

Internet Use and Firms' Exports: Empirical Findings Based on Chinese Enterprise Survey Data

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Abstract:

Using data from the World Bank's Enterprise Survey, this empirical study identifies the effects of Internet use on export frequency and intensity of firms in China. The results show that Internet use has a positive effect on the probability and intensity of enterprise export. In order to test the robustness of this result, this paper changes the construction method of the core explanatory variable, and finds that Internet use still plays a significant role in promoting the export of enterprises. Further, in view of the possible endogeneity problems caused by selection bias, this paper uses the balanced samples of propensity score matching (PSM) method for regression analysis, and the results are still robust. Finally, we find that firms with high capacity are more likely both to enter export markets and to be export intensive.

Key words: Internet use, Export of enterprises, Enterprise capacity

1. Introduction

In recent years, the Internet has been developing rapidly in China. According to the 44th statistical report on Internet development by China Internet network information center (CNNIC), the number of Internet users in China has reached 854 million and the Internet penetration rate has reached 61.2% by June 2019. The rapid popularization of the Internet provides a new, convenient and efficient information exchange channel for individuals and enterprises, which greatly reduces the cost of information exchange. Chinese internet-based economic activities are also showing a trend of rapid growth. According to the data of the general administration of customs, the total value of cross-border e-commerce imports and exports approved by customs in 2018 reached 134.7 billion yuan, up 50.0% year on year. It can be seen from the above data that rapid development of Internet is playing an increasingly important role in international trade. However, we cannot infer the relationship between Internet use and the export of enterprises only by the macro data. We believe that it is necessary to conduct detailed analysis and discussion on this issue from the micro level.

In terms of the possible impact of the Internet on corporate exports, Anderson & Wincoop (2004) argue that search cost and communication cost are two important and widespread forms of trade costs. And Venables (2001) points out that Internet can reduce the cost of organization management, search, match and communication between enterprises and upstream and downstream suppliers, as well as between enterprises and consumers. Therefore, it can be inferred that Internet can promote the export of enterprises by reducing the cost of trade search and communication. The objective of this study is to explore whether Internet use has an impact on the export of enterprises.

Using firm-level data from the World Bank's Enterprise Survey database, which covers 2848 enterprises in China, this paper finds that enterprises' use of Internet has a significant positive impact on their exports. Specifically, firms that use e-mail to communicate with clients and suppliers are 14.5% more likely to export and sell 6.68% more abroad on average than firms that do not use e-mail. This paper further changes the construction of the core explanatory variables to test the robustness of the results, and finds that Internet still plays a significant role in promoting the export of enterprises. In view of the possible endogenous problems caused by selection bias, this paper uses the balanced samples of propensity score matching (PSM) method for regression analysis, and finds that the results are still robust. Finally, we find that firms with high capacity are more likely both to enter export markets and to be export intensive. Specifically, firms with high-capacity are more 28.1% likely to export and sell 9.94% more abroad than firms do not use e-mail, which is a more significant promoting effect than the average effect.

This paper contributes to three strands of the literature. Firstly, based on the data from the World Bank's EnterpriseSurvey, this paper provides empirical evidence for Internet use to promote the export of enterprises from micro perspective. Secondly, this paper systematically studies the impact of Internet use on the probability and intensity of export of enterprises, exploring this impact qualitatively and quantitatively. Finally, we use the PSM method to solve the selection bias problem and make the regression results more reliable.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the data, variables, and summary statistics. Section 4 presents the main empirical results regarding the effect of Internet use on firm export. Section 5 concludes this paper.

2. A Brief Review of Relevant Literature

As a general-purpose technology, the Internet has exerted extensive influence on all fields and levels of society (Harris, 1998; Anastasiadis et al., 2018; Ciruela-Lorenzo et al., 2020). A large number of literatures have studied the impact of information technology represented by the Internet on production efficiency (Jorgenson et al., 2008; Oliner et al., 2008; Van Ark et al., 2008), and some scholars have studied the relationship between the Internet and economic growth (Roller & Waverman, 2001; Czernich et al., 2011; Choi & Yi, 2009), as well as the relationship between the Internet and product sales and employment (Levin, 2011; Stevenson, 2008). In particular, the rapid development of the Internet has brought about a huge impact on the development of global trade. And we will summarize the related literature from the theoretical and empirical aspects.

