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The Impact of Foreign Technology Transfer on Firm Productivity

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ABSTRACT
Based on the important impact of technology transfer on the firm, this paper discusses in detail how technology transfer affects the productivity of enterprises. At present, some research results preliminarily show that in areas with high level of economic development, the impact of enterprise technology introduction on its productivity is more significant. There is still a lack of specific literature on the impact of time factors on the relationship between enterprise technology transfer and enterprise productivity. This paper further discusses the relationship between technology transfer and the firm productivity by introducing two external factors: economic development level and year time. This study constructs a multiple regression model, which tests the impact of technology transfer, region, year and countries with different development levels on firm productivity. The research shows that technology transfer plays a positive role in promoting firm productivity. Compared with developed countries, technology transfer has a more significant impact on the productivity of developing countries; At the same time, there are heterogeneity effects in different countries and years. This paper only analyzes the impact of technology transfer between different countries on firms, which has practical significance for the future study of the impact of technology transfer on enterprises in various industries.

Keywords: *"foreign technology transfer", "firm productivity", "economic development level","countries","year".*

1. INTRODUCTION

Technology transfer refers to the process in which a particular technology (including mature technology and technology in an invented state) is transferred from its place of origin or field of practice to another site or field (Baidubaike). In other words, technology transfer is an essential method for local enterprises to obtain technological resources and technological innovation. As a critical technological supplement to independent research and development, technology transfer is an important way for modern enterprises to obtain the technological resources required for technological innovation. Licensing technology to other firms is a relatively common way of technology transfer. With economic globalization as the main body of international technology transfer, multinational corporations undoubtedly play a huge role and increasingly become a significant force influencing world economic development and technological progress. On the one hand, multinational companies use their market and technical advantages to maximize profits worldwide. On the other hand, most developing countries and regions also hope to attract direct investment from transnational corporations to promote their economic growth and skill improvement [1]. Therefore, it is vital to study the impact of technology transfer on the company. This article will explore in detail how technology transfer affects a firm's productivity.

Introducing technology through technology authorization can provide the authorized company with more experience and knowledge and help the company accumulate technical knowledge faster. The benefits of technology transfer to companies are obvious. As a technology introduction strategy of the company, in addition to the authorization contract itself, technology authorization also involves technology transfer, training, and technical training and support [2]. As a result, it can not only promote the firm to break through the shortcomings of technological development in the short term but also help the firm integrate existing technologies and make full use of its idle resources. Technology transfer can enable the company to gain time and cost advantages and help the firm gain a larger market share, thus improving productivity [3]. There is evidence that

firms can improve their productivity to some extent through technology transfer.

The positive effects of technology transfer on firm productivity are apparent, but whether these effects are different for firms in developed and developing countries should be explored further. By absorbing the technological achievements and management experience of developed countries through technology transfer, developing countries will shorten the exploration cost of technology and management, avoid the risk of independent research and development failure, accelerate domestic economic development, and improve national welfare. With the increasingly fierce global technological competition and the acceleration of technological upgrading, enterprises face more complex problems in technological innovation, and the integration of technologies is becoming stronger and stronger. Even large and powerful companies have a shortage of technical resources. Therefore, technology transfer will also take place among developed countries. This paper argues that the relationship between technology transfer and firm productivity should be discussed in theoretical and operational gaps.

In addition, when the company introduces technology from others, it is inevitable to have some external factors, such as the level of regional economic development or the different periods in which the company receives technology transfer. Specifically, in regions with varying levels of economic growth, is there any difference in the degree of impact of the firm's technology transfer on their productivity? What about the difference? Some of the current research results preliminarily show that in areas with a high level of economic development, the firm's technology introduction has a more significant effect on their productivity. On the contrary, in areas with a lower level of economic growth, the productivity improvement effect of the company's technology introduction is weak [4] [5] [6]. Regarding the influence of time factors on the relationship between firm technology transfer and company productivity, there is still a lack of specific literature researches. Only a few studies have explored the different changes in company productivity under different exchange rate periods. The company's technology investment plays the part of the intermediary role [7]. Therefore, this paper further discusses the relationship between technology transfer and enterprise productivity by introducing two external factors: economic development level and time.

The structure of this article is as follows. Section 2 is a literature review. Section 3 discusses the data used. Section 4 explains the estimation strategy of the foreign technology transfer on local firm productivity. Section 5 offers possible interpretations. The last section gives concluding remarks.

