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# *Research on Embedded Technology Import and the Growth of TFP in China's Manufacturing Industry —— Based on the Panel Data from 1992 to 2020*

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***Abstract:*** In the past few decades, the import of embodied technologies, mainly the import of capital goods and intermediate goods, has met the needs of industrial structure upgrading and export expansion. This paper uses the DEA-Malmquist method to measure the total factor productivity and its decomposition value of 26 manufacturing industries in China from 1992 to 2020, and uses a fixed effect model to empirically analyze the impact of embedded technology imports on China's manufacturing total factor productivity. The results show that the import of embedded technology has a positive effect on the total factor productivity of the manufacturing industry and technological advancement, while the impact on technical efficiency is not significant. After classifying the manufacturing industry according to the technical level, it is found that the import of embedded technology significantly improves the total factor productivity of low-tech and medium-tech manufacturing, while the impact on resource-based manufactured goods and high-tech manufactured goods is not significant. Finally, this paper gives policy recommendations based on the empirical results.

***Keywords:*** Embedded technology Import, Manufacturing, DEA-Malmquist Index Method, Fixed Effects Model.

## 1. Introduction

The import of embedded technology is the main way for developing countries to obtain the dynamic benefits of trade. It can not only make up for the "shortcomings" of industrial technology in developing countries in the short term, and create conditions for the upgrading of export product structure and export growth, but also help developing countries accumulate technical elements in the process of embedded technology import and product export. So as to realize the transformation of independent industrial technology innovation and economic growth model. However, the import of embedded technology to promote technological advancement is only a possibility. Its specific effect is affected by various factors, such as the motivation for importing embedded technology [1][2], domestic digestion and absorption capacity [3][4], etc.

Importing embedded technology has emerged as a key strategy for China to quicken the pace of technical advancement, particularly since the reform and opening up of the late 1990s. Under the guidance of foreign trade policies, China's embedded technology imports and product exports have greatly improved industrial technology and economic growth. Besides, China's embedded technology

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imports and product exports have made technological advancement with the characteristics of export-oriented technological advancement. Chinese academia has conducted a significant amount of research on this kind of global technological advancement in recent years. How to objectively examine the influence of imported embedded technology on total factor productivity (TFP), a crucial metric for gauging the rate of technological advancement, is one of the main focuses of the study. Existing research results usually use the import of intermediate products as a proxy variable for the import of embodied technologies [5][6]. The DEA technique does not need setting the producer's ideal behavior target or making certain assumptions about the structure of the production function, so it has become a main calculation method to measure the TFP [7][8]. The DEA-Malmquist method designed by Fare et al. in 1997 can better describe the dynamic changes of relative efficiency, so it has been widely used in analyzing historical data of different industries and regions [9]. We may develop an econometric model to estimate the effect of Chinese embedded technology import on technological advancement and assess the particular circumstances of Chinese export-oriented technological advancement based on assessing the level of embedded technology import and variations in TFP.

Academic studies on the influence of imported embedded technology on Chinese technological advancement have come to differing conclusions as a result of disparities in variable setup, data selection, and measurement model design. Using panel data from 32 industrial sectors in China from 1998 to 2003, Li et al. used a fixed effect regression model to empirically analyze the relationship between trade openness and industry technological improvement [10]. Their analysis shows that industries with high trade openness are not more technologically and scale-efficient than those with low trade openness. Yang used the data of the world input-output table from 1996 to 2009 to empirically analyze the effect of technological advancement of imports, and believed that the import trade of final consumer goods and intermediate products to be processed can significantly promote technological advancement, while the import trade of non-subsidiary processing intermediate products has a hindering effect on technological advancement [11].

This paper argues that the concept of "intermediate goods" is very broad, the import of embedded technology cannot be measured only by the import value of intermediate goods. Therefore, this paper tries to use the data in the UN Comtrade Database, and takes capital goods and "processed industrial supplies" as proxy variables for embedded technology imports.

