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The historical observation of the relationship between foreign trade and employment: Evidence from China's manufacturing industry

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Abstract: This paper aims to explore the relationship between foreign trade and employment in China's manufacturing sector, covering data analysis from 1998 to 2014. We used various econometric methods to analyze the impact of different components of foreign trade on related manufacturing employment. The findings indicate that export trade has a significant positive effect on employment in China's manufacturing sector, while import trade generally exerts a suppressive impact on employment, particularly imports from countries other than the United States. Specifically, the influence of imports from the United States is positive but not significant, warranting cautious interpretation. Additionally, the study elucidates the mechanisms of influence, suggesting that foreign trade affects employment levels in relevant industries through its impact on aggregate supply and demand. Furthermore, this study provides policy recommendations, including promoting trade development and optimizing trade structure, actively engaging in trade negotiations to address trade frictions, and focusing on domestic circulation to stabilize employment. These measures offer valuable references for policymakers to ensure the robust development and employment growth of China's manufacturing sector amid a complex and changing international environment.
Keywords: *Employment, Manufacturing industry, Trade.*

1. Introduction

China's economy has experienced rapid development over the past few decades following the initiation of the reform and opening-up policy. Key national economic indicators have improved significantly, and the rapid growth of foreign trade has powerfully boosted the domestic manufacturing sector. However, the increasingly complex and volatile international landscape presents challenges to the steady development of the foreign trade industry and affects employment in related manufacturing sectors. Therefore, a sound understanding of the historical relationship between foreign trade and employment is crucial for formulating reasonable policy recommendations. The relationship between international trade and employment involves both domestic and international factors, and the research background needs to be discussed from both perspectives. Currently, the world is undergoing profound changes unprecedented in a century, with a significant increase in unfavorable factors, posing challenges to the sustained and healthy development of China's foreign trade [1] A series of deglobalization factors, such as the Sino-US trade war, have increased uncertainty in China's foreign trade. As a major manufacturing exporter, China has a large labor force concentrated in trade-related industries such as assembly and manufacturing. Consequently, against the backdrop of constantly evolving international dynamics, China's domestic employment is likely to be affected to some extent. Concurrently, the domestic economy is at a critical stage of transformation and upgrading, and maintaining stable employment under the "new normal" is a key policy objective [2].

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This study focuses on the period surrounding China's accession to the WTO up to 2014, examining the impact of foreign trade on employment in related manufacturing industries. Using a variety of methods, the analysis rigorously assesses the influence of foreign trade on Chinese manufacturing employment. By dividing foreign trade into four components, we construct separate trade exposure variables and develop multiple instrumental variables to address endogeneity issues and capture a broader range of trade-related factors. The paper also presents regression results of trade exposure variables with other industry indicators and further tests robustness using the Limited-Information Maximum Likelihood (LIML) regression method and by adjusting the study period. Based on the findings regarding the impact of foreign trade on Chinese manufacturing employment, this paper proposes policy recommendations aimed at reducing foreign trade risk exposure and further optimizing the domestic manufacturing employment market.

2. Literature Review

Research on the relationship between import/export trade and employment has primarily focused on two aspects: aggregate employment and employment structure. Early studies, limited by data availability, mainly concentrated on the national level. According to traditional factor endowment theory and comparative advantage theory, trade will increase the relative demand for labor in a country's advantageous industries. Recent studies have also pointed out the positive impact of trade on employment [3] and similar conclusions have been drawn from research on Chinese companies Rodríguez-Lopez and Yu [4]. Greenaway, et al. [5]; Scott [6] and Spilerman [7] all argue that for developed countries, globalization increases the proportion of workers in capital-intensive industries, raising overall wage levels and quality of life. However, it also decreases the demand for low-skilled labor, thereby altering the employment structure. In contrast, Zhao [8] through analysis and summary, found that trade may lead to an increase in demand for high-skilled labor in all countries. Helpman, et al. [9] argue that in both developed and developing countries, companies engaged in export trade tend to be larger, more productive, better at screening workers, and pay higher wages than those not involved in export trade. However, Wei [10] points out the challenges of trade for developing countries. Because foreign trade can cause changes in industrial structure and the allocation of labor factors across different industries, it may lead to imbalances in the employment structure. Furthermore, with the continuous development of specialization and trade, imbalances may also occur within industries. Zhao [8] explicitly points out the uncertainty of the impact of imports on employment. Due to the increasing depth of international specialization, factors are rationally allocated on a global scale. Import trade, especially in some developing countries, is often the import of raw materials or intermediate goods, rather than the import of finished products to meet domestic consumption needs. At this point, the imported raw materials and intermediate goods are re-exported after processing, reflecting the country's foreign trade processing capacity. Therefore, the impact of imports on employment cannot be simply concluded to be employment-suppressing based solely on traditional theoretical analysis. Maltseva and Chupina [11] citing a WTO report, point out that there is no conclusive evidence that import competition leads to nationwide job losses, and the overall impact of trade on employment is positive. Additionally, with the deepening of international trade specialization, companies in various countries can import higher quality raw materials and intermediate goods at lower costs, which helps to expand company size and create more job opportunities [8, 12, 13]. There are also studies on the impact of the US trade war on domestic employment in the United States, and they found that the positive significance of trade protectionism on domestic employment is not significant [14].

Regarding the impact of import/export trade on employment in China, Liu [15] verified the promoting effect of China's foreign export trade on the national economy and employment after the reform and opening up. Li, et al. [16] based on the Cobb-Douglas production function and other related models, studied the impact of foreign trade on employment in different industries. They found that the impact of imports on employment in related industries was not significant, while export trade had a significant positive impact on employment in related industries during the period 2000-2014. Xue and Zhou [17] also conducted research using similar methods. Zhang, et al. [18] studied the impact of export trade on employment at the industry level during the period 2000-2009. They employed a more classic input-output model and found that exports had a significant promoting effect on employment in related industries, but the marginal impact gradually decreased as exports increased. Wang and Zhang [19] analyzed the effects of trade liberalization on employment in China, providing evidence that further supports the positive association between export trade and employment growth.