First, from the theoretical level, Internet may promote the export of enterprises by reducing transaction costs. Anderson & Wincoop (2004) argue that search cost and communication cost are two important and widespread forms of trade costs. Fink et al. (2005) give empirical evidence of the cost of international trade exchanges, and concludes that the higher the cost of bilateral exchanges, the smaller the scale of international trade. Li and Li (2017) point out that the use of the Internet can reduce the cost of information exchange, especially for long-distance information exchange. These time and financial savings make it more likely that businesses using the Internet will engage in trade, and they will do so more frequently (Sheng et al., 2011; Ferro, 2011; Timmis, 2013; Niru, 2014; Meijers, 2014; Yushkova, 2014). Venables (2001) also points out that Internet can reduce the cost of organization management, search, match and communication between enterprises and upstream and downstream suppliers, as well as between enterprises and consumers.

Secondly, from the perspective of empirical analysis, the literature analyzes the impact of Internet use on the export of enterprises from both domestic and corporate levels. At the national level, Freund and Weinhold (2004) find that there is a significant effect of the Internet on trade in recent years based on time-series and cross-section regressions. The results suggest that a 10% increase in the growth of web hosts in a country leads to about a 0.2% increase in export growth. Lin (2014) uses panel data from nearly 200 countries from 1990 to 2006 to estimate the promotion effect of the Internet on international trade. The results show that every 10% increase in Internet users will increase the total amount of international trade by 0.2%-0.4%. Mallick (2014) uses gravity model to study the impact of infrastructure on the export of goods and services in 48 countries from 2000 to 2010, and finds that the Internet in the technological infrastructure has a greater promoting effect on the service trade.

With the introduction of the hypothesis of heterogeneity into the trade model by the new trade theory represented by Melitz (2003), there are many studies on the impact of Internet on the export of enterprises from the enterprise level. Based on transnational data, Freund & Weinhold (2004) find that the increase of Internet development would increase the growth rate of the country's export trade. Timmis (2013) finds that the Internet use is beneficial to the direct export of enterprises, but has no significant impact on the indirect export. Niru (2014) studies the impact of the Internet on the export and import of enterprises in Asia and sub-Saharan Africa, and finds that the Internet reduces the cost related to information entering the international market, and the use of email and website has a positive impact on the margin of enterprises' export and import. Ferro (2011) finds that using websites to communicate with customers and suppliers increases the export probability of enterprises by 11%.

It can be seen from the summary of the above literature that there are abundant studies on the impact of the Internet on the export of enterprises. However, there are few studies on the sample of Chinese enterprises, which is not commensurate with China's status as the largest Internet country in the world (Li and Li, 2017). Next we will make a detailed empirical test of the above inferences using the World Bank's Survey Data on Chinese enterprises.

3. Variables and Data

3.1 Sample and Variable Selection

We use the data from the World Bank's EnterpriseSurvey which includes all available information for Chinese manufacturing firms in 2012. This survey adopts the method of stratified random sampling and contains 2700 private enterprises and 148 state-owned enterprises, covering 25 cities in Chinese manufacturing industry. In addition, with this dataset, it is possible to identify which firm is exporter as there is information on the proportion of total sales that are sold both in foreign and domestic markets. It is also possible to control other factors that may affect the export of enterprises with the survey containing the basic characteristics of the enterprise, such as its finance, production and operation status, as well as the business environment and other indicators. Owing to the different incentives to export between state-owned enterprises and private enterprises, this article only chooses 2700 private enterprises as the sample. After deleting the missing samples, we finally obtained 1541 sample points.