Considering that the gap between imported embedded technology and the existing technology base will affect the technology absorptive capacity, this paper classifies each sector of the manufacturing industry according to technology intensity to examine the speed of technological advancement and the nature of technological advancement from 1992 to 2020. Finally, this article adopts a fixed effects model to experimentally examine the influence of imported embedded technology on the technological advancement of various industrial sectors. Based on this, this paper discusses the characteristics and sustainability of China's export-oriented technological advancement, and how to adjust the foreign trade policy to promote the level of opening to the outside world and achieve high-quality growth.

## 2. Basic situation of embedded technology import

The import level of embedded technology in this paper is expressed by the proportion of the total import of capital goods and intermediate goods (only processed industrial supplies) in the added value of each industry, which reflects the degree of dependence of a specific manufacturing sector on foreign technology. The Fig. 1. shows the proportion of each part in total import.

A large amount of literature equates the import of intermediate products with the import of embedded technology, but in fact, as a large category of products, the technical content of intermediate products varies greatly. To be precise, only "processed industrial products" have the properties of embedded technology. Therefore, we only consider the proportion of the industry's added value that comes from the importation of capital goods and the importation of processed industrial supplies in the intermediate products. This indicator reveals the degree of the industry's embedded technology imports.

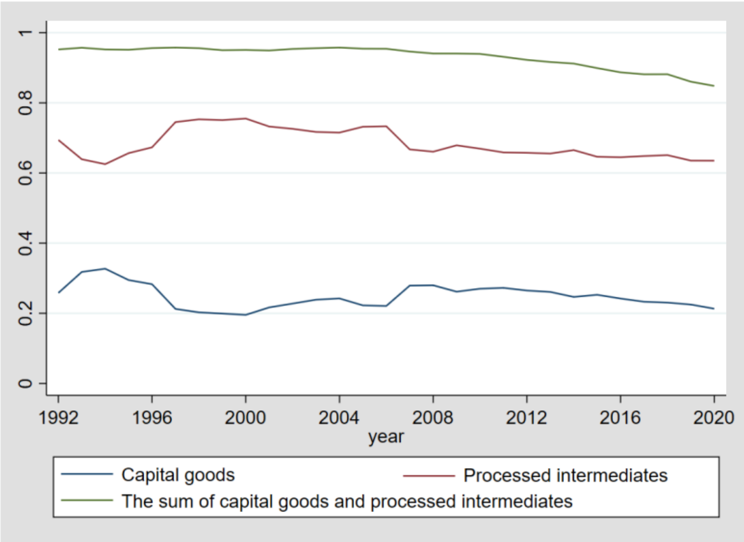


Figure 1: The proportion of each part in total import.

During the statistical process, we used the UN Comtrade Database to download all 76,525 import records under the SITC3 five-digit code, and used the correspondence table between the SITC3 five-digit code and the BEC4 classification provided by the United Nations Trade Statistics Division to classify all imported products into capital goods, processed intermediates goods, other intermediate goods, and consumer goods. The SITC3 five-digit code data is then divided into three-digit code data, and the SITC3 three-digit code data is then classified using processing principle of the Sheng in accordance with the standard GB/T 4754-2017 [12]. In this way, the values of capital goods, processed intermediate goods, other intermediate goods, and consumer goods in imports under the industry classification of the national economy are obtained. Calculate the proportion of the added value of capital goods and processed intermediate products in each industry and year in the added value of each industry in that year, and then the level of embedded technology imports can be obtained.

## 3. Calculation of Total Factor Productivity

### 3.1. Calculation method

The DEA-Malmquist index method takes each industry as a decision-making unit, uses the input-based DEA method to construct the best frontier of each industry in each period, compares the actual production and the best production frontier of each industry. So as to measure the total factor productivity change(TFPCH).

$$\mathrm{TFPCH} = \left[\frac{D^t(x_{t+1},y_{t+1})}{D^t(x_t,y_t)} * \frac{D^{t+1}(x_{t+1},y_{t+1})}{D^{t+1}(x_t,y_t)}\right]^{0.5} \tag{1}$$

In the formula (1), x represents the input and y the output, while the formulas $D^t(x_{t+1}, y_{t+1})$, $D^t(x_t, y_t)$, $D^{t+1}(x_{t+1}, y_{t+1})$, and $D^{t+1}(x_t, y_t)$ reflect the technological level of the $t+1$ period based on the $t+1$ period's technology, the current technical level of the t-period based on the t-period, the