Many empirical studies on the relationship between trade and employment in China (e.g., [20, 21] adopted the method of constructing a benchmark model using the Cobb-Douglas production function, as used by Greenaway, et al. [22]. Differently, this paper mainly refers to the research methods of Autor, et al. [14]; Acemoglu, et al. [23] and Feenstra, et al. [24] on the relationship between trade and employment in the United States. In terms of the benchmark model, Autor, et al. [14] established a benchmark regression equation at the local level in the United States to study the impact of import trade, especially US imports from China, on employment in related manufacturing industries in the United States. Acemoglu, et al. [23] built a benchmark model at the industry level based on Autor, et al. [14] to study the relationship between import trade and employment in related manufacturing industries in the United States. Acemoglu, et al. [23] pointed out that establishing benchmark models at either the industry level or the local level has certain advantages and disadvantages, mainly due to the impact of labor reallocation and aggregate demand effects at different levels. Therefore, while establishing a model at the industry level to study the impact of import trade on employment, Acemoglu, et al. [23] also considered local-level factors, transforming the model and related variables to verify and supplement the research conclusions from a local perspective. Feenstra, et al. [24] extended the model of Acemoglu, et al. [23] expanding from only studying the impact of imports on US employment to studying the impact of both imports and exports on related employment in the United States, dividing imports and exports into four main parts and analyzing the impact of each part on employment. The research in this paper is also based on the model established by Acemoglu, et al. [23] and with the help of the extension method of Feenstra, et al. [24] adjusts and establishes a model equation for studying the impact of import and export trade on related manufacturing in China.

3. Mechanisms of Foreign Trade's Impact on Employment

One of the most direct mechanisms by which trade affects employment is through the impact of imports and exports on aggregate supply and demand, respectively, which in turn influences employment in related industries. When domestic effective demand is insufficient, exports can drive an increase in aggregate demand, thereby promoting employment and wage growth in related sectors. For China, during the historical period of leveraging its cheap labor advantage and the continuous adjustment of foreign trade policies, exploring overseas markets has generally and effectively promoted employment and income growth [2, 25]. Conversely, according to most trade theories, imports can inhibit domestic employment and income levels by affecting aggregate supply and domestic competitive intensity. In fact, with the deepening of international specialization and the rapid development of intra-industry trade, the impact of imports on domestic employment and income has become more complex. There are bound to be differences in the impact of importing finished products versus intermediate goods on the national economy. In addition, overall, because exports increase aggregate demand while imports pose a challenge to domestic supply, imports often have a negative impact on employment, while the impact of exports is usually positive. However, with the continuous deepening of industrial specialization, rapid technological progress, and the increasing complexity of factor composition, judging the impact of imports and exports on employment through aggregate supply and demand becomes increasingly difficult. For example, when technology advances, export growth still means an increase in aggregate demand, but at this time, labor may be replaced by other factors due to technological innovation.

According to major trade theories, specialized international division of labor means that countries will focus on industries in which they have advantages, whether due to higher labor productivity, richer resources, or more advanced technology. At this time, the factor inputs and final allocation of related industries will be affected by international division of labor and trade, and the labor market is no exception. Therefore, specialized international division of labor can affect a country's employment size and employment structure. For example, when a country specializes in the production of labor-intensive products, although the country's labor income is still low in international comparison, from its own development perspective, various factors will gather towards labor-intensive industries, and the employment situation and labor income in related industries are expected to improve. Conversely, the employment and income of other sectors may be affected, but given the mobility of labor between industries, this impact is relatively limited. For China, after the reform and opening up until the beginning of this century, it mainly relied on cheap labor and resource advantages to specialize in the production of low value-added, labor-intensive products. During the same period, labor continued to concentrate in the economically developed coastal areas with flourishing foreign trade. Taking manufacturing as an example, the number of people employed in the related manufacturing industries studied in this paper increased from more than 40 million in 1998 to more than 120 million in 2014. However, as China's position in the global industrial chain and value chain has gradually improved in recent years, and as domestic and foreign industrial chains have become increasingly rich and optimized, the employment structure and the employment scale of various industries have also been continuously changing.

Actively developing foreign trade can simultaneously drive the cross-border flow of related factors, especially capital and technology, thereby impacting the development and technological progress of related industries, and thus affecting employment and income in related industries. For China, foreign trade, especially export trade, has effectively promoted domestic capital accumulation in related industries, driven the expansion of industry scale, and thus promoted employment and income levels. At the same time, the deepening of openness to the outside world and the rapid development of related industries will also attract more foreign investment. The continuous growth of investment further boosts the expansion and structural optimization of industry scale, thereby causing changes in employment scale and employment structure. In addition, increased investment and the cross-border flow of technology can effectively promote technological progress in related industries, promote overall industrial upgrading, and thus affect employment in related industries.

4. Empirical Research Design

To study the impact of foreign trade, especially export trade to the United States, on employment in related manufacturing industries in China at the industry level, this study transforms the equation used by Acemoglu, et al. [23] to study the impact of trade on employment in the United States, and optimizes and extends the equation with the help of the method of Feenstra, et al. [24] establishing the following benchmark equation:

$$\Delta \ln(Numlar_{ind,t}) = \delta_t + B \cdot VAR_{ind,t} + \Gamma Z_{ind,t} + \varepsilon_{ind,t} \qquad (1)$$

Where, the dependent variable $\Delta \ln\left(Numlar_{ind,t}\right)$ is the annual average change in the logarithm of the number of labor employed in industry ind during period t. ind is the 2-digit industry classification code in the "National Economic Industry Classification" (GB/T4754-2002). $VAR_{ind,t}$ is a column vector composed of a set of trade exposure variables $\left(Var_{ind,t}^{us,cn}, Var_{ind,t}^{row,cn}, Var_{ind,t}^{cn,us}, Var_{ind,t}^{cn,row}\right)^T$, including four trade exposure variables: $Var_{ind,t}^{us,cn}$ is China's import trade exposure from the United States,