2. LITERATURE REVIEW

Technology transfer is an essential way for enterprises to import technology. It is also a necessary way for enterprises to recover R&D costs and win more profits quickly. The earliest research on technology transfer in economics can be traced back to Arrow's study in 1962. This study mainly discusses the profit difference of R&D enterprises through technology transfer under different technological innovation levels [8]. Subsequently, Kamien and Tauman(1986) and Katz and Shapiro(1986) further studied enterprise-owned technology transfer strategies. [9] [10]

Nowadays, technology has gradually become the fundamental factor in determining the long-term development of a company. The technological development level has a significant impact on its competitiveness [11]. Mainly for enterprises lacking R&D ability, technology introduction is the primary source of technology, and technology transfer is the main means of technology introduction. Therefore, whether technology transfer can bring high productivity and efficiency to enterprises has gradually attracted the attention of relevant scholars.

Technology transfer occurs in the trade between developed and developing countries and different industries within the same country. However, due to the limitations of current data and analysis methods, this paper mainly explores technology transfer between different countries. In this paper, technology transfer is entirely equivalent to foreign technology transfer.

2.1. Hypothesis 1: Technology transfer has a positive impact on firm productivity

The technology transfer has brought about the improvement of production efficiency and income to the technology transfer party. Moreover, it has brought considerable profits to the granting party and prepared funds for further research and development. At the same time, as far as technology exporters are concerned, technology transfer expands the application scope of technology and competes for more market space for companies [12].

A company that accepts technology transfer only needs to pay royalties for the imported technology through technology authorization and does not need to pay all the rights to use the imported technology. Therefore, in this way, each company consumes lower costs in terms of technology and can achieve technological development and upgrading quickly. As a result, scholars have explored the relationship between technology transfer and the "welfare" that enterprises obtain from it. For example, by investigating and researching the technology licensing of Indian companies, Evenson and Joseph (1999) concluded that technology

licensing intensified competition in the technology market of Indian companies and significantly increased the firm's productivity. Selecting more than 40 electronic manufacturing industries in Taiwan (China) as a research sample for empirical analysis[13], Tasi and Wang (2007) concluded that technology transfer is vital for independent research and development. Technology transfer has improved the company's operating performance[14]. However, the investigation of Lopez (2008) has concluded that technology licensing has different effects on the productivity of different types of enterprises[15]. Downstream firms' productivity has risen, while upstream firms' productivity may have been suppressed. Therefore, there is a lack of relevant research on this subject, and the conclusions are inconsistent. Guo and Yang (2019) made an empirical analysis on the micro-data of the 2012 World Bank survey on the investment environment of Chinese enterprises. They found that technology transfer has a significant positive impact on firm productivity, which shows the guiding significance for the research of this article[3].

2.2. Hypothesis 2: The impact of foreign technology transfer on firm productivity is related to regional economic development

Is the impact of technology transfer on enterprise productivity affected by other factors? In different regions, is there any difference in the effects of technology transfer on firm productivity? Relevant literature research shows that there is no research directly pointing out the influence of the economic development level of different regions on the relationship between technology transfer and company productivity. Existing researchers have explored from the perspective of technological innovation, for example, by analyzing the relationship between technological innovation and economic growth in China's Yangtze River Delta, where the level of economic construction is relatively high. Jiang and Liu (2015) affirmed the positive correlation between technological innovation and economic growth[4]. This conclusion suggests that the level of economic development in the region may affect the relationship between technology transfer and enterprise productivity. Moreover, Tang and Chen (2019) conducted an empirical analysis of firm data in the different areas of China. They found that the level of technological development brought about by technology introduction in different regions was different. Specifically, the eastern region's productivity level and industrial development foundation are higher than the western part. Combining these factors, the positive impact of technology introduction in the east of the area on enterprises will be more significant[5].. Wang and Li (2019) studied the effect of technology introduction on the efficiency of enterprise innovation output under different opening levels[6].. They found that the gains from technology introduction and the output efficiency are higher in the eastern coastal areas with a high degree of opening up and a high level of economic development. In the central and western regions, where the degree of space to the outside world is relatively low, the output efficiency brought by technology introduction to enterprises is correspondingly low.