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technical level of the t-period, and the technical level of the t-period based on the t-period. The TFPCH can be further decomposed into formula (2).

$$\mathrm{TFPCH} = \left[\frac{D^t(x_{t+1},y_{t+1})}{D^{t+1}(x_{t+1},y_{t+1})} * \left(\frac{D^{t+1}(x_{t+1},y_{t+1})}{D^t(x_t,y_t)}\right)^2 * \frac{D^t(x_t,y_t)}{D^{t+1}(x_t,y_t)}\right]^{0.5} = \left[\frac{D^t(x_{t+1},y_{t+1})}{D^{t+1}(x_{t+1},y_{t+1})} * \frac{D^t(x_t,y_t)}{D^{t+1}(x_t,y_t)}\right]^{0.5} * \frac{D^{t+1}(x_{t+1},y_{t+1})}{D^t(x_t,y_t)} = TECHCH * EFFCH \quad (2)$$

The TECHCH measures the movement of the technological boundary over two time periods, and the EFFCH measures the degree to which each decision object is catching up with the best practice boundary.

### 3.2. Selection of input-output indicators

In order to calculate the TFP using the DEA-Malmquist index approach, input and output indicators must be identified. We choose the added value of various industries as output indicators, and we choose labor input and capital stock as input indicators, taking data availability into consideration.

Considering output indicators, the China Industrial Statistical Yearbook directly provided the annual value-added data by industry from 1992 to 2007, but did not provide the value-added data for 2008 and later. We use the 2008-2020 industrial added value growth rate provided by the "China Economic Prosperity Monthly Report" to calculate the added value data for 2008 and subsequent years.

In terms of input indicators, we use the annual average number of all employees as labor input. When calculating the capital stock, the perpetual inventory method is used, and 1990 is selected as the base period, and the difference between the original values of fixed assets for two consecutive years is used as the newly added fixed assets. Data such as capital stock, depreciation rate, and new investment amount in the base period are sorted out and calculated in turn, and then the actual capital stock of each industry in the manufacturing industry is calculated. The formula for the computation is as follows.

$$K_t = I_t + (1-\delta)K_{t-1} \quad (3)$$

In the formula (3), $\delta$ is the depreciation rate of the current year, $K_t$ represents the actual capital stock in year t, $I_t$ is the new fixed assets of the manufacturing industry in that year.

### 3.3. Data processing

The sample data in this paper selects the data of 26 sub-sectors of the manufacturing industry from 1992 to 2020. The China Economic Census Yearbook in 2004, 2008, 2013, and 2018 provided the main of the data for this study. Besides, including the China Economic Statistics Yearbook from 1991 to 2021, the Statistical yearbook of China's industrial economy from 1991-2021, the China Monthly Economic Prosperity Report from 2008-2021, the China Science and Technology Statistical Yearbook from 1991-2021, and the China Price Statistical Yearbook, etc. Data are consolidated by industry, adjusted by statistical coverage, price and exchange rate indices.

First, drawing on the processing process of Chen, this paper names the data in different periods according to the GB/T4754-2017 industry classification standard, and on this basis, carries out the necessary merging and classification, and finally obtains 26 industry [13].

The second is the adjustment of statistical calibers. In 1997 and before, the scope of China's industrial statistics was divided by affiliation; in 1998 and later years, it was divided by enterprise

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scale. The change in statistical caliber prevents us from using the data in the yearbook directly. So, this study applies the method of Wang et al. to unify the caliber [14].

The third is the adjustment of price and exchange rate indices. In order to compare the data published at the price of the current year, in the calculation of the TFP, this paper adjusts the value-added data using the producer price index, taking 1990 as 100. The national fixed asset investment price index by year is used to modify the cost of fixed capital. The prices in the import and export data are converted using the "RMB exchange rate (annual average price)" reported in the China Economic Statistical Yearbook.

## 3.4. Calculation results

The TFP and associated breakdown variables for the manufacturing sector from 1992 to 2020 were calculated using the DEAP2.1 program.

