.01	0.95	23.24	14.50
Total (1267)	0.13	0.01	0.56	9.79	0.43	0.14	1.33	29.21	23.57

Table 2 displays several findings. First, for ROA, the mean value of G7 is 0.22, while that of B5 is 0.17, which is 0.05 smaller than that of the former. The median value of G7 is 0.13, while that of B5 is 0.11, which is 0.02 smaller than that of the former. Furthermore, the median value of G7 is nearly the same as that of worldwide companies, while B5's is a little bit smaller. It means that e-commerce companies' ROA of G7 is bigger than B5.

Second, for R&D intensity, the mean value of B5 is 0.07, while that of G7 is 0.15, which is more than twice that of the former. The median value of B5 is close to zero, while that of G7 is 0.05, which is almost five times that of the former. It means that e-commerce companies' R&D intensity of G7 is much bigger than B5.

However, inside G7, R&D intensity is unbalanced. The median value of it in the US e-commerce companies is 0.15, while that of the remaining six countries all close to zero. Similar things happen in B5. The median value of R&D intensity in Chinese e-commerce companies is 0.04, while that of the remaining four countries close to zero, too. This shows that the United States and China each occupy a leading position in the R & D investment of their respective groups.

Third, for operating intensity, the mean value of G7 is 1.52, while that of B5 is 1.02, which is 0.5 less than that of the former. The median value of G7 is 0.55, while that of B5 is 0.49, which is 0.06 less than that of the former. It means that the gap of operating intensity between G7 and B5 is very small.

Inside G7, the gap in operating intensity has narrowed: the median of operating intensity among the top three is Canada (0.76), the United Kingdom (0.69), and Germany (0.62). US e-commerce companies are ranked fourth in operating intensity (0.57). Similarly, in B5 countries, the gap in operating intensity has also narrowed: the median of operating intensity ranks among the top three are India (0.73), South Africa (0.46), Brazil (0.43), China's e-commerce companies are ranked fourth in operating intensity (0.41).

Overall, as representatives of developed countries, G7 has higher R&D intensity, more operating intensity, higher asset-liability ratio, higher GDP and more intellectual property receipts in e-commerce companies. In contrast, as representatives of emerging countries, B5 has far larger size, more sales growth and more capital intensity compared with samples worldwide. In terms of R & D investment, G7 is much larger than B5; and the two major economies are very close in terms of operating investment.

4. RESULTS

4.1 Regression results of worldwide samples

We initially estimate unbalanced sample penal dataset simultaneously by fixed effect models and random effect models. The Hausman test shows that fixed effect models bring better results than random effect models. Therefore, we report results acquired from fixed effect models.

Table 3 shows the regression results of worldwide samples applying fixed effect models. The firms' performance proxy variable is ROA. Based on the previous literature, in the first column, we list micro-level financial indexes of companies. In the second column, we add macro-economic indexes to do regression analysis. Starting from the third column, we add the main study variables step by step, aiming at exploring the relationships between R&D intensity and operating intensity with e-commerce firms' performance.

In column 1, we study the influences on firms' performance by variables in previous literature. The within R-squared value in column 1 is 0.084, which means that company-level factors of control variables have extremely limited influences on firms' performance. In column 2, we continuously input two macro factors, with R-squared value increasing a bit to 0.086. In column 3, we input linear term of operating intensity. In column 4, we input both linear term and quadratic term of operating intensity. Based on column 4, we input first-lagged R&D intensity variables into column 5. Based on column 5, we input two dummy variables, "Real Local Market" and "Year", into column 6. Column 6 shows the regression result of model (1). Compared with column 2, the R-squared value of column 6 increases drastically to 0.174, with the explanation of regression model ascending dramatically accordingly. We input cross terms of R&D intensity with operating intensity in column 7 on the basis of column 6. Column 7 shows the regression result of model (2).

According to column 6, the regression coefficient of first-lagged R&D intensity is significantly positive (β=0.169, $p<0.01$), which means that first-lagged R&D intensity is positively related with e-commerce firms' performance worldwide. Therefore, **H1 is supported**. Meanwhile, the

regression coefficient of the linear term of operating intensity is significantly positive (β=0.099, p<0.01), and its quadratic term is significantly negative (β= -0.004, p<0.01), which means that operating intensity contributes an inverted-U shape to the e-commerce firms' performance worldwide. Therefore, **H2 is supported**. According to column 7 in Table 3, the cross terms of first-lagged R&D intensity with operating intensity is significantly positive (β=0.022, p<0.01). Therefore, **H3 is supported**.