Countries and regions with relatively backward economies can increase productivity through technology transfer and save R&D costs and time. Some studies believe that the economic level of the society affects the firm's attitude towards seeking and accepting new technologies, which is an essential factor in the impact of technology transfer on the firm's productivity [16]. Developing countries have used the opportunity to digest and absorb technological updates to meet their own innovation needs. To improve the speed and quality of economic growth, developing countries and regions are going through a phase of massive technology transfer. This conclusion is consistent with the research in this paper.

2.3. Hypothesis 3: The impact of foreign technology transfer on a firm's productivity varies with the year

Similarly, considering that the time factor may also affect the relationship between technology transfer and firm productivity when I checked the literature, I found that there is no directly related research. However, exchange rates can be used as a measure of different economic cycles. For example, Hu (2019) conducted an empirical analysis on the relevant data of Chinese manufacturing companies from 2011 to 2017[7].. During this period, as the RMB exchange rate rose, the company's productivity showed a downward trend.

Generally speaking, no literature explicitly explores the relationship between company technology transfer and firm productivity from a time perspective.

However, we have concluded from the existing related literature research that changes in the exchange rate also essentially reflect changes in the economic operating cycle. Therefore, there may be some correlation between the enterprise's technology transfer, productivity, and economic operation cycle.

3. DATA

This article uses the World Bank enterprise survey. The World Bank has been conducting enterprise-level surveys since 1998. This paper is an empirical analysis of the impact of foreign technology transfer on firm productivity, and the World Bank's enterprise survey data precisely cover the main indicators involved in this paper. The companies covered most of the world's developing countries, as well as some developed ones. And these surveys are representative of firms in the non-agricultural

formal economy. These data are very important in the creation of indicators to measure the quality of the business and investment environment in countries and provide reference values for the study of economic issues.

The data used in this article include the latest one-year survey data of 32,201 companies in 141 countries that can be used, including the 13 years from 2007 to 2019. After removing variables unrelated to the research topic, the regression model's fundamental data and independent variables are saved. Based on the research of this paper, I added the current exchange rate of each country against the US dollar into the data set to eliminate the influence of the exchange rate on the results. In addition, to compare the impact of technology transfer in different economic regions on the productivity of companies, I added the geographical location indicator of each country's continent. And whether the country is a developed economy or a developing country. However, no unified definition of developed and developing countries is available in official literature, so this paper defines countries with annual per capita GDP of $30,000 or more like developed countries (Google). The description of the relevant variables is clearly shown in Table 1

3.1. Hypothesis 3: The impact of foreign technology transfer on a firm's productivity varies with the year

Table 1. Variable definition

	Variable encoding	Variable	Variable definition
Dependent variable	Ln(productivity)	take log of the firm's productivity	the number of the log of the firm's productivity
Variable of interest	Transfer	whether there is a technical transfer	dummy variable, take value 1 when technical transfer is authorized, otherwise take value 0
Control variables	Import technology	whether new technologies or services have been introduced in the past three years	dummy variable, take value 1 when new technologies or services have been introduced in the past three years, otherwise take value 0
	Import license	whether an import permit has been applied for in the last two years	dummy variable, take value 1 when there is an application for an import license in the last two years, otherwise take value 0
	Foreign ownership	the proportion of foreign investors' holdings	the proportion of foreign investors' holdings
	Export percentage	the proportion of exports	percentage of export product or service sales to total sales
	Purchase new equipment	whether to purchase any equipment and fixed assets in the last year	dummy variable, take value 1 when any equipment and fixed assets are purchased, otherwise value 0
	Number of skilled workers	the number of skilled product workers	the number of skilled product workers

	Train	whether the company has a formal training program for its permanent full-time employees	dummy variable, take value 1 when a company has a formal training plan for its permanent full-time employees, otherwise take value 0
	Average education year	the average number of years of education for full-time production workers	the average number of years of education for full-time production workers
	Legislative fairness	the degree of impartiality and integrity of the local court system	orderly variables, based on the degree of impartiality and integrity of the court system, are valued from 1 to 4
	Firm's own web	whether the company has its own website	dummy variable, take value 1 when the company has its own website, otherwise take value 0