$Var_{ind,t}^{row,cn}$ is China's import trade exposure from countries other than the United States, $Var_{ind,t}^{cn,us}$ is China's export trade exposure to the United States, and $Var_{ind,t}^{cn,row}$ is China's export trade exposure to countries other than the United States. B is a row vector composed of a set of coefficients $(\beta_1, \beta_2, \beta_3, \beta_4)$, and the coefficients correspond to the four trade exposure variables respectively. Theoretically, to study the impact of total import exposure and two export exposures on Chinese employment, $VAR_{ind,t}$ is adjusted to $\left(Var_{ind,t}^{global,cn}, Var_{ind,t}^{cn,us}, Var_{ind,t}^{cn,row}\right)^T$, where $Var_{ind,t}^{global,cn}$ represents the total import trade exposure variable, and B is also adjusted accordingly. For convenience, the experiment will not change the form of the benchmark equation, but rather limit the parameters, for example, by limiting $\beta_1 = \beta_2$ in B to achieve the experimental purpose.

$Z_{ind,t}$ is a column vector composed of industry-specific control variables for industry ind including some industry initial indicators and process control variables, where the initial indicators do not change with t. Correspondingly, Γ is a row vector composed of control variable coefficients. δ_t represents the time-varying constant, and $\varepsilon_{ind,t}$ is the error term. t represents the five sub-periods selected for the study, which are 1998-2001, 2001-2004, 2004-2007, 2007-2011, and 2011-2014. The variables in the benchmark equation and related subsequent experiments are matched to the changes in these five periods. In addition, since the length of each sub-period is not equal (3-4 years), all indicators involving changes within a certain period in the benchmark equation need to be annualized. The value-related variables involved in the equation are converted through exchange rates and price deflators, and the units are all adjusted to initial-period US dollars.

4.1. Trade Exposure Variables

The trade exposure variables are constructed using a method similar to that of Acemoglu, et al. [23] calculated by adjusting the ratio of the change in trade volume during a specific period to the domestic total industrial output value in the base period. First, the variable used to measure import trade exposure from the United States is defined as:

$$Var_{ind,t}^{us,cn} \equiv \frac{\Delta V_{ind,t}^{us,cn}}{Y_{ind,t_0'}} \qquad (2)$$

Where $Var_{ind,t}^{us,cn}$ is the import trade exposure from the United States faced by China's industry ind in period t. The subscript "us, cn" represents that the variable reflects China's imports from the United States, and ind is the 2-digit industry classification code in the "National Economic Industry Classification" (GB/T4754-2002). t is the five time periods, which are 1998-2001, 2001-2004, 2004-2007, 2007-2011, and 2011-2014. The numerator $\Delta V_{ind,t}^{us,cn}$ in the formula is the annual average change in China's import trade volume from the United States in industry ind during period t, and the denominator $Y_{ind,t_0'}$ is the initial total output value of China's industry ind, with 1998 set as the initial period in this study. Similarly, the formula for measuring import trade exposure variables from countries other than the United States is:

$$Var_{ind,t}^{row,cn} \equiv \frac{\Delta V_{ind,t}^{row,cn}}{Y_{ind,t_0'}} \qquad (3)$$

The overall import exposure variable is:

$$Var_{ind,t}^{global,cn} \equiv \frac{\Delta V_{ind,t}^{global,cn}}{Y_{ind,t_0'}} \qquad (4)$$

Where *global* does not represent all countries in the world other than China, but rather the set of the United States and other countries selected in this study. Therefore, it can be assumed that $\Delta V_{ind,t}^{global,cn}$ is equal to the sum of $\Delta V_{ind,t}^{us,cn}$ and $\Delta V_{ind,t}^{row,cn}$, and formula (4) can be transformed into:

$$Var_{ind,t}^{global,cn} = Var_{ind,t}^{us,cn} + Var_{ind,t}^{us,cn} \qquad (5)$$

In subsequent experiments, if the impact of overall imports on Chinese employment needs to be studied, that is, the overall import exposure $Var_{ind,t}^{global,cn}$ faced by China needs to be used, then the parameters of $Var_{ind,t}^{us,cn}$ and $Var_{ind,t}^{us,cn}$ can be directly restricted to be the same, or the sum of the two can be substituted into the experiment. The above is the variable setting for the import exposure faced by China. The export exposure variables faced by China are set as follows:

$$Var_{ind,t}^{cn,us} \equiv \frac{\Delta V_{ind,t}^{cn,us}}{Y_{ind,t_0'}} \qquad (6)$$

$$Var_{ind,t}^{cn,us} \equiv \frac{\Delta V_{ind,t}^{cn,row}}{Y_{ind,t_0'}} \qquad (7)$$

$$Var_{ind,t}^{cn,us} \equiv \frac{\Delta V_{ind,t}^{cn,global}}{Y_{ind,t_0'}} \qquad (8)$$

Similarly, *global* represents the set of the United States and other countries selected in this study, that is, it is assumed that $\Delta V_{ind,t}^{cn,global}$ is equal to the sum of $\Delta V_{ind,t}^{cn,us}$ and $\Delta V_{ind,t}^{cn,row}$, so we get:

$$Var_{ind,t}^{cn,global} = Var_{ind,t}^{cn,us} + Var_{ind,t}^{cn,row} \qquad (9)$$

In subsequent experiments, if the impact of overall exports on Chinese employment needs to be studied, that is, the overall export exposure variable $Var_{ind,t}^{cn,global}$ faced by China needs to be used, then the parameters of $Var_{ind,t}^{cn,us}$ and $Var_{ind,t}^{cn,row}$ can be directly restricted to be the same, or the sum of the two can be substituted into the experiment. It should be emphasized that the original data units involving value used in the above variable calculations are inconsistent, such as the change in trade volume and the total industrial output value, and the units have all been adjusted to initial-period US dollars. In addition, since the selected time periods for the study are of different lengths, data involving changes within a certain period need to be annualized, such as the change in trade volume in a certain period needs to be the annual average change in the relevant time period.