Table 3. Regression results of worldwide samples in 2001–2015

VARIABLES	Dependent Variable: ROA						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Size	-0.054***	-0.054***	-0.051***	-0.046***	-0.043***	-0.041***	-0.041***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Leverage	0.033***	0.034***	0.029***	0.029***	0.029***	0.031***	0.031***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sales Growth	-0.003	-0.003	-0.005	-0.004	-0.011***	-0.011***	-0.012***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Capital Intensity	0.001***	0.001***	-0.004***	-0.008***	-0.008***	-0.008***	-0.008***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
lnGDP		-0.007	-0.007	-0.004	-0.004	0.034**	0.034**
		(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
ln IP_ receipt		-0.000	0.004	0.002	0.002	0.024**	0.024***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Operating			0.023***	0.108***	0.102***	0.099***	0.094***
			(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
$Operating^2$				-0.004***	-0.004***	-0.004***	-0.003***
				(0.00)	(0.00)	(0.00)	(0.00)
L.R&D					0.186***	0.169***	0.112***
					(0.02)	(0.02)	(0.03)
L.R&D×Operating							0.022***
							(0.00)
dum_RealCountry						control	control
dum_year						control	control
Constant	0.742***	0.935***	0.811***	0.659**	0.630**	-0.870**	-0.862**
	(0.03)	(0.29)	(0.30)	(0.30)	(0.30)	(0.42)	(0.42)
F-statistic	116.873	79.141	71.659	90.808	88.919	39.797	39.626
Within R^2	0.084	0.086	0.106	0.147	0.161	0.174	0.180
Observations	6123	6050	5068	5068	5006	5006	5006

Note: In the brackets, there are standard errors. *, **, *** p<0.1, p<0.05, and p<0.01, respectively. Two-tailed Test.

4.2 Regression results of Group 7 and BRICS 5

This paper focuses on two sub-samples, G7 (Group 7) and B5 (BRICS 5), and studies the most representative countries within them. In G7 sub-sample, we analyze the regression results of G7, as well as that of the representative country - the United States. Similarly, in B5 sub-sample, we also analyze the regression results of B5 and China. Table 4 shows their regression results.

First, the regression results of the G7 are consistent with the worldwide sample. The result shows that the regression coefficients of R&D intensity of both G7 and the US are significantly positive, while the regression coefficient of G7 (β = 0.111, P <0.01) is a little bit larger than that of the US (β = 0.087, P <0.05). At the meantime, compared with G7, operating intensity of the US contributes a shaper inverted-U shape to firms' performance. The marginal effect on firms' performance by operating intensity of US is larger than that of G7. The regression coefficient of cross terms of R&D intensity and operating intensity of both G7 and the US are significantly positive, but the regression coefficient of G7 (β = 0.021, P <0.01) is a little bit larger than that of the US (β = 0.017, P <0.01).

Second, the regression results are more or less the same in both B5 and the worldwide sample, and the difference is only the regression coefficient of R&D intensity. The result shows that the regression coefficient of R&D intensity of B5 is significantly negative, and the absolute value of regression coefficient of B5 (β=-0.401, P<0.01) is a little bit larger than that of China (β=-0.337, P<0.05). This means that the research and development of the BRICS e-commerce companies contributes a negative effect on the companies' performance, which will lead to the lack of enthusiasm in R&D for the BRICS. At the meantime, compared with B5, operating intensity of China contributes a shaper inverted-U shape to firms' performance. The marginal effect on firms' performance by operating intensity of China is larger than that of B5. The regression coefficient of cross terms of R&D intensity and operating intensity of both B5 and China are significantly positive, but the regression coefficient of B5 (β=0.200, P<0.01) is a little bit larger than that of the China (β=0.167, P<0.01).