3.2. Variables descriptive statistics

Table 2. Variable definition

	N	Mean	Std. Dev.	Min	Max
Ln(productivity)	32088	9.395	1.752	.043	25.517
transfer	31604	.167	.373	0	1
Import technology	23370	.382	.486	0	1
Import license	31774	.105	.307	0	1
Foreign ownership	31705	7.707	24.721	0	100
Export percentage	31912	15.451	29.824	0	100
Purchase new equipment	31969	.442	.497	0	1
Number of Skilled workers	26265	61.313	292.638	0	19000
Train	31805	.418	.493	0	1
Average education year	18307	9.01	3.374	0	36
Legislative fairness	29460	2.454	.972	1	4
Firm's own web	32122	.547	.498	0	1

Table 2 is the descriptive statistics of the data. The total sample size of this empirical analysis is about 32,000. Some firm samples have missing values in the variables. Thus, their dummy variables will be generated to participate in the regression of the model. The logarithm of firm productivity is 9.395, the standard deviation is 1.752, the minimum is 0.043, and the maximum is 25.517. 16.7% of companies have technology transfer behavior. From this, we can see that quite a few countries are affected by technology transfer. 38.2% of enterprises have introduced new technologies or services in the past three years. 10.5% of companies have applied for an import license within the last two years. Foreign investment is widespread among the surveyed enterprises, and the average value of the foreign investment in the firm has reached 7.7%. The export ratio accounts for 15.5% of the firm's average sales. These variables reflect that foreign investment and trade are factors that cannot be ignored in enterprise development. 44.2% of the companies purchased new equipment or put fixed assets into production in the previous year. Given that skilled workers are a factor that affects a company's productivity, this model also considers the number of skilled workers the enterprise has. And its mean value is 61.3. The company pays more and more attention to the training of employees, which can improve the firm's efficiency and enhance the personal significance of employees. Among the 31,805 companies shown in the data, 41.8% of the companies will train their employees. Employees' average years of education will also be considered related to the firm's performance, but this data is missing for a large part of the company. In 18,307 companies with this data, the average number of years of education for employees is 9. The data set also retains the rating survey of the country's court system where the company is located. 1 to 4 represents strongly disagree, disagree, agree, and strongly agree, respectively. The mean value of this data is 2.45, which means that enterprises are generally compared concur with the local legal system, and the law protects their business. In the governance of modern enterprises, having the firm's website or not has a positive effect on the firm's publicity and management. The survey shows that 54.7% of companies have their websites.

3.3. Variable correlation analysis

The variable correlation coefficient matrix in Table 3 shows that transfer, import technology, import license, foreign ownership, export percentage, purchase of new equipment, train, average education year, legislative fairness, and firm's web have a positive correlation with firm productivity. The correlation between the number of skilled workers and firm productivity is not significant. ***, **, and * represent the significance level of 1%, 5%, and 10%, respectively.

Table 3. Matrix of variable correlation coefficients

	Ln(productivity)	Transfer	Import Technology	Import license	Foreign ownership	Export percentage	Purchase new equipment	Number skilled workers	Train	Average education year	Legislative faimess	Firm's owm web
Ln(productivity)	1											
Transfer	0.129***	1										
Import technology	0.029***	0.149***	1									
Import license	0.140***	0.130***	0.086***	1								
Foreign ownership	0.109***	0.134***	0.042***	0.249***	1							
Export percentage	0.072***	0.136***	0.033***	0.190***	0.250***	1						
Purchase new equipment	0.045***	0.104***	0.183***	0.120***	0.081***	0.073***	1					

Number of skilled workers	0.014	0.119***	0.020*	0.113***	0.139***	0.215***	0.031***	1				
Train	0.152***	0.055***	0.174***	0.132***	0.072***	0.153***	0.132***	0.114***	1			
Average education year	0.213***	0.113***	0.052***	0.093***	0.074***	0.028***	-0.008	0.010	0.115***	1		
Legislative fairness	0.073***	0.040***	0.032***	-0.046***	-0.068***	0.059***	0.063***	-0.023**	0.051***	0.151***	1	
Firm's own web	0.281***	0.239***	0.183***	0.110***	0.057***	0.194***	0.112***	0.158***	0.229***	0.209***	0.112***	1