Table 1: TFP of China's Manufacturing Industry and Its Decomposition.

| Serial number | Industry | TECHCH | EFFCH | TFPCH |
|---|---|---|---|---|
| 1 | Food Processing and Manufacturing | 1.011 | 1.025 | 1.036 |
| 2 | Manufacture of Liquor, Beverages and Refined Tea | 1.014 | 1.024 | 1.038 |
| 3 | Manufacture of Tobacco | 1.059 | 1.000 | 1.059 |
| 4 | Manufacture of Textile | 1.011 | 1.032 | 1.044 |
| 5 | Manufacture of Textile, Wearing Apparel and Accessories | 1.011 | 1.009 | 1.020 |
| 6 | Manufacture of Leather, Fur, Feather and Related Products and Footwear | 1.011 | 1.014 | 1.025 |
| 7 | Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products | 1.011 | 1.068 | 1.080 |
| 8 | Manufacture of Furniture | 1.011 | 1.015 | 1.026 |
| 9 | Manufacture of Paper and Paper Products | 1.015 | 1.009 | 1.024 |
| 10 | Printing and Reproduction of Recording Media | 1.012 | 1.008 | 1.020 |
| 11 | Manufacture of Articles for Culture, Education, Arts and Crafts, Sport and Entertainment Activities | 1.012 | 0.958 | 0.97 |
| 12 | Manufacture of Raw Chemical Materials and Chemical Products | 1.106 | 0.945 | 1.046 |
| 13 | Manufacture of Raw Chemical Materials and Chemical Products | 1.015 | 1.005 | 1.020 |
| 14 | Manufacture of Medicines | 1.013 | 1.021 | 1.034 |
| 15 | Manufacture of Chemical Fibres | 1.049 | 1.016 | 1.066 |
| 16 | Manufacture of Rubber and Plastics Products | 1.011 | 1.020 | 1.031 |
| 17 | Manufacture of Non-metallic Mineral Products | 1.013 | 1.014 | 1.027 |
| 18 | Smelting and Pressing of Ferrous Metals | 1.024 | 1.011 | 1.035 |
| 19 | Smelting and Pressing of Non-ferrous Metals | 1.014 | 1.013 | 1.026 |
| 20 | Manufacture of Metal Products | 1.011 | 1.014 | 1.025 |
| 21 | Manufacture of General Purpose Machinery | 1.011 | 1.026 | 1.037 |
| 22 | Manufacture of Special Purpose Machinery | 1.011 | 1.032 | 1.043 |
| 23 | Transportation Equipment Manufacturing | 1.013 | 1.023 | 1.036 |
| 24 | Manufacture of Electrical Machinery and Apparatus | 1.011 | 1.028 | 1.039 |
| 25 | Manufacture of Computers, Communication and Other Electronic Equipment | 1.012 | 1.047 | 1.06 |
| 26 | Manufacture of Measuring Instruments and Machinery | 1.011 | 1.05 | 1.061 |
| Average | | 1.019 | 1.016 | 1.036 |

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The Table 1. shows that between 1992 and 2020, manufacturing industris achieved notable strides in both technological advancement and technological efficiency. Technology efficiency and technological advancement have worked together to boost the TFP. From the perspective of industry segments, Processing of Petroleum, Coal and Other Fuels industry have the greatest improvement in technological advancement; the largest improvement in technical efficiency is Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products followed by Manufacture of Measuring Instruments and Machinery and Manufacture of Computers, Communication and Other Electronic Equipment; the largest increase in total factor productivity is Manufacture of Chemical Fibres. From the decomposed values of TFP, it can be found that the technical efficiency of industry 11 and industry 12 is less than 1. From the average term, it can be seen that in the past few decades, the contribution of technological advancement is greater than that of technical efficiency. There is still room for improvement and improvement in the technical efficiency of my country's manufacturing industry.