Third, we compare the results of e-commerce companies in China and the United States. Both the United States and China occupies an important position in their respective economies. The United States' observations account for 45.28% of G7, and China's observations account for 65.68% of B5. In R&D intensity aspect, the effect of US e-commerce companies' R & D on company performance has been well reflected, while Chinese e-commerce companies' R & D has a negative effect on company performance. It can be inferred that Chinese e-commerce companies' research enthusiasm is not high. In operating intensity aspect, both Chinese and American e-commerce companies have an inverted-U structure, but the US

"inverted U" curve is steeper, and the marginal effect of the US e-commerce company's operational investment intensity on company performance is greater than that of China. In cross terms of R&D intensity and operating intensity aspect, e-commerce companies in China and the United States are almost similar, both of which are positive. This shows that China's e-commerce companies have insufficient motivation to invest in research and development. In order to improve performance, they will spend more energy on operational investment.

Table 4. Regression results of Group 7 vs. BRICS 5 in 2001 – 2015

VARIABLES	Dependent Variable: ROA			
	G7		B5	
	US	G7	CN	B5
L.R&D	0.087**(0.04)	0.111***(0.03)	-0.337**(0.14)	-0.401***(0.13)
Operating	0.166***(0.02)	0.123***(0.01)	0.140***(0.03)	0.093***(0.02)
$Operating^2$	-0.006***(0.00)	-0.004***(0.00)	-0.005***(0.00)	-0.003***(0.00)
L.R&D×Operating	0.017***(0.01)	0.021***(0.00)	0.167***(0.06)	0.200***(0.05)
lnGDP	0.000(.)	-0.010(0.04)	0.000(.)	-0.015(0.05)
ln IP_ receipt	0.000(.)	-0.021(0.03)	0.011(0.02)	0.057***(0.02)
Size	-0.039***(0.01)	-0.034***(0.00)	-0.030**(0.01)	-0.021**(0.01)
Leverage	0.064***(0.01)	0.087***(0.01)	0.104***(0.02)	0.089***(0.02)
Sales Growth	-0.017**(0.01)	-0.016***(0.00)	-0.007(0.01)	0.005(0.01)
Capital Intensity	-0.015***(0.00)	-0.011***(0.00)	-0.004**(0.00)	-0.005***(0.00)
dum_RealCountry	control	control	control	control
dum_year	control	control	control	control
Constant	0.581***(0.08)	1.335(1.35)	0.182(0.46)	-0.285(1.33)
F-statistic	22.580	33.951	7.292	6.932
Within R^2	0.280	0.224	0.339	0.255
Observations	1482	3273	377	574

Note: In the brackets, there are standard errors. *, **, *** p<0.1, p<0.05, and p<0.01, respectively. Two-tailed Test.

4.3 Robustness test

As concluded, H1, H2 and H 3 are both supported. To test the robustness of those supported hypotheses, this paper conducts the test by inputting standard deviation of clustering robust and changing dependent variables.

4.4 Regression results of worldwide samples gained after inputting standard deviation of clustering robust

To control serial correlation heteroscedasticity that may occur in regression of fixed effect, we input two clustering algorithms into the regression analysis [34], clustering by "Real Local Country" and clustering by companies. Table 5 shows regression results of worldwide samples after inputting standard deviation of clustering robust.

Table 5 shows that clustering by "Real Local Country" and by companies both show a stable trend for main variables, continuously supporting H1, H2 and H3.

Table 5. Regression results of Worldwide samples in 2001-2015 (Input with standard deviation of clustering robust)

VARIABLES	Dependent Variable: ROA			
	Model (1)	Model (2)	Model (1)	Model (2)
L.R&D	0.169***(0.03)	0.112***(0.03)	0.169***(0.03)	0.112***(0.03)
Operating	0.099***(0.02)	0.094***(0.02)	0.099***(0.01)	0.094***(0.01)
$Operating^2$	-0.004***(0.00)	-0.003***(0.00)	-0.004***(0.00)	-0.003***(0.00)
L.R&D×Operating	-	0.022***(0.00)	-	0.022***(0.00)
lnGDP	0.034(0.02)	0.034(0.02)	0.034(0.02)	0.034(0.02)
ln IP_ receipt	0.024**(0.01)	0.024**(0.01)	0.024**(0.01)	0.024**(0.01)
Size	-0.041***(0.01)	-0.041***(0.01)	-0.041***(0.01)	-0.041***(0.01)
Leverage	0.031(0.02)	0.031(0.02)	0.031(0.02)	0.031(0.02)
Sales Growth	-0.011**(0.00)	-0.012***(0.00)	-0.011***(0.00)	-0.012***(0.00)
Capital Intensity	-0.008***(0.00)	-0.008***(0.00)	-0.008***(0.00)	-0.008***(0.00)
dum_RealMarket	control	control	control	control
dum_year	control	control	control	control
Cluster_RealMarket	cluster	cluster	-	-
Cluster _company	-	-	cluster	cluster
Constant	-0.870(0.54)	-0.862(0.54)	-0.870(0.56)	-0.862(0.56)
F-statistic	285.974	203.615	16.622	18.667
Within R^2	0.174	0.180	0.174	0.180
Observations	5006	5006	5006	5006