***, ** and * represent the significance level of 1%, 5% and 10%.

Table 4. The t-test result of the variable please be consistent with font

	Non-transfer		With transfer		
	N	Mean	N	Mean	Difference
Ln(productivity)	26221	9.311	5274	9.839	-0.528***
Import technology	19499	0.353	3641	0.537	-0.184***
Import license	26058	0.083	5205	0.216	-0.133***
Foreign ownership	25922	5.877	5201	16.726	-10.849***
Export percentage	26078	13.488	5251	25.406	-11.918***
Purchase new equipment	26169	0.418	5242	0.572	-0.154***
Number of skilled workers	21635	47.534	4366	128.253	-80.719***
Train	26145	0.387	5232	0.578	-0.191***
Average education year	15103	8.862	2974	9.75 6	-0.894***
Legislative fairness	24146	2.441	4927	2.521	-0.080***
Firm's own web	26258	0.508	5283	0.755	-0.247***

***, ** and * represent the significance level of 1%, 5% and 10%

The variable t-test results show that the average productivity of firms with technology transfer is 0.528 higher than those without transfer, and the t-test is significant. In the mean values of other variables, companies with technology transfer are all higher than those without technology transfer, and the t-test is essential at the 1% level. The proportion of foreign investment is greatly affected by technology transfer. The mean foreign investment proportion of companies with technology transfer is 10.8 higher than that of companies without technology transfer. Whether there is technology transfer has a tremendous difference in the impact of the firm's export ratio. Technology transfer factors increase the mean value of exports in sales by 11.9. From Table 4, we can see that the number of skilled workers is the most affected variable by technology transfer, and the mean difference is 80.7.

4. METHODOLOGY

To study whether technology authorization (transfer) has a promoting effect on the firm's productivity (Ln(productivity)), this study constructs a multiple regression model for empirical testing. The regression model is as follows:

$$y_{idt} = \theta_d + \lambda_t + \alpha \text{transfer}_{\$t} + \beta X_{\$t} + \varepsilon_{\$t}$$

(i=firm, d=country, t=year)

Ln(productivity) is the dependent variable, which indicates the logarithm of the firm's productivity. The transfer is the core independent variable, and X is a series of related variables that may affect the firm's productivity. These variables were added as control variables in this study. And ε$t is a random perturbation item. In addition, the foot code i means different companies, d represents the country, and t means year, respectively.

The dependent variable is the productivity of the enterprise. Productivity of the firm equals the company's value-added divided by the number of employees. Value added is the difference between the sales volume and the cost of raw materials in that year.

The independent variable is the technology transfer, and it is a binary variable. If the firm has a technology transfer, the transfer variable will be assigned the value 1; otherwise, the value is 0.

The control variables in this study include: whether the introduction of new technology or new service (import) in nearly three years, whether to apply for import license (import license) within the last two years, the foreign investor ownership (foreign shareholding), export accounts for the percentage of the sales percentage (export), whether to buy any equipment and fixed assets to purchase new equipment, skilled production workers, skilled workers), whether the company has a formal training program for its permanent full-time employees (training), the average number of years of education (average number of years of education) of full-time production workers, the fairness and integrity of the court system (legislative fairness), and whether the company has its website (the company's website).

5. RESULTS

5.1. Full sample regression results

Table 5. Table Type Styles

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Ln(productivity)	Ln(productivity)	Ln(productivity)	Ln(productivity)	Ln(productivity)	Ln(productivity)
Transfer	0.528***	0.146***	0.218***	0.459***	0.222***	0.366***
	(0.0272)	(0.0313)	(0.0529)	(0.0224)	(0.0261)	(0.0503)
Import license		0.247***	0.506***		0.258***	0.452***
		(0.0429)	(0.0805)		(0.0372)	(0.0784)
Foreign ownership		0.00509***	0.00574***		0.00427***	0.00501***
		(0.000606)	(0.00109)		(0.000464)	(0.001158)
Export percentage		0.00115***	-0.000207		0.00136***	0.00143***
		(0.000411)	(0.000618)		(0.000335)	(0.000579)
Purchase new equipment		0.133***	-0.00153		0.0987***	0.023***
		(0.0226)	(0.0356)		(0.0185)	(0.0332)
Number of Skilled workers		-0.000280***	-0.000236***		-0.000145***	-0.000197***
		(5.35e-05)	(7.46e-05)		(3.41e-05)	(5.51e-05)
Train		0.439***	0.266***		0.267***	0.236***
		(0.0226)	(0.0346)		(0.0199)	(0.0330)
Legislative fairness		0.0426***	0.0483***		0.0119	-0.00398*