# 4. Empirical Analysis

## 4.1. Econometric Model

Taking the import level of embedded technology as the core explanatory variable, and drawing on the ideas of Chen and Liu, Liu and Zheng, Sheng and Liu [15-17]. This paper introduces foreign investment level, industry R&D investment level, human capital level and capital intensity as control variables, and establishes the regression model (4).

$$\mathrm{TH} = \alpha_{\mathrm{i}} + \beta_1 PHY_{it} + \beta_2 EXPD_{it} + \beta_3 FDI_{it} + \beta_4 RD_{it} + \beta_5 HUMAN_{it} + \beta_6 CAPITAL_{it} + \varepsilon_{it} \quad (4)$$

In the formula (4), TH represents the technological level of the industry, which is represented by the TFPCH, the TECHCH, and the EFFCH. The remaining variables are as follows. The i stands for the industry, t for the year, $\alpha_i$ for the industry fixed effect, PHY for the degree of embedded technology import, EXPD for the level of export dependence, FDI for the amount of foreign investment, RD for the amount of R&D investment, HUMAN for the degree of human capital, CAPITAL for the amount of capital intensity, and $\varepsilon_{it}$ for the random disturbance term.

## 4.2. Variable description

### 4.2.1. Explained variables

The TFPCH, TECHCH, and EFFCH are the explained variables in this paper.

### 4.2.2. Explanatory variables

The amount of imported embedded technology serves as the primary explanatory factor in this study. According to the above-mentioned, it measures the technical level contained in the imported products of different industries, and is expressed by the proportion of the sum of imports of capital goods and intermediate products (only processed industrial supplies) in each industry in the added value of each industry.

### 4.2.3. Control variables

Considering the influencing factors such as industry characteristics and years, this paper selects the following variables as control variables. The EXPD measures an industry's reliance on export trade by expressing the proportion of export value to added value by industry and year. The FDI denotes

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the amount of foreign money invested in various industries in my country. It is expressed as the ratio of total as-sets invested by international investors, Hong Kong, Macao, and Taiwan investors to total assets of the industry in various industries and years. The RD denotes the level of expenditure on scientific and technical activities in various sectors by calculating the proportion of total internal expenditure on technology development funds to product sales revenue by industry and year. The density of personnel engaged in scientific and technical activities in various sectors is represented by HUMAN, which is expressed as the number of scientific and technological personnel in the total number of employees by industry and year. The CAPITAL denotes the capital-labor ratio in an industry, as indicated by the capital stock-to-average annual employee ratio.

## 4.3. Evidence process

### 4.3.1. Descriptive statistics

Table 2 lists the descriptive statistical characteristics of all variables, and all continuous variables are tailed at the 1% level. According to the aforementioned statistical data, there is a significant disparity between the import levels of embedded technologies in different Chinese manufacturing industry subsectors. Additionally, the variations in capital intensity between industries are also rather significant.

Table 2: Descriptive Statistics.

| variable | sample | average value | standard deviation | minimum | maximum value |
|---|---|---|---|---|---|
| TFPCH | 754 | 1.0418 | 0.1060 | 0.7640 | 1.2640 |
| TECHCH | 754 | 1.0259 | 0.1196 | 0.7570 | 1.2580 |
| EFFCH | 754 | 1.0247 | 0.1318 | 0.7480 | 1.3840 |
| PHY | 754 | 0.3721 | 0.7408 | 0.0000 | 4.2051 |
| EXPD | 754 | 0.9340 | 1.2887 | 0.0084 | 5.7208 |
| RD | 739 | 0.2226 | 0.1161 | 0.0056 | 0.5085 |
| HUMAN | 754 | 0.0199 | 0.0204 | 0.0031 | 0.1183 |
| FDI | 629 | 0.0563 | 0.0396 | 0.0068 | 0.1606 |
| CAPITAL | 754 | 8.6003 | 8.4957 | 0.9154 | 37.5668 |

### 4.3.2. Analysis of regression results

The TFPCH, the TECHCH, and the EFFCH are used in this study as the explanatory variables for regression analysis, as indicated in Table 3. After adding control variables, it is discovered that the import of embedded technology has positive influence on TFPCH at the 1% level, and a considerable positive impact on TECHCH at the 5% level, but has no impact on EFFCH. Similar results persist after adding industry fixed effects. This demonstrates that while China's ability to advance technologically is restricted, the import of embodied technologies, particularly the import of capital goods and the import of processed intermediate goods, has an impact on total factor productivity. Capital goods and processed intermediate products are technology-intensive products, and a large number of imported machinery and equipment have replaced China's independent research and development, improved the production process of enterprises, and can directly change China's technology level. However, because there is a technological difference between China's manufacturing industry and that of advanced countries, direct purchase and introduction of technology would not solve the problem of technical efficiency.