Note: In the brackets, there are standard errors. *, **, *** p<0.1, p<0.05, and p<0.01, respectively. Two-tailed Test.

4.5 Regression results of samples worldwide gained after changing dependent variables

Furthermore, we re-conduct regression analysis of fixed effect to analyze original companies by applying ROE ratio (Return on Equity) instead of financial index of ROA as dependent variables. By adopting the original samples of companies, regression analysis on fixed effects is conducted

once again by Model (1) and Model (2) in accordance with non-cluster, "real-market" cluster, and company cluster. The results in Table 6 continuously support the stability of H1, H2 and H3.

Table 6. Regression results of Worldwide samples in 2001- 2015 (changing dependent variables)

VARIABLES	**Dependent Variable: ROE**					
	Model (1)			Model (2)		
L.R&D	0.505***	0.505***	0.505***	0.368***	0.368***	0.368***
	(0.09)	(0.13)	(0.13)	(0.10)	(0.09)	(0.14)
Operating	0.292***	0.292***	0.292***	0.292***	0.292***	0.292***
	(0.02)	(0.04)	(0.04)	(0.02)	(0.04)	(0.04)
$Operating^2$	-0.009***	-0.009***	-0.009***	-0.009***	-0.009***	-0.009***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
L.R&D×Operating	-	-	-	0.032***	0.032*	0.032*
				(0.01)	(0.02)	(0.02)
lnGDP	0.061	0.061	0.061	0.061	0.061	0.061
	(0.06)	(0.06)	(0.08)	(0.06)	(0.06)	(0.08)
ln IP_ receipt	0.048	0.048	0.048	0.047	0.047	0.047
	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)
Size	-0.162***	-0.162***	-0.162***	-0.161***	-0.161***	-0.161***
	(0.01)	(0.03)	(0.02)	(0.01)	(0.03)	(0.02)
Leverage	2.002***	2.002***	2.002***	2.004***	2.004***	2.004***
	(0.06)	(0.11)	(0.12)	(0.06)	(0.12)	(0.12)
Sales Growth	-0.026**	-0.026	-0.026	-0.025**	-0.025	-0.025
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Capital Intensity	-0.028***	-0.028***	-0.028***	-0.029***	-0.029***	-0.029***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
dum_RealMarket	control	control	control	control	control	control
dum_year	control	control	control	control	control	control
Cluster_RealMarket	-	cluster	-	-	cluster	-
Cluster _company	-	-	cluster	-	-	cluster
Constant	-1.262	-1.262	-1.262	-1.247	-1.247	-1.247
	(1.67)	(1.49)	(2.21)	(1.66)	(1.48)	(2.23)
F-statistic	91.284	271.446	19.057	87.833	493.608	18.775
Within R^2	0.334	0.334	0.334	0.336	0.336	0.336
Observations	4848	4848	4848	4848	4848	4848

Note: In the brackets, there are standard errors. *, **, *** p<0.1, p<0.05, and p<0.01, respectively. Two-tailed Test.

5. CONCLUSION AND INNOVATION

5.1 Conclusion

These empirical results show that:

Hypothesis 1 is supported. R&D intensity of listed e-commerce companies worldwide contributes positively and significantly to the regression coefficient of firms' performance, and with a lag. But the regression results of the two sub-samples are opposite: the regression coefficient of R&D intensity in G7 is significantly positive, while that in B5 is significantly negative. This means that the e-commerce companies' R&D investments have not yet work in BRICS countries.