Firstly, we construct two dependent variables according to the question "In fiscal year 2011, what percentage of this achievement's sales were national sales?" On one hand, the variable *DOMESTIC* is defined to reflect the proportion of total sales that are sold in domestic markets, which measures the intensity of export quantitatively. On the other hand, the binary variable *EXPORT* is defined to measure an enterprise's export behavior qualitatively. If the domestic sales volume of the product is less than 100%, the value of *EXPORT* is assigned to 1, otherwise is 0.

Secondly, we define the independent variable *EMAIL* according to the question "At the present time, does this establishment use E-mail to communicate with clients or suppliers?" If the enterprise uses, the variable *EMAIL* is assigned to 1, otherwise is 0. This paper also constructs the variable *custom_ICT* to replace the core explanatory variable and test the robustness of the results, which measures the application degree of ICT in the customer relationship. According to the question "To what extent are information and communication technologies (computers, Internet, and software) used to support partner relations, marketing and sales?", the enterprises answer from 1 to 5, which means "Never", "Rarely (once in a while)", "Sometimes (few times a month)", "Frequently (few times a week)" and "All the time (Daily)", respectively. The value of *custom_ICT* is based on the average value of the ICT level applied by the enterprise in partner relations and marketing these two aspects.

This paper also controls a series of other factors that may affect the export of enterprises (Arato et al., 2016). Firstly, at the firm level, we include the size of the firm as given by the logarithm of the number of formal employees. We also include the age of the firm and whether the firm provides formal training to its workers. And we consider the output of enterprises, which is expressed by the logarithm of the sales volume of enterprises. Secondly, we control the factors related to the business environment (Gulzar et al., 2018; Sial et al., 2018). We use the dummy variable *INFORM* to measure the competitive relationship between the enterprise and the informal enterprises, which is constructed according to whether the enterprise competes with the non-registered or informal enterprise. And we use the variable *CRIME* to measure the degree of obstacle caused by crime and theft to the company's operation, with a value of 0 to 4, which means "No obstacle", "Minor obstacle", "Moderate obstacle", "Major obstacle" and "Very Severe obstacle", respectively. We also construct the variables *UNCERT* and *COURTS* to measure the obstacle caused by political instability or courts, with a value of 0 to 4, meaning the same as above.

Finally, we use two other sets of dummy variables to control city and industry fixed effects, considering that export activities may be concentrated due to industry or regional industrial policies. In addition, the dummy variable *HIGH* is constructed by whether the natural logarithm of the sales volume of the enterprise is greater than the average level of the sample enterprise. If it is greater than the average level, it is regarded as a high-capacity enterprise, and the variable *HIGH* is assigned to 1, otherwise 0.

3.2 Descriptive Statistics

Table 1 is the descriptive statistics of the main variables. As can be seen from Table 1, in terms of the export of enterprises, about 23% of enterprises export products, and the domestic sales of products account for 89.1% of the total sales on average. 86.6% of enterprises use e-mail to contact customers and suppliers and the level of ICT application in maintaining customer relations is high, with an average value of 3.535. For the control variables, the average age of enterprises is 12.4 years, and 60.9% of enterprises have competitive relationship with the unregistered or informal enterprises. The average obstacle value caused by crimes is only 0.263, which means crime has done little to hamper the company's operations. 83.5 enterprises provide training for employees. Policy uncertainty hindered 21.4% of business operations, courts 24.9%. And 47.2% of the enterprises are high capacity enterprises.

Table 1. Summary Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
export	1541	0.230	0.421	0	1
domestic	1541	89.103	25.189	0	100
email	1541	0.866	0.340	0	1
custom_ICT	1541	3.535	1.267	1	5
output	1541	16.468	1.661	4.605	24.124
age	1541	12.421	7.077	0	84
size	1541	3.960	1.316	1.386	9.210
inform	1541	0.609	0.488	0	1
crime	1541	0.263	0.544	0	4
train	1541	0.835	0.372	0	1
uncert	1541	0.214	0.410	0	1
courts	1541	0.249	0.432	0	1
high	1541	0.472	0.499	0	1