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Table 3: Regression Results.

| | | | |
|---|---|---|---|
| Panel A: TFPCH | | | |
| PHY | 0.010 * | 0.022 *** | 0.067 *** |
| | (0.01) | (0.01) | (0.02) |
| _cons | 1.038 *** | 1.044 *** | 0.982 *** |
| | (0.00) | (0.01) | (0.03) |
| Control variable | No | Yes | Yes |
| Fixed industry | No | No | Yes |
| $R^2$ | 0.005 | 0.028 | 0.058 |
| N | 754 | 615 | 615 |
| Panel B: TECHCH | | | |
| PHY | 0.004 | 0.020 ** | 0.069 *** |
| | (0.01) | (0.01) | (0.02) |
| _cons | 1.024 *** | 1.006 *** | 0.913 *** |
| | (0.00) | (0.02) | (0.03) |
| Control variable | No | Yes | Yes |
| Fixed industry | No | No | Yes |
| R 2 | 0.001 | 0.042 | 0.118 |
| N | 754 | 615 | 615 |
| Panel C: EFFCH | | | |
| PHY | 0.006 | 0.003 | -0.006 |
| | (0.01) | (0.01) | (0.01) |
| _cons | 1.022 *** | 1.061 *** | 1.106 *** |
| | (0.01) | (0.02) | (0.01) |
| Control variable | No | Yes | Yes |
| Fixed industry | No | No | Yes |
| R 2 | 0.001 | 0.029 | 0.050 |
| N | 754 | 615 | 615 |

Note: ***, **, * represent the significance levels of 1%, 5%, and 10%, respectively, and the robust standard errors are in brackets.

### 4.3.3. Robustness test

After fully considering the reverse causality and endogeneity caused by omitted variables, we use the following methods to test the robustness in turn: using stochastic frontier analysis (SFA) to remeasure the explained variables, excluding the observations of the tobacco industry, and taking the explanatory variables as one period behind. These tests all prove that the regression results of this paper are relatively robust.

### 4.3.4. Heterogeneity analysis

In order to more thoroughly examine how embedded technology imports affect various industries' technical levels in China, this paper refers to the classification method of Lall[1] and divides 26 manufacturing industries into four categories according to their technical levels, including the

[1] Referring to classification method of Lall [18], this paper divides the 26 industries in Table 1 into 4 categories according to the technical level, which are resource-based manufactures (1, 2, 3, 7, 8, 12, 17), low-tech manufacturing Products industries (4, 5, 6, 9, 10, 11, 16, 19, 19, 20), medium-tech manufactures (13, 15, 21, 22, 23, 24) and high-tech manufactures (14, 25, 26).

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resource-based manufacturing industry (RB), low-tech manufactured products (LT), medium-tech manufactured products (MT) and high-tech manufactured products (HT). The results of regression on them are shown in Table (4).

Table 4: Regression grouped by technology level.

| | RB | | | LT | | |
|---|---|---|---|---|---|---|
| | TFPCH | TECHCH | EFFCH | TFPCH | TECHCH | EFFCH |
| PHY | 0.070 | -0.115 | 0.189*** | 0.249** | 0.270** | 0.000 |
| | (0.05) | (0.07) | (0.04) | (0.08) | (0.09) | (0.07) |
| _cons | 0.992*** | 0.948*** | 1.070*** | 0.853*** | 0.772*** | 1.104*** |
| | (0.02) | (0.02) | (0.03) | (0.03) | (0.04) | (0.04) |
| Control variable | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed | Yes | Yes | Yes | Yes | Yes | Yes |
| R2 | 0.050 | 0.131 | 0.060 | 0.140 | 0.181 | 0.059 |
| N | 168 | 168 | 168 | 236 | 236 | 236 |
| | MT | | | HT | | |
| | TFPCH | TECHCH | EFFCH | TFPCH | TECHCH | EFFCH |
| PHY | 0.100*** | 0.092*** | 0.010 | 0.116 | 0.049 | 0.095 |
| | (0.01) | (0.01) | (0.01) | (0.06) | (0.04) | (0.11) |
| _cons | 0.938*** | 0.875*** | 1.101*** | 1.098*** | 0.920*** | 1.235*** |
| | (0.05) | (0.05) | (0.02) | (0.07) | (0.08) | (0.02) |
| Control variable | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry fixed | Yes | Yes | Yes | Yes | Yes | Yes |
| R2 | 0.124 | 0.168 | 0.060 | 0.179 | 0.111 | 0.165 |
| N | 139 | 139 | 139 | 72 | 72 | 72 |