4.2. OTH Instrumental Variables

The benchmark equation faces the problem of endogeneity. Different types of supply- and demand-side shocks can have multiple complex effects on both employment and trade simultaneously, thus affecting the accuracy of the experiment. For example, export growth driven by increased external demand can promote employment growth, but comparative advantages brought about by technological progress promote China's export growth, which may lead to domestic labor being replaced by automated machines [24]. In their research on related issues in the United States, Autor, et al. [14] first used foreign trade indicators of similar countries as instrumental variables to solve the endogeneity problem in the model, and this approach has been widely borrowed [23, 24, 26]. Similarly, this study selects trade indicators from 10 similar emerging countries or regions as instrumental variables to, to

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some extent, address endogeneity and obtain more accurate impacts. OTH represents a collection of 10 similar countries or regions, including Brazil, Hong Kong, India, Malaysia, Mexico, the Philippines, Singapore, Taiwan, Thailand, and Vietnam. First, the calculation formula for the OTH import trade exposure variable from the United States is as follows:

$$Oth_{ind,t}^{us,cn} \equiv \frac{\Delta V_{ind,t}^{us,oth}}{Y_{ind,t_0'}} \tag{10}$$

Where $Oth_{ind,t}^{us,cn}$ is the import trade exposure from the United States faced by the OTH collection's ind industry in period t. On the right side of the formula, $\Delta V_{ind,t}^{us,oth}$ is the annual average change in the import trade volume of the ind industry from the United States during period t, with the 10 countries or regions of OTH treated as a whole. $Y_{ind,t_0'}$ is still the initial total output value of China's ind industry. Similarly, the calculation formula for the OTH import trade exposure variable from countries other than the United States is as follows:

$$Oth_{ind,t}^{row,cn} \equiv \frac{\Delta V_{ind,t}^{row,oth}}{Y_{ind,t_0'}} \tag{11}$$

The calculation formula for the OTH export trade exposure variable to the United States is:

$$Oth_{ind,t}^{cn,us} \equiv \frac{\Delta V_{ind,t}^{oth,us}}{Y_{ind,t_0'}} \tag{12}$$

The calculation formula for the OTH export trade exposure variable to countries other than the United States is:

$$Oth_{ind,t}^{cn,row} \equiv \frac{\Delta V_{ind,t}^{oth,row}}{Y_{ind,t_0'}} \tag{13}$$

4.3. PRE Instrumental Variables

Although OTH has been proven to be an effective instrumental variable, previous studies have focused more on using OTH variables to accurately capture factors of a single trading partner and trade flow. Accuracy can be improved through related controls during the experiment. For a comprehensive study of the impact of multiple trading partners and trade flows, PRE and TAR instrumental variables need to be further introduced [24]. Based on the above considerations and inspired by Feenstra, et al. [24] this study will establish a set of gravity model-based instrumental variables on the basis of the OTH instrumental variables, so that the entire instrumental variable strategy simultaneously includes OTH countries' trade indicators and tariff indicators, and effectively captures and handles some of the influencing factors that need to be excluded in the process of constructing instrumental variables. Taking China's import trade from the United States as an example, first refer to Romalis [27] to establish the following CES symmetric equation:

$$\frac{V_{k,v,t'}^{us,cn}}{V_{k,v,t'}^{us,i}} = \left(\frac{w_{k,t'}^{cn} d^{us,cn} \tau_{k,t'}^{us,cn}}{w_{k,t'}^{i} d^{us,i} \tau_{k,t'}^{us,i}}\right)^{1-\sigma} \tag{14}$$

Where, theoretically, i can represent any country other than China. To some extent, the above formula reflects the substitution relationship between China and country i in imports from the United States. In this study, $i \in oth$, that is, i only represents one country or region in the OTH collection.

$V_{k,v,t'}^{us,cn}$ refers to the value of China's import trade from the United States in the v subdivision of product category k at time t'; t' represents the initial year of each t period and the final year of the total time period, 2014, namely 1998, 2001, 2004, 2007, 2011 and 2014; k is the 6-digit product code according to the HS92 standard, which is different from the 2-digit code used by ind in the benchmark equation. v is a further subdivision under product category k, v must be greater than 6 digits but is not specifically set, and is only used for instrumental variable model derivation, and the data experiment does not involve this content. $V_{k,v,t'}^{us,i}$ refers to the import trade value of the v subdivision of product k from the United States by country i at time t'. $w_{k,t'}^{cn}$ is the relative marginal cost of China producing product k at time t'; $w_{k,t'}^{i}$ is the relative marginal cost of country i producing product k at time t'. $d^{us,cn}$ refers to the trade distance between the United States and China, including geographical distance and other general trade costs; $d^{us,i}$ refers to the trade distance between country i and the United States, including the geographical distance between country i and the United States and other general trade costs. $\tau_{k,t'}^{us,cn}$ represents the average tariff rate of the United States' k product imported into China at time t'; $\tau_{k,t'}^{us,i}$ represents the average tariff rate of the United States' k product imported into country i at time t'; i is the elasticity of substitution. Referring to the derivation process of Feenstra, et al. [24] and making reasonable adjustments, both sides of formula (14) are multiplied by the number of v subdivisions under product category k imported by country i at time t', $N_{k,t'}^{*,i}$, and country i is aggregated into the OTH collection to obtain the following formula:

$$V_{k,v,t'}^{us,cn} \sum_{i\in oth} N_{k,t'}^{*,i}\left(w_{k,t'}^{i} d^{us,i}\right)^{1-\sigma} = \left(w_{k,t'}^{cn} d^{us,cn} \tau_{k,t'}^{us,cn}\right)^{1-\sigma} \sum_{i\in oth} N_{k,t'}^{*,i} V_{k,v,t'}^{us,i}\left(\tau_{k,t'}^{us,i}\right)^{\sigma-1} \qquad (15)$$