4. Main Findings

4.1 The Baseline Model

We first study the impact of Internet use on the export of enterprises. Considering that the explained variable, *EXPORT*, is a binary discrete variable, the probit model is used for regression analysis in this paper. The specific settings of the regression model are as follows:

$$\Pr(\text{export}_{i,j,k} = 1) = \Phi(\alpha + \beta \text{email}_{i,j,k} + \gamma \text{control}_{i,j,k} + \text{city}_j + \text{industry}_k + \mu_{i,j,k})$$

Here, $\text{export}_{i,j,k}$ refers to whether the enterprise exports as the explained variable, and i, j, k represent enterprise, city and industry respectively. $\text{Email}_{i,j,k}$ refers to whether the enterprise uses the Internet as the core explanatory variable. This paper mainly focuses on the coefficient of the core explanatory variable email_i . $\text{Control}_{i,j,k}$ represents a series of control variables, including *OUTPUT*, *AGE*, *SIZE*, *INFORM*, *CRIME*, *TRAIN*, *UNCERT*, and *COURTS*. City and industry fixed effects are controlled with city_j and industry_k respectively. And $\mu_{i,j,k}$ refers to the random disturbance term.

Since whether an enterprise exports is a dummy variable, which cannot reflect the intensity of the enterprise's exports, we further use variable *DOMESTIC* to reflect the intensity of export, as another explained variable. In addition, the percentage of the products in the domestic sales (*DOMESTIC*) is non-negative, so we use the tobit model to estimate the impact of Internet use on the export intensity of enterprises.

Table 2 reports the regression results of the influence of Internet use on enterprises' export. In the regression equation, we controlled a series of variables, such as *OUTPUT*, *AGE*, *SIZE*, whether to train employees or not, and also controlled city and industry fixed effects. Column (1) of Table 2 is the regression result of probit model, which shows that enterprises' use of Internet will increase the probability of enterprises' export by 14.5%. Column (2) is the regression result of tobit model, which shows that enterprises' use of the Internet will reduce the proportion of domestic sales by 6.68%. The above results all indicate that Internet use will promote the export of enterprises.

Table 2 Baseline Regression Results (Probit and Tobit models)

	(1) export b/se	(2) domestic b/se
email	0.145*** [0.040]	-6.683*** [1.872]
output	0.032*** [0.010]	-0.763 [0.539]
age	0.000 [0.001]	0.087 [0.087]
size	0.027** [0.012]	-1.291* [0.712]
inform	-0.015 [0.022]	2.493* [1.302]
crime	0.028 [0.020]	-2.289* [1.202]
train	0.061* [0.032]	-1.659 [1.726]
uncert	-0.033 [0.040]	0.680 [2.276]
courts	0.038 [0.037]	-0.708 [2.113]
Industry fixed effects	yes	yes
City fixed effects	yes	yes
_cons		120.619*** [8.131]
/		
var(e.national)		511.085*** [18.412]
N	1393	1541

Note: *, **, and *** indicate significant at 10%, 5%, and 1% levels, respectively. Standard errors are reported in brackets.

4.2 Robustness Test

In fact, the variable *custom_ICT* can still measure the extent to which an enterprise applies the Internet in terms of customer relationship and marketing, etc. Therefore, in order to verify the robustness of the above regression results, the core explanatory variable *EMAIL* is replaced by *custom_ICT* for regression analysis. Table 3 reports the regression results. The results show that enterprises' use of the Internet in customer relations still has a significant promoting effect on their export, which is consistent with the previous conclusion.

Table 3 Robustness Test (Probit and Tobit Models)

	(1) export b/se	(2) domestic b/se
custom_ICT	0.029*** [0.010]	-0.942* [0.540]
output	0.031*** [0.010]	-0.823 [0.542]
age	0.000 [0.001]	0.094 [0.087]
size	0.027** [0.012]	-1.291* [0.715]
inform	-0.017 [0.022]	2.586** [1.308]
crime	0.027 [0.020]	-2.090* [1.205]
train	0.079** [0.032]	-2.296 [1.721]
uncert	-0.036 [0.040]	1.039 [2.280]
courts	0.040 [0.037]	-1.024 [2.119]
Industry fixed effects	yes	yes
City fixed effects	yes	yes
_cons		120.222*** [8.169]
/		
var(e.national)		514.297*** [18.528]
N	1393	1541

Note: *, **, and *** indicate significant at 10%, 5%, and 1% levels, respectively. Standard errors are reported in brackets.