Hypothesis 2 is supported. Operating intensity of listed e-commerce companies worldwide contributes an inverted U shape to firms' performance. Regression coefficient of operating intensity of listed e-commerce companies worldwide in Group 7 (β=0.123) is higher than that of BRICS 5 (β=0.093). Meanwhile, the absolute value of the quadratic term of operating intensity of regression coefficient of listed e-commerce companies worldwide in Group 7 (β=-0.004) is higher than that of BRICS 5 (β=-0.003). This means that operating intensity of listed e-commerce companies worldwide in Group 7 contributes a larger slope and sharper gradient. Compared with BRICS 5, firms' performance in Group 7 is more sensitive to operating intensity. This means that operating intensity of e-commerce companies in Group 7 contributes a more fluctuant to firms' performance when variation of operating intensity remains at the same value.

Hypothesis 3 is supported. For listed e-commerce companies worldwide, the regression coefficient of cross terms of R&D intensity and operating intensity is significantly positive. This means that the relationship between R&D intensity and operating intensity is stimulating the companies' performance. The regression results of the two sub-samples of the G7 and B5 are consistent with the global sample.

5.2 Innovation and contribution

Innovation and contributions made in this paper can be seen theoretically and practically.

5.3 Theoretical innovation and contribution

First, this paper has innovation on the objective chosen. It is classic to study the relationship between R&D intensity and firms' performance, while studies of e-commerce companies are rare. Some of the existing literature either focuses on all the industries or on a certain kind of industry (such as pharmaceutical manufacturing or high-tech industries). We observe the influences on firms' performance caused by R&D intensity, operating intensity and their cross terms by analyzing a dataset of listed e-commerce companies worldwide in 2001-2015. Except for samples of worldwide companies, we especially observe two sub-samples for further

comparative studies, Group 7 (the representative of developed countries) and BRCIS 5 (representative of emerging markets), to expose their internal interaction rules.

Second, this paper has innovation on research perspective. E-commerce industry has its own characteristics, that is, a great many salespeople and managers coordinate in the work of e-commerce companies. Therefore, people tend to refer to all of them as "operators" in practical work. According to this characteristic, this paper brings out the concept of "operating intensity" to divide previous studies about the relationship between SG&A and firms' performance into two parts, namely R&D intensity and operating intensity, to observe their respective relationships with firms' performance.

Third, this paper considers both micro- and macro-factors in choosing control variables. We take into consideration both micro-level factors (size, sales growth ratio, asset-liability ratio, capital intensity ratio), and macro-level factors (GDP of "Real Local Country" and receipt of intellectual property use fees) on a company's performance. This makes the results more reliable.

5.4 Practical innovation and contribution

First, we prove that suitable R&D intensity contributes positively to e-commerce firms' performance. This means that enhancing R&D intensity helps increase financial performance in e-commerce companies and increases the recognition of capital markets to the companies, which would, in the long run, enhance the companies' sustainable development.

Second, we find that operating intensity contributes an inverted U shape to firms' performance. This means that the increase of expenditures (such as administration and sales expenditures) in the initial stage of operating intensity may promote operational efficiency and enhance firms' performance. However, once operating input resources reach a surplus, it will decrease the company's operational efficiency and finally decrease the company's performance. It can be seen that the production factors such as operational input must be in line with the actual situation of the enterprise in order to improve enterprise performance. E-commerce companies cannot expand blindly. It is unreasonable to expect improve corporate performance by increasing operational investment.

Third, there are differences in preferences among e-commerce industries in different countries. This paper finds that R&D investment needs to be combined with other supporting resources in order to have a positive impact on corporate performance. In terms of representatives of developing countries (BRICS) in this study, the positive effect of the input in research and development hasn't been shown; whereas in terms of representatives of developed countries Group of Seven (G7), the input in research and development plays a positive role on the company performance, from which it can be seen that developing countries might lack the drive to conduct research and development, but prefer to the input in operation.

5.5 Expectations

Due to the data limitation, other issues in the paper still need to be further studied.

First, by analysis, it can be seen in the paper that as for developing countries, the input in research and development plays a negative role in the company performance. Further studies are needed to analyze the reasons of the negative role, to dig up the possible reasons behind it, for which in-depth studies can be made in the culture, religion and psychology etc., of various countries.