		(0.0123)	(0.0164)		(0.00991)	(0.0158)
Firm's own web		0.795***	0.716***		0.428***	0.488***
		(0.0232)	(0.0348)		(0.0196)	(0.0336)
Import technology			-0.161***			-0.041***
			(0.0338)			(0.0318)
Average education year			0.0766***			0.0402*
			(0.00689)			(0.00704)
Constant	9.311***	8.502***	7.544***	9.322***	8.850***	8.046***
	(0.0107)	(0.0350)	(0.0680)	(0.00813)	(0.0278)	(0.0729)
Observations	31,495	23,163	9,132	31,495	23,163	9,132
R-squared Year FE Country FE	0.013 No No	0.111 No No	0.129 No No	0.420 Yes Yes	0.447 Yes Yes	0.248 Yes Yes

***, ** and * represent the significance level of 1%, 5% and 10%

5.2. Regional regression results

Table 6. Regional regression results

	Africa	Latin America	Asia	Europe	Oceania
VARIABLES	Ln(productivity)	Ln(productivity)	Ln(productivity)	Ln(productivity)	Ln(productivity)
transfer	0.315***	0.176**	0.256***	0.0550	0.365
	(0.104)	(0.0709)	(0.0339)	(0.0442)	(0.361)
Import license	0.315***	0.272***	0.291***	-0.00362	0.469
	(0.108)	(0.0687)	(0.0618)	(0.0580)	(0.356)
Foreign ownership	0.00351***	0.00523***	0.00338***	0.00384***	-0.00473
	(0.00114)	(0.000960)	(0.000837)	(0.000704)	(0.00293)
Export percentage	0.000160	0.00380***	0.00117***	0.00178***	0.00566
	(0.00127)	(0.00105)	(0.000450)	(0.000570)	(0.00613)
Purchase new equipment	0.217***	0.232***	0.0117	0.169***	0.234

	(0.0672)	(0.0471)	(0.0235)	(0.0372)	(0.385)
Number of Skilled workers	0.000198	-8.48e-05	-0.000167***	-9.86e-05	0.00416*
	(0.000361)	(0.000141)	(3.96e-05)	(8.79e-05)	(0.00220)
Train	0.231***	0.379***	0.235***	0.256***	0.217
	(0.0708)	(0.0515)	(0.0266)	(0.0373)	(0.323)
Legislative fairness	-0.0338	0.0652**	-0.00405	0.0655***	-0.105
	(0.0353)	(0.0269)	(0.0127)	(0.0189)	(0.267)
Firm's own web	0.579***	0.428***	0.432***	0.246***	0.464
	(0.0730)	(0.0537)	(0.0248)	(0.0422)	(0.306)
Constant	8.579***	9.009***	8.754***	9.340***	10.93***
	(0.0936)	(0.0717)	(0.0365)	(0.0593)	(1.177)
Observations	3,053	3,275	13,105	3,692	37
R-squared Year FE Country FE	0.659 Yes Yes	0.222 Yes Yes	0.283 Yes Yes	0.284 Yes Yes	0.409 Yes Yes

***, ** and * represent the significance level of 1%, 5% and 10%

Table 7. Regression results of countries with different development degrees

	Developed	Developing
VARIABLES	Ln(productivity)	Ln(productivity)
transfer	0.0842	0.230***
	(0.0779)	(0.0272)
Import license	0.0176	0.262***
	(0.117)	(0.0381)
Foreign ownership	0.00359***	0.00433***
	(0.00105)	(0.000491)
Export percentage	0.00243***	0.00131***
	(0.000842)	(0.000358)
Purchase new equipment	0.0901	0.0987***

	(0.0629)	(0.0191)
Number of Skilled workers	-0.00103***	-0.000145***
	(0.000394)	(3.41e-05)
Train	0.249***	0.268***
	(0.0638)	(0.0208)
Legislative fairness	0.166***	0.00549
	(0.0351)	(0.0103)
Firm's own web	0.254***	0.433***
	(0.0850)	(0.0201)
Constant	9.657***	8.811***
	(0.101)	(0.0289)
Observations	1150	22013
R-squared Year FE Country FE	0.300 Yes Yes	0.219 Yes Yes