Next, both sides of formula (15) are multiplied by $N_{k,t'}^{*,cn}$, and it is assumed that $V_{k,t'}^{us,cn}$ is equal to $N_{k,t'}^{*,cn}\, V_{k,v,t'}^{us,cn}$, and $V_{k,t'}^{us,i}$ is equal to $N_{k,t'}^{*,i}\, V_{k,v,t'}^{us,i}$, after a simple transformation, we get:

$$V_{k,t'}^{us,cn} = \left[\frac{N_{k,t'}^{*,cn}\left(w_{k,t'}^{cn} d^{us,cn} \tau_{k,t'}^{us,cn}\right)^{1-\sigma}}{\sum_{i\in oth} N_{k,t'}^{*,i}\left(w_{k,t'}^{i} d^{us,i}\right)^{1-\sigma}}\right] \times \left(\sum_{j\in oth} V_{k,t'}^{us,j}\right) \times \sum_{i\in oth} \frac{V_{k,t'}^{us,i}\left(\tau_{k,t'}^{us,i}\right)^{\sigma-1}}{\sum_{j\in oth} V_{k,t'}^{us,j}} \qquad (16)$$

Formula (16) is further adjusted, and logarithms are taken on both sides. At the same time, $V_{k,t}^{us,oth}$ is equal to $\sum_{j\in oth} V_{k,t}^{us,j}$ is substituted to obtain:

$$\ln\left(V_{k,t'}^{us,cn}\right) = \theta_{k,t'}^{cn} + \varphi^{us,cn} + \ln\left(\tau_{k,t'}^{us,cn}\right)^{1-\sigma} + \ln\left[\frac{\sum_{i\in oth} V_{k,t'}^{us,i}\left(\tau_{k,t'}^{us,i}\right)^{\sigma-1}}{V_{k,t'}^{us,sth}}\right] + \ln\left(V_{k,t'}^{us,oth}\right) + \varepsilon_{st'}^{us} \qquad (17)$$

Where, $\theta_{k,t'}^{cn}$ is equal to $\ln\left(N_{k,t'}^{*,cn}\left(w_{k,t'}^{cn}\right)^{1-\sigma}\right)$ represents relevant domestic factors in China, and a two-way fixed effect is adopted in the empirical study and is appropriately adjusted; $\varphi^{us,cn}$ is equal to $(1-\sigma)\ln(d^{us,cn})$ represents the trade distance between the United States and China, including geographical distance and other general trade costs, which is a constant in the experimental results. $\varepsilon_{st'}^{us}$

is equal to $-\ln\left(\sum_{i\in oth} N_{k,t'}^{*,i}\left(w_{k,t'}^{i} d^{us,i}\right)^{1-\sigma}\right)$ is treated as an error term in the experiment. Finally, based on formula (17), the following linear regression equation is established:

$$\ln\left(V_{k,t'}^{us,cn}\right) = \theta_{k,t'}^{cn} + \varphi^{us,cn} + \alpha_1 \ln\left(\tau_{k,t'}^{us,cn}\right)$$
$$+\alpha_2 \ln\left(T_{k,t'}^{us,oth}\right) + \ln\left(V_{k,t'}^{us,oth}\right) + \varepsilon_{k,t'}^{us} \quad (18)$$

Where, the dependent variable $\ln\left(V_{k,t'}^{us,cn}\right)$ is the logarithm of China's import trade value from the United States for product k at time t'. The core explanatory variables mainly consist of the logarithms of $\tau_{k,t'}^{us,cn}$、$T_{k,t'}^{us,oth}$, and $V_{k,t'}^{us,oth}$. $\tau_{k,t'}^{us,cn}$ represents the import tariff rate (percentage points) of product k imported from the United States at time t'; $T_{k,t'}^{us,oth} \equiv \left(\frac{\sum_{i\in oth} V_{k,t'}^{us,i}\left(\tau_{k,t'}^{us,i}\right)^{\sigma-1}}{V_{k,t'}^{us,sth}}\right)^{\frac{1}{\sigma-1}}$ is the geometric weighted average of the import tariff rate (percentage points) of product k imported from the United States by the OTH collection at time t', based on the elasticity of substitution and trade share. $V_{k,t'}^{us,oth}$ is the value of the import trade of product k from the United States by the OTH collection at time t'. According to theoretical derivation, the coefficient $\alpha_1 = 1-\sigma$, and $\alpha_2 = \sigma - 1$, but in the experiment, the relationship between α_1 and α_2 will not be restricted, and only the influence direction of the sign, that is, the variable, will be verified when observing the parameter estimation results. Since $\sigma > 1$, it is reasonable to speculate that $\alpha_1 < 0$, that is, the import tariff on China's imports from the United States has a negative impact on China's import trade value from the United States. At the same time, it can be speculated that $\alpha_2 > 0$, that is, the import tariff of the OTH collection from the United States has a positive impact on China's import trade value from the United States. Furthermore, the same method is used to establish a linear regression equation for constructing instrumental variables for China's imports from countries other than the United States:

$$\ln\left(V_{k,t'}^{row,cn}\right) = \theta_{k,t'}^{cn} + \varphi^{row,cn} + \alpha_1 \ln\left(\tau_{k,t'}^{row,cn}\right)$$
$$+\alpha_2 \ln\left(T_{k,t'}^{row,oth}\right) + \ln\left(V_{k,t'}^{row,oth}\right) + \varepsilon_{k,t'}^{row} \quad (19)$$