4.3 Endogenous Analysis

To explore the causal effect of Internet use on corporate exports, we need to address two potential endogenous issues. First, there may be a bias of omitted variable, that is, some unobservable factors in enterprise, market and policy levels will affect whether enterprises use the Internet and export at the same time. In the regression, we try to mitigate the omitted variable bias by controlling a series of variables such as *OUTPUT*, *AGE* and *SIZE* on the level of enterprise, and whether to compete with informal enterprises in the market level, also by controlling the industry and city fixed effects to reduce the agglomeration effect caused by industrial policies and the industry characteristics.

Second, there may be a problem of selection bias, that is, there is a big difference between the enterprises that use and do not use the Internet. In fact, it can be seen from the above descriptive statistics that only 23% enterprises exporting products, which are likely to be quite different from most other enterprises that do not export. If we adopt full sample for regression analysis, it is equivalent to use all non-exporting enterprises as the control group, which will make the sample unbalanced. We try to solve this problem by using the PSM method.

The PSM method is a non-parametric estimation method, whose core idea is to select individuals with similar characteristics and conditions from the control group by using the propensity value score (Chen, 2010). Therefore, the first thing is to calculate the propensity score. We take the enterprises that never or rarely use ICT as the control group and the others as the treatment group according to the application degree of ICT in the customer relationship. And all the control variables in the benchmark regression are taken as covariables to calculate the propensity score. Secondly, according to the propensity score value, 1:1 nearest neighbor matching method is adopted for sample matching. After matched, the standardized deviation of all variables is less than 20%, and the results of all t tests do not reject the null hypothesis that there is no systematic difference between the treatment group and the control group, which indicates

that our matching results balance the data well, and the comparability between the treatment group and the control group is improved (Rosenbaum & Rubin, 1983; Smith & Todd, 2005; Rosenbaum & Rubin, 1985). Then we use subsamples for the baseline regression analysis.

Table 4 reports the regression results. The result of the column (1) reflects that the probability of enterprises to export which use the Internet increase by 16.2%. Column (2) shows the proportion of domestic sales of products will drop by 4.97% among enterprises using the Internet. It can be seen from the above results that after we solve the selection bias, Internet use still significantly promotes the enterprises to export.

Table 4 Endogenous analysis (PSM balanced samples, Probit and Tobit models)

	(1)	(2)
	export	domestic
	b/se	b/se
email	0.162*** [0.054]	-4.971** [2.135]
output	0.041** [0.016]	-0.964 [0.695]
age	-0.002 [0.003]	0.120 [0.134]
size	0.019 [0.022]	-1.412 [0.995]
inform	0.018 [0.039]	1.486 [1.912]
crime	0.003 [0.036]	-0.032 [2.014]
train	0.054 [0.046]	-0.756 [1.999]
uncert	-0.114 [0.081]	-1.167 [3.623]
courts	0.181** [0.075]	-6.479* [3.331]
Industry fixed effects	yes	yes
City fixed effects	yes	yes
_cons		120.967*** [11.232]
/		
var(e.national)		390.053*** [21.737]
N	466	644

Note: *, **, and *** indicate significant at 10%, 5%, and 1% levels, respectively. Standard errors are reported in brackets.