***, ** and * represent the significance level of 1%, 5% and 10%

The regression results by region show that the transfer coefficients of all regions are positive, but the coefficients of Europe and Oceania are not significant. From Table 5, we can see that the productivity of African enterprises is most affected by technology transfer, and the results are also the most significant. An increase of one unit in technology transfer increases the Ln(productivity) by 31.5%. The changes in Asia and Latin America are 25.6% and 17.6%, respectively. It shows regional differences in the impact of technology transfer on the company's productivity, and different regions have different effects. Table 6 divides the surveyed countries into two categories according to developed and developing countries. We can see that technology transfer has a more significant impact on the productivity of developing countries. For a one-unit increase in technology transfer from developing countries, the Ln(productivity) increases by 23%, significant at the 1% level. It can be seen from the comparison between developing countries and developed countries that, developed countries have relatively little demand for technology transfer due to their strong independent innovation capacity. However, for developing countries, the cost of independent innovation is far greater than technology transfer, so technology transfer is a rational choice to promote developing countries to improve labor efficiency. Therefore, the difference in regional economic level greatly affects the impact of technology transfer on productivity.

5.3. Regression results by annual interval

Table 8. Regression results by annual interval

	2006-2010	2011-2015	2016-2020
VARIABLES	Ln(productivity)	Ln(productivity)	Ln(productivity)
transfer	0.136*	0.295***	0.132***

	(0.0801)	(0.0358)	(0.0421)
Import license	0.214**	0.316***	0.218***
	(0.0837)	(0.0608)	(0.0536)
Foreign ownership	0.00354***	0.00442***	0.00422***
	(0.000987)	(0.000856)	(0.000650)
Export percentage	0.00462***	0.000397	0.00210***
	(0.00130)	(0.000459)	(0.000534)
Purchase new equipment	0.213***	0.0516**	0.121***
	(0.0511)	(0.0253)	(0.0320)
Number of skilled workers	-8.23e-05	-0.000162***	-0.000149**
	(0.000132)	(4.14e-05)	(6.96e-05)
Train	0.359***	0.242***	0.254***
	(0.0536)	(0.0279)	(0.0339)
Legislative fairness	0.0675**	-0.00476	0.0110
	(0.0310)	(0.0138)	(0.0155)
Firm's own web	0.418***	0.475***	0.345***
	(0.0548)	(0.0266)	(0.0344)
Constant	9.106***	8.687***	9.026***
	(0.0800)	(0.0381)	(0.0478)
Observations	3,443	12,421	7,299
R-squared Year FE	0.159	0.326	0.620
Country FE	Yes Yes	Yes Yes	Yes Yes

The results of annual interval regression show that in these three intervals, the coefficient of transfer is significantly positive. However, the coefficient is different, which indicates that there are time differences in the impact of technology transfer on the company's productivity, and different years have different effects. In 2006-2010, when technology transfer increased one unit, the Ln(productivity) increased by 13.6%, significant at the 10% level. This data increased to 29.5% in 2011-2015. In 2016-2020, it dropped to 13.2%, which is significant at the 1% level. Consequently, the impact of technology transfer on firm productivity is indeed different in different periods. However, productivity growth is not increasingly dependent on technology transfer. Perhaps technology transfer is related to the economic situation in different periods. 2006-2010 was the global financial

crisis, and 2011-2015 was at the stage of economic recovery. During the economic upturn, technology transfer has a more obvious promotion effect on enterprise productivity. Due to the impact of COVID-19 since 2021, global economic growth has slowed down, and the future economic recovery is bound to become an important factor affecting the productivity promotion of technology transfer. In the post-epidemic era, more and more in-depth research should be conducted on how to make technology transfer play a greater role in promoting productivity development in different regions and industries.

6. CONCLUSION

This empirical analysis separately tested the impact of technology transfer, region, year, and countries with different levels of development, on the firm productivity. Overall, technology transfer has a positive role in promoting the effect on the firm productivity, and there is heterogeneity effect in different countries and years.

Firstly, this paper concludes through empirical analysis that technology transfer in developing countries has a significant positive impact on firm productivity. The reason is that the introduction of advanced foreign technology can significantly improve productivity in countries with lower technological levels. Developing countries are generally technology absorbents, and technology transfer plays a relatively significant role in their technology improvement. While developed countries are usually technology exporters and absorb less technology from other countries, the impact of tech transfer is relatively low. Although economically advanced regions can benefit from technology transfer, it is not as effective as economically backward regions. Therefore, areas with high economic development levels should rely more on their technological innovation. Secondly, technology transfer in different years has different effects on firm productivity. Companies are usually more productive in an economic upturn. 2011-2015 was the early stage after the financial crisis. Markets had been recovering, and companies had been becoming more effective. During the global economic recession from 2016 to 2020, enterprise productivity showed a downward state.