Similarly, regarding exports, taking China's export trade to the United States as an example, refer to Romalis [27] and Feenstra, et al. [24] to establish a CES symmetric equation:

$$\frac{V_{k,v,t'}^{cn,us}}{V_{k,v,t'}^{i,us}} = \left(\frac{w_{k,t'}^{cn} d^{cn,us} \tau_{k,t'}^{cn,us}}{w_{k,t'}^{i} d^{i,us} \tau_{k,t'}^{i,us}}\right)^{1-\sigma} \quad (20)$$

The intermediate derivation process is similar to that of imports, and the specific derivation process is omitted. Based on the derivation results, a linear regression equation for constructing instrumental variables for China's exports to the United States is established:

$$\ln\left(V_{k,t'}^{cn,us}\right) = \theta_{k,t'}^{cn} + \varphi^{cn,us} + \alpha_1 \ln\left(\tau_{k,t'}^{cn,us}\right)$$
$$+\alpha_2 \ln\left(T_{k,t'}^{oth,us}\right) + \ln\left(V_{k,t'}^{oth,us}\right) + \varepsilon_{k,t'}^{us} \quad (21)$$

A linear regression equation for constructing instrumental variables for China's exports to countries other than the United States is established:

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$$\ln\left(V_{k,t'}^{cn,row}\right) = \theta_{k,t'}^{cn} + \varphi^{cn,row} + \alpha_1 \ln\left(\tau_{k,t'}^{cn,row}\right)$$
$$+\alpha_2 \ln\left(T_{k,t'}^{oth,row}\right) + \ln\left(V_{k,t'}^{oth,row}\right) + \varepsilon_{k,t'}^{row} \quad (22)$$

Table 1.
PRE Regression Results.

	$\ln(V_{k,t'}^{us,cn})$		$\ln(V_{k,t'}^{row,cn})$		$\ln(V_{k,t'}^{cn,us})$		$\ln(V_{k,t'}^{cn,row})$	
	$\ln(V_{k,t'}^{us,oth})$	1	$\ln(V_{k,t'}^{row,oth})$	1	$\ln(V_{k,t'}^{oth,us})$	1	$\ln(V_{k,t'}^{oth,row})$	1
	$\ln(\tau_{k,t'}^{us,cn})$	-0.05	$\ln(\tau_{k,t'}^{row,cn})$	-0.19***	$\ln(\tau_{k,t'}^{cn,us})$	-0.45***	$\ln(\tau_{k,t'}^{cn,row})$	-0.09***
	$\ln(T_{k,t'}^{us,oth})$	0.19***	$\ln(T_{k,t'}^{row,oth})$	0.05***	$\ln(T_{k,t'}^{oth,us})$	0.36***	$\ln(T_{k,t'}^{oth,row})$	0.10***
N		22899		25979		21448		26761
Id FE		√		√		√		√
Year FE		√		√		√		√
R2		0.12		0.04		0.20		0.18

Note: * p < 0.10, ** p < 0.05, *** p < 0.01。

Table 1 reports the regression results from the four linear equations used to construct the instrumental variables. The experimental process utilizes panel data from six years: 1998, 2001, 2004, 2007, 2011, and 2014, adhering to the HS92 six-digit code standard, with sample sizes exceeding 20,000 in each case. All regressions are based on a two-way fixed effects model, and the monetary values are consistently expressed in initial U.S. dollars. Column (1) presents the results from the regression based on Equation (18). In order to align with the equation's specification and effectively isolate the impact of the trade indicators related to OTH, the parameter of $\ln(V_{k,t'}^{us,oth})$ is constrained to 1 during the regression. The estimated coefficient for $\ln\left(\tau_{k,t'}^{us,cn}\right)$ is -0.05 and is not significant; in contrast, the estimated coefficient for $\ln(T_{k,t'}^{us,oth})$ is 0.19 and is significant. This supports the hypothesis formulated during the equation construction that tariffs on imports from the U.S. negatively affect China's import trade value from the U.S., while tariffs on products in the OTH category positively influence China's import trade value from the U.S. Column (2) shows the results from the regression based on Equation (19), where the parameter for the trade indicator $\ln(V_{k,t'}^{row,oth})$ is similarly constrained to 1. The estimated coefficient for $\ln(\tau_{k,t'}^{row,cn})$ is -0.19, significant; while $\ln(T_{k,t'}^{row,oth})$ yields a coefficient estimate of 0.05, also significant, consistent with the initial hypotheses. Columns (3) and (4) display regression results based on Equations (21) and (22), respectively, where all estimated coefficients are significant and their signs match the predictions made during the equation construction; further elaboration on these results is unnecessary.

The next step involves fitting the relevant dependent variables based on the associated regression equations and their results. This allows for the calculation of the fitted values for China's imports from the U.S. for product k at time t', denoted as $\hat{V}_{k,t'}^{us,cn}$, as well as the fitted values for imports from countries outside the U.S., exports to the U.S., and exports to other countries, represented as $\hat{V}_{k,t'}^{row,cn}$, $\hat{V}_{k,t'}^{cn,us}$, and $\hat{V}_{k,t'}^{cn,row}$, respectively. Since $\hat{V}_{k,t'}^{us,cn}$, $\hat{V}_{k,t'}^{row,cn}$, $\hat{V}_{k,t'}^{cn,us}$, and $\hat{V}_{k,t'}^{cn,row}$ are all data at the k product level (according to the HS92 six-digit product code), it is necessary to use a code conversion table to aggregate these four fitted values into two-digit industry code data at the ind product level, according to the "National Economic Industry Classification" (GB/T 4754-2002). The conversion process can be summarized as follows:

$$\hat{V}_{ind,t'}^{us,cn} = \sum_{k \in ind} \hat{V}_{k,t'}^{us,cn} \quad (23)$$

$$\hat{V}^{row,cn}_{ind,t'} = \sum_{k\in ind} \hat{V}^{row,cn}_{k,t'} \tag{24}$$

$$\hat{V}^{cn,us}_{ind,t'} = \sum_{k\in ind} \hat{V}^{cn,us}_{k,t'} \tag{25}$$

$$\hat{V}^{cn,row}_{ind,t'} = \sum_{k\in ind} \hat{V}^{cn,row}_{k,t'} \tag{26}$$

At this stage, we have obtained fitted values for the four types of China's foreign trade at the ind industry level for time t'. Utilizing these fitted values, we can construct the PRE instrumental variables. First, the PRE instrumental variable for China's import exposure from the U.S. is defined as:

$$Pre^{us,cn}_{ind,t} \equiv \frac{\Delta\hat{V}^{us,cn}_{ind,t}}{Y_{ind,t'_0}} \tag{27}$$