4.4 Heterogeneity Analysis

According to the new trade theory represented by Melitz (2003), manufacturers' decisions on production and trade mainly depend on their own productivity level, and enterprises need to pay certain fixed costs to enter the international market. These entry costs might include expenses related to establishing a distribution channel, transport costs, or production costs to modify domestic models for foreign tastes (Ferro, 2011). Given the variable costs, the level of fixed costs will directly determine whether enterprises choose to export. A series of papers by Bernard and Jensen (1999, 2003, 2005) find clear evidence that good firms become exporters. Ricci and Trionfetti (2012) investigate the impact of enterprise productivity and network on enterprises' export ability, and find that enterprises with higher productivity are more likely to export and benefit more from foreign network, domestic network and communication network (mailbox and Internet). So it is likely that Internet use has different effects on the export behavior of enterprises with different capacity. We divide the sample into high and low capacity groups to investigate whether Internet plays a different role in enterprise export. And then the regression analysis is carried out respectively using the two subsamples.

The regression results are reported in Table 5. The results show that for high-capacity enterprises, Internet use will increase their export probability by 28.1%, and the proportion of domestic sales of products will decrease by 9.95%, which is a more significant promoting effect than the average effect, and these impacts are both significant at the significance level of 1%. For low-capacity enterprises, Internet use only increases the export probability by 8.3%, resulting in a decrease in the proportion of domestic sales by 4.71%, and the significance of these effects are obviously reduced. The results indicate that the promotion effect of Internet use on the export of enterprises varies with the different capacity of enterprises. Specifically, enterprises with high capacity are more likely both to enter export markets and to be export intensive.

Table 5 Heterogeneity analysis (Probit and Tobit models)

	(1) export High-capacity	(2) export Low-capacity	(3) domestic High-capacity	(4) domestic Low-capacity
email	0.281*** [0.085]	0.083* [0.044]	-9.948*** [3.443]	-4.714** [2.180]
output	0.024 [0.018]	0.043** [0.020]	-0.168 [0.980]	-1.104 [0.887]
age	0.001 [0.002]	-0.000 [0.002]	0.064 [0.114]	0.165 [0.133]
size	0.006 [0.019]	0.053*** [0.018]	-0.069 [1.033]	-2.953*** [1.023]
inform	-0.011 [0.036]	-0.019 [0.029]	1.889 [1.936]	2.379 [1.724]
crime	-0.000 [0.036]	0.036 [0.024]	-3.267* [1.983]	-1.799 [1.458]
train	0.052 [0.062]	0.017 [0.038]	1.771 [3.260]	-0.504 [2.036]
uncert	0.018 [0.061]	-0.093 [0.057]	-0.325 [3.293]	1.365 [3.092]
courts	0.028 [0.057]	0.066 [0.054]	-2.329 [3.054]	-0.125 [2.920]
Industry fixed effects	yes	yes	yes	yes
City fixed effects	yes	yes	yes	yes
_cons			109.267*** [17.071]	129.504*** [13.500]
/				
var(e.national)			522.917*** [27.408]	443.530*** [21.998]
N	666	668	728	813

Note: *, **, and *** indicate significant at 10%, 5%, and 1% levels, respectively. Standard errors are reported in brackets.

5. Conclusion

The Internet in China has developed rapidly in recent years, which provides a new, convenient and efficient information communication channels for individuals and businesses. In addition, Internet greatly reduces the cost of information exchange, and Chinese Internet-based economic activities are also showing a trend of rapid growth. A follow-up question is whether the Internet boosts corporate exports? This paper made a systematic study of the impact of Internet use on the export of enterprises using the data of the World Bank's Enterprise Survey in 2012.

The empirical research results of this paper show that enterprises' use of the Internet has a significant positive impact on their exports. Specifically, firms that use e-mail to communicate with clients and suppliers are 14.5% more likely to export and sell 6.68% more abroad on average than firms that do not use e-mail. In order to test the robustness of this result, we change the construction method of the core explanatory variables and find that this effect is still significant. Furthermore, in view of the endogenous problem caused by possible selection bias, this paper uses the balanced samples of PSM method for regression analysis, and finds that the Internet still plays a significant role in promoting the export

of enterprises. Finally, we find that firms with high capacity are more likely both to enter export markets and to be export intensive. Specifically, firms with high-capacity are more 28.1% likely to export and sell 9.94% more abroad than firms do not use e-mail, which is a more significant promoting effect than the average effect.

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