However, this paper only analyzes the impact of technology transfer between different countries on companies. Future research should investigate the effect of technology transfer on companies in various industries, such as how manufacturing and information technology industries conduct technology transfer to promote social productivity. Technology transfer can enhance the competitiveness of enterprises and prevent them from being easily eliminated in the constantly updated market.

Therefore, relevant research has practical significance.

REFERENCES

[1] Jianbo Hu(2008). Kuaguo gongsi jishuzhuanyi de fangshi, yingxiang ji duice fenxi [Analysis on the ways, influencing factors, and countermeasures of technology transfer in multinational corporations]. Guoji jingji hezuo, 2008(02).

[2] Wang, L. (2015). Licensing Foreign Technology and the Moderating Role of Local

[3] Shulong Guo & Fan Yang. (2019). Guowai jishu shouquan, yanfa chuangxin yu qiye shengchanlv [Foreign technology licensing, R&D innovation and enterprise productivity]. *Chanye Jingji Pinglun:* 18-19.

[4] Tianying Jiang & Chengjun Liu. (2015). Changjiang sanjiaozhou quyu chuangxin yu jingji zengzhang de ouhe xietiao yanjiu [Research on the Coupling coordination between Innovation and economic growth in The Yangtze River Delta region]. *Diyu yanjiu yu kaifa, 34(06):* 8-13

[5] Zhaohan Tang & Zhang Chen. (2019). Quyu jingji chaju de xingcheng dongyin, yanbian lujing he fazsan qushi——jiyu jishu yinjin shijiao de yanjiu [Formation motivation, Evolution path and Development Trend of regional economic gap -- Based on the Perspective of technology introduction]. *Shanghai jingle yanjiu, (02):* 46-56.

[6] Feihang Wang & Youshun LI. (2019). Zizhu yanfa, jishu yinjin dui quyu chuangxin jixiaoyingxiang de menkan xiaoying [The threshold effect of independent research and development and technology introduction on regional innovation performance]. Diyu yanjiu yu kaifa, (02): 7-11.

[7] Hong Hu (2019). Huilv biandong due yizhixing qiye shengchanlv de yingxiang yanjiu—jiyu zhizaoye shangshi gongsi shuju de zhengju [Study on the effect of Exchange rate Fluctuations on productivity of Heterogeneous firms: Evidence based on the data of listed companies in manufacturing industry]. Shandong University.

[8] Arrow, K. (1962). Economic welfare and the allocation of resources for inventions. In: Nel son, R. (Ed.), The Rate and Direction of Inventive Activity. Princeton University Press, Princeton.

[9] Kami en, M. I. and Tauman, Y. (1986). Fees versus Royal ties and the Private Value of a Patent. Quarterly Journal of Economics,（101）: 471-491

[10] Katz, M. and Shapi ro, C. (1986). How to License Intangible Property. Quarterly Journal of Economics, 1986（101）: 567-589.

[11] Guiyun Cai & Aibing Li. (2011). Qiyejian jishu shouquan lilun: yige wenxian zongshu [The Theory of technology empowerment between enterprises: a literature review]. Xiandai guanli kexue, (02): 51.

[12] Zhongyi Ke (2008) . Jishu shouquan, Jishu chuangxin yu shehui fuli [Technology authorization, technology innovation and social welfare] Jinan University.

[13] Evenson R E & Joseph. J. (1999). Foreign Technology Licensing in Indian Industry: An Econometric Analysis of the Choice of Partners. Terms of Contract and the Effect on Licensees' Performance. Economic and Political Weekly, 34(27), 1801–1809.

[14] Tsai K H & Wang J C. (2007). Inward technology licensing and firm performance: alongitudinal study. *R&D Management, 37 (02) :* 151-160.R&D Collaboration: Extending the Relational View. The Journal of Product Innovation Management, 32(6), 997–1013.

[15] Lopez R A. (2008). Foreign Technology Licensing.Productivity and Spillovers. World Development, 2008, 36（04）: 560-574.

[16] Osabutey, W. (2014). The potential for technology and knowledge transfers between foreign and local firms: A study of the construction industry in Ghana. Journal of World Business: JWB, 49(4), 560–571.