Here, $Pre^{us,cn}_{ind,t}$ is the constructed instrumental variable representing the fitted value of China's import exposure from the U.S. in the ind industry at time t, with the subscript "us,cn" indicating the trade direction of the endogenous variable associated with the actual data measure of China's import exposure from the U.S., denoted as $Var^{us,cn}_{ind,t}$. $\Delta\hat{V}^{us,cn}_{ind,t}$ represents the annual average change in the fitted value $\hat{V}^{us,cn}_{ind,t'}$ at time t. Y_{ind,t'_0} is the total initial output of China's ind industry. Likewise, the PRE instrumental variable for import exposure from countries outside the U.S. is:

$$Pre^{row,cn}_{ind,t} \equiv \frac{\Delta\hat{V}^{row,cn}_{ind,t}}{Y_{ind,t'_0}} \tag{28}$$

For exports, the PRE instrumental variable for China's export exposure to the U.S. is:

$$Pre^{cn,us}_{ind,t} \equiv \frac{\Delta\hat{V}^{cn,us}_{ind,t}}{Y_{ind,t'_0}} \tag{29}$$

While for exports to countries outside the U.S., the PRE instrumental variable is:

$$Pre^{cn,row}_{ind,t} \equiv \frac{\Delta\hat{V}^{cn,row}_{ind,t}}{Y_{ind,t'_0}} \tag{30}$$

At this point, the PRE instrumental variables have been constructed: $Pre^{us,cn}_{ind,t}$, $Pre^{row,cn}_{ind,t}$, $Pre^{cn,us}_{ind,t}$ and $Pre^{cn,row}_{ind,t}$.

4.4. TAR Instrumental Variables

Through the equations and regression results, it is evident that the PRE instrumental variables consist of two main components: first, the trade exposure to the OTH countries or regions, and second, the tariff indicators for China and the OTH collection. For instance, Equation (18) decomposes China's import trade value $V^{us,cn}_{k,t'}$ into the import trade value from the OTH collection $V^{us,oth}_{k,t'}$ and the tariff indicators $\tau^{us,cn}_{k,t'}$ and $T^{us,oth}_{k,t'}$. By using the regression results to reconvene the values through a series of transformations and model calculations, we obtain the PRE instrumental variable for China's import exposure from the U.S., represented as $Pre^{us,cn}_{ind,t}$. Therefore, following the approach outlined by Feenstra, et al. [24] we can decompose the PRE instrumental variable into the OTH instrumental variable and the TAR instrumental variable that represents tariff indicators. First, the TAR instrumental variable for China's imports from the U.S. is defined as follows:

$$Tar^{us,cn}_{ind,t} \equiv Pre^{us,cn}_{ind,t} - Oth^{us,cn}_{ind,t} \tag{31}$$

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Here, $Oth_{ind,t}^{us,cn}$ refers to the previously constructed OTH instrumental variable. Since the construction formula for the PRE instrumental variable and the regressions have constrained the parameters of the OTH trade variable to 1, we can directly derive the TAR instrumental variable by removing the corresponding OTH variable from the PRE variable as shown in Equation (31). Using the same method, the other three TAR instrumental variables can be derived:

$$Tar_{ind,t}^{row,cn} \equiv Pre_{ind,t}^{row,cn} - Oth_{ind,t}^{row,cn} \quad (32)$$

$$Tar_{ind,t}^{cn,us} \equiv Pre_{ind,t}^{cn,us} - Oth_{ind,t}^{cn,us} \quad (33)$$

$$Tar_{ind,t}^{cn,row} \equiv Pre_{ind,t}^{cn,row} - Oth_{ind,t}^{cn,row} \quad (34)$$

Since the PRE instrumental variable has already been decomposed into components of OTH and TAR, subsequent experiments will only utilize the OTH and TAR instrumental variables, while the PRE instrumental variable will solely be used in the construction process for TAR variables.

5. Empirical Research Results

Table 2 presents the relevant regression results, including both the Ordinary Least Squares (OLS) regression outcomes and the Two-Stage Least Squares (2SLS) regression results utilizing all instrumental variables. The regression process weights by the initial industry total assets for the year 1998 and incorporates control variables such as time dummy variables, industry dummy variables, initial industry indicators, and process indicators. Below the table, the statistical tests for the instrumental variables are listed, with weak instrument statistics including two metrics: the KP F statistic and the minimal S-W F statistic. Weak instruments are deemed present only if both statistics fail to pass the set thresholds. Based on the results of the first stage, both the OTH and TAR instrumental variables demonstrate good explanatory power for the overall import and export trade exposure; consequently, the relevant regression outcomes are highlighted in columns (3) to (5) and are addressed in detail.