Note: ***, **, * represent the significance levels of 1%, 5%, and 10%, respectively, and the robust standard errors are in brackets.

The regression results show that, for the resource-based manufactured products sector, the amount of imported embedded technology strongly encourages the growth of EFFCH but has little bearing on TFPCH and TECHCH. For the low-tech manufactured goods industry, the embedded technology imports significantly promote the improvement of TEPCH and TECHCH, but the impact on EFFCH is not significant; for the medium-tech manufactured goods industry, the rise of TFPCH and TECHCH are both greatly boosted by the import of embedded technology, while the EFFCH has no effect; for high-tech manufactured goods, the level of embedded technology imports has no effect on TFPCH, TECHCH, or EFFCH. China is a big importer and also a big exporter. From the empirical results, the import of embedded technology has limited technological improvement in high-tech industries. China's manufacturing industry cannot achieve industrial technology upgrade only by pursuing embedded technology imports.

## 5. Conclusions

This study measures the total factor productivity across 26 industries in China's manufacturing sector from 1992 to 2020 and breaks it down into technological advancement and technological efficacy using the DEA-Malmquist index method. The impact of embedded technology import on TFP and its decomposition variables is then empirically analyzed. The empirical findings demonstrate that, while the impact on technical efficiency is minimal, the import of embedded technology greatly increases total factor productivity by fostering technological advancement. After classifying and regressing the manufacturing industry by technology level, it is found that the import of embedded technology significantly promotes the TFP of the low-tech manufactured goods industry and the medium-tech manufactured goods industry, while the impact on the TFP of the resource-based manufactured goods industry and the high-tech manufactured goods industry is not significant. While the effect on the advancement of technology is not immediately apparent, the import of embedded technology plays a larger role in increasing the technical efficiency of the sector for resource-based produced goods. For the low-tech manufactured goods industry and the medium-tech manufactured goods industry, the import of embedded technology is mainly to improve the TFP of the manufacturing industry by promoting technological advancement. China's high-tech industries have a low level of accumulation of technological capabilities, the import of embodied technologies therefore cannot significantly increase the TFP of high-tech companies since the capacity to absorb and digest imported embodied technologies is low.

To this end, this paper proposes the following suggestions. China's foreign trade is a significant approach to increase the rate of advancement in manufacturing technology, particularly at a time of deepening economic globalization and global value chains. China should continue to strongly support multilateral free trade, defend the basic rules of international trade, and effectively utilize both domestic and international markets and resources by expanding opening up, in order to improve the manufacturing industry's development level in open competition, and thus improve the manufacturing industry's TFP. Furthermore, the import of embedded technology can encourage the accumulation of technical knowledge and capacities, as well as the transition of China's industrial technological innovation into independent innovation. While pursuing the upgrading of the export product structure and the upgrading of the overall industrial structure based on the import of physical and chemical technologies shouldn't be taken too far, the import of embedded technology should match the accumulation of China's current industrial technical knowledge and technical capabilities. Giving embedded technology imports their due is crucial for fostering autonomous innovation. By stepping up investments in key technology research and development as well as the training of key talent, cultivating core technologies, speeding up the transformation and modernization of the manufacturing sector, encouraging new industries, developing strategic industries, collaborating with breakthrough industries to create a modern economic system, and enhancing China’s global competitiveness.

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