Second, experience studies suggest that the linear term of R&D intensity contributes positively firms' performance. However, because R&D intensity is a production factor, it is speculated that excessive intensity of R&D may also decrease firms' performance, finally contributing an inverted U shape. Hence, we speculate that the R&D input is probably "inverted-U shape" with a company's performance. But because e-commerce business worldwide is still in rapid development, historical data is temporarily unavailable. With the further development of e-commerce business, studies might prove this rule.

ACKNOWLEDGMENT

This paper is supported by "the Fundamental Research Funds for the Central Universities", Zhongnan University of Economics and Law (Grant No.: 2722020JCG052).

REFERENCES

[1] Drucker, P.F. (2007). Management Challenges for the 21st Century. Routledge.

[2] Lee, J. M., Kim, J., Bae, J. (2020). Founder CEOs and innovation: Evidence from CEO sudden deaths in public firms. Research Policy, 49(1): 103862. https://doi.org/10.1016/j.respol.2019.103862

[3] Gorączkowska, J. (2018). Influence of business support organizations on innovation activity in manufacturing companies in the Masovian Voivodeship in Poland. Equilibrium. Quarterly Journal of Economics and Economic Policy, 13(4): 741-759.

[4] Revilla-Camacho, M.Á., Palacios-Florencio, B., Garzón, D., Prado-Román, C. (2020). Marketing capabilities and innovation. How do they affect the financial results of hotels? Psychology & Marketing, 37(3): 506-518. https://doi.org/10.1002/mar.21316

[5] Horbach, J., Jacob, J. (2018). The relevance of personal characteristics and gender diversity for (eco-) innovation activities at the firm-level: Results from a linked employer-employee database in Germany. Business Strategy and the Environment, 27(7): 924-934. https://doi.org/10.1002/bse.2042

[6] Lin, R., Xie, Z., Hao, Y., Wang, J. (2020). Improving high-tech enterprise innovation in big data environment: a combinative view of internal and external governance. International Journal of Information Management, 50: 575-585. https://doi.org/10.1016/j.ijinfomgt.2018.11.009

[7] Su, J., Zhang, S., Ma, H. (2020). Entrepreneurial orientation, environmental characteristics, and business model innovation: A configurational approach. Innovation, 22(4): 399-421. https://doi.org/10.1080/14479338.2019.1707088

[8] Chen, Z., Lee, S.H., Xu, W. (2017). R&D performance in high-tech firms in China. Asian Economic Papers, 16(3): 193-208. https://doi.org/10.1162/asep_a_00565

[9] Liao, S., Fu, L., Liu, Z. (2020). Investigating open innovation strategies and firm performance: The

moderating role of technological capability and market information management capability. Journal of Business & Industrial Marketing. 35(1): 23-39. https://doi.org/10.1108/JBIM-01-2018-0051
[10] Jia, N. (2018). Corporate innovation strategy and stock price crash risk. Journal of Corporate Finance, 53: 155-173. https://doi.org/10.1016/j.jcorpfin.2018.10.006
[11] Karahan, Ö. (2015). Intensity of business enterprise R&D expenditure and high-tech specification in European manufacturing Sector. Procedia - Social and Behavioral Sciences, 195(3): 806-813. https://doi.org/10.1016/j.sbspro.2015.06.180
[12] Liu, Y., Huang, X., Chen, W. (2019). The dynamic effect of high-tech industries' R&D investment on energy consumption. Sustainability, 11(15): 4090-4112. https://doi.org/10.3390/su11154090
[13] Usman, M. (2019). Relationship between R&D investment and high-tech exports: Empirical study from Pakistan. Journal on Innovation and Sustainability, 10(1): 110-123.
[14] Chen, S., Xu, K., Nguyen, L.T., Yu, G. (2018). TMT's attention towards financial goals and innovation investment: Evidence from China. Sustainability, 10(11): 4236-4253. https://doi.org/10.3390/su10114236
[15] Chen, S., Chen, H.H., Shen, T. (2020). Suitable business models for innovation in different levels of the smart grid energy industry. Environmental Progress & Sustainable Energy, 39(1): 13275-13283. https://doi.org/10.1002/ep.13275
[16] Schwab, K. (2017). The fourth industrial revolution. Currency. New York: Crown Publishing Group, 2017.
[17] Exposito, A., Sanchis-Llopis, J.A. (2018). Innovation and business performance for Spanish SMEs: New evidence from a multi-dimensional approach. International Small Business Journal, 36(8): 911-931. https://doi.org/10.1177/0266242618782596
[18] Al-kalouti, J., Kumar, V., Kumar, N., Garza-Reyes, J.A., Upadhyay, A., Zwiegelaar, J.B. (2020). Investigating innovation capability and organizational performance in service firms. Strategic Change, 29(1): 103-113. https://doi.org/10.1002/jsc.2314
[19] Calabrese, A., Forte, G., Ghiron, N.L. (2018). Fostering sustainability-oriented service innovation (SOSI) through business model renewal: The SOSI tool. Journal of Cleaner Production, 201: 783-791. https://doi.org/10.1016/j.jclepro.2018.08.102
[20] Severo, E.A., Sbardelotto, B., de Guimarães, J.C.F., de Vasconcelos, C.R.M. (2020). Project management and innovation practices: Backgrounds of the sustainable competitive advantage in Southern Brazil enterprises. Production Planning & Control, 31(15): 1276-1290. https://doi.org/10.1080/09537287.2019.1702734
[21] Greenhalgh, C. (2018). Innovation in the Asia Pacific: From manufacturing to the knowledge economy. Journal of Economic Literature, 56(4): 1600-1601.
[22] Çiğdem, K.A.Y.A., Ataman, G., Elbaşi, İ.H. (2018). Perceived environmental uncertainty and innovation adoption: Exploring the Turkish context. Business & Management Studies: An International Journal, 6(4): 770-789. http://dx.doi.org/10.15295/bmij.v6i4.277
[23] Anwar, M., Zaman Khan, S., Ali Shah, S.Z. (2020). A study of the relationship between innovation and performance among NPOs in Pakistan. Journal of Social Service Research, 46(1): 26-40. https://doi.org/10.1080/01488376.2018.1516265
[24] Chege, S.M., Wang, D., Suntu, S.L. (2020). Influence of technology innovation intensity on firm performance: Technology innovation on firm performance-case of Kenya. International Journal of Technology and Human Interaction (IJTHI), 16(2): 34-52. https://doi.org/10.4018/IJTHI.2020040104
[25] Merkley, K.J. (2014). Narrative disclosure and earnings performance: Evidence from R&D disclosures. The Accounting Review, 89(2): 725-757. https://doi.org/10.2308/accr-50649
[26] Berchicci, L. (2013). Towards an open R & D system: Internal R & D investment, external knowledge acquisition and innovative performance. Research Policy, 42(1): 117-127. https://doi.org/10.1016/j.respol.2012.04.017
[27] Nunes, P.M., Serrasqueiro, Z., Leitão, J. (2012). Is there a linear relationship between R&D intensity and growth? Empirical evidence of non-high-tech vs. high-tech SMEs. Research Policy, 41(1): 36-53. https://doi.org/10.1016/j.respol.2011.08.011
[28] Cyert, R.M., March, J.G. (1963). A behavioral theory of the firm. Englewood Cliffs, NJ, 2(4): 169-187.
[29] Baumgarten, D., Bonenkamp, U., Homburg, C. (2010). The information content of the SG&A ratio. Journal of Management Accounting Research, 22(1): 1-22. https://doi.org/10.2308/jmar.2010.22.1.1
[30] Faryabi, M. (2018). Achieving Superior Performance in Small and Medium-Sized Organizations: Pervasive Role of Innovation and Marketing Capabilities. Pacific Business Review International, 11(6): 109-116.
[31] Nollet, J., Filis, G., Mitrokostas, E. (2016). Corporate social responsibility and financial performance: A non-linear and disaggregated approach. Economic Modelling, 52: 400-407. https://doi.org/10.1016/j.econmod.2015.09.019
[32] Vithessonthi, C., Racela, O.C. (2016). Short-and long-run effects of internationalization and R&D intensity on firm performance. Journal of Multinational Financial Management, 34: 28-45. https://doi.org/10.1016/j.mulfin.2015.12.001
[33] Greene, W.H. (2003). Econometric Analysis. Pearson Education India.
[34] Cameron, A.C., Gelbach, J.B., Miller, D.L. (2012). Robust inference with multiway clustering. Journal of Business & Economic Statistics, 29(2): 238-249. https://doi.org/10.1198/jbes.2010.07136