Column (1) of Table 2 displays the OLS regression results of the benchmark equation, which examines the impacts of China's import trade exposure from the U.S. (denoted as $Var_{ind,t}^{us,cn}$), import trade exposure from other countries excluding the U.S. ($Var_{ind,t}^{row,cn}$), export trade exposure to the U.S. ($Var_{ind,t}^{cn,us}$), and export trade exposure to other countries excluding the U.S. ($Var_{ind,t}^{cn,row}$) on employment in related manufacturing sectors in China. The results indicate that exports have a positive impact on employment in these manufacturing sectors; notably, the positive effect on employment from exports to the U.S. is substantial and significant at the 1% level. Conversely, the positive impact of exports to countries outside the U.S. on employment is not significant. The effect of imports on employment is more complicated. While imports from countries outside the U.S. significantly suppress employment in related manufacturing sectors, imports from the U.S. yield a positive but not significant impact on employment. This outcome contradicts the expectation that imports suppress employment, warranting a cautious interpretation. The overestimation of the parameter for $Var_{ind,t}^{us,cn}$ may stem from two potential reasons. First, the equilibrium effect of trade implies that the significant negative impact of imports from countries excluding the U.S. may hinder an accurate estimation of the impact of U.S. imports on employment. Second, unmeasured fluctuations in domestic demand in China, and the potential relationships between these fluctuations and the trade structure, may also contribute to the bias in estimation.

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Table 2.
Regression Results at the Industry Level.

	(1)		*(2)*		*(3)*		*(4)*		*(5)*
	OLS		**2SLS**		**2SLS**		**2SLS**		**2SLS**
	$\Delta \ln(Numlar_{ind,t})$								
$Var_{ind,t}^{global,cn}$					-0.18* (0.11)				-0.18* (0.11)
$Var_{ind,t}^{us,cn}$	0.26 (0.40)		0.71 (0.74)				0.70 (0.64)		
$Var_{ind,t}^{row,cn}$	-0.15* (0.09)		-0.19* (0.11)				-0.19* (0.11)		
$Var_{ind,t}^{cn,global}$							0.09*** (0.02)		0.11*** (0.03)
$Var_{ind,t}^{cn,us}$	0.20*** (0.08)		0.16** (0.08)		0.15* (0.09)				
$Var_{ind,t}^{cn,row}$	0.01 (0.03)		0.00 (0.06)		0.04 (0.05)				
IV			8		8		8		8
KP rk LM p			0.31		0.00		0.26		0.00
KP F			0.74		10.18		2.43		10.75
Min S-W F			3.77		5.80		4.80		12.53
S-Y (10%)			11.39		11.39		11.39		11.39
Hansen-J p			0.30		0.24		0.42		0.30

Note: Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$。

Column (2) of Table 2 reports the regression results using all OTH instrumental variables and TAR instrumental variables. Similar to the OLS results, it shows a significant positive effect of exports to the U.S. on employment in related manufacturing sectors in China. In contrast, exports to countries other than the U.S. have a relatively minor impact on employment in the relevant manufacturing sectors. Regarding imports, trade imports from countries excluding the U.S. still exert a significant negative impact on employment, while the effect of imports from the U.S. is greater than when instrumental variables were not utilized, yet remains statistically insignificant. Additionally, based on the instrumental variable tests listed in Table 2, such as a KP p-value of 0.31 and both KP F-statistic below 10 and S-W F-statistic below the S-Y critical value, the results in column (2) should be interpreted with caution. This is particularly true for the implications drawn from the import perspective, as their interpretive power and accuracy are limited. Therefore, the impact relationships reflected in the results of column (2) cannot be considered a primary research conclusion.

Columns (3) to (5) of Table 2 include the overall import exposure variable and the overall export exposure variable in the regression equation, either separately or together, to investigate the overall impact of imports and exports on employment in related manufacturing sectors in China. Column (3) presents the regression results assuming the coefficients of $Var_{ind,t}^{us,cn}$ and $Var_{ind,t}^{row,cn}$ are equal, effectively treating imports as a whole to observe its impact on employment. Exports are still categorized into trade exposure from China to the U.S. $Var_{ind,t}^{cn,us}$, and trade exposure from China to other countries excluding the U.S. $Var_{ind,t}^{cn,row}$. The results indicate that, overall, imports have a significant negative impact on employment in related manufacturing sectors, whereas exports to the U.S. positively and significantly influence employment. Moreover, exports to countries other than the U.S. have a positive effect on employment but are not statistically significant. In the two-stage regression results reported in column (3), the minimum S-W F statistic is 5.80, which is below the S-Y critical value; however, another weak instrument variable test, the KP F statistic, is 10.18, exceeding 10, suggesting that weak

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instruments do not rigorously undermine the accuracy of the two-stage regression. Additionally, the Hansen-J p-value is 0.24, confirming the exogeneity of the instruments used, thus the results on the impacts of total imports and exports to the U.S. on employment in related manufacturing in China are reliable. Column (4) displays the results when exports are considered as a whole. The impact of imports from the U.S. and from countries other than the U.S. on employment in related manufacturing sectors is similar to that in column (2), with exports exerting a significantly positive effect on employment. However, several instrumental variable tests have not passed. Based on the analyses of columns (2) to (4), when studying the effects of imports and exports on employment at the manufacturing sector level, treating imports as a whole—rather than distinguishing between U.S. imports and imports from countries other than the U.S.—yields more accurate results. In contrast, when studying exports, distinguishing between exports to the U.S. and those to other countries is more precise; whether to treat them as a whole can be based on the research needs. Thus, column (5) presents the impact of total imports and total exports on employment in related manufacturing sectors in China, indicating that total imports have a significant constraining effect on employment, while exports exhibit a significant promoting effect. The instrumental variable tests also confirm the relevance and exogeneity of the instruments, aligning with experimental expectations. Furthermore, the impact of overall import exposure on employment is consistent with the findings in column (3), further showing that constraining the import variable parameters by treating imports as a whole contributes to the robustness of the experimental results.

At the industry level, the trade exposure's impact on other performances in related manufacturing can be examined using a similar approach to that of the baseline equation, with modifications made only to the explained variables. Referring to column (5) of Table 2, which employs a full set of instrumental variables and constrains the import and export parameters, imports and exports are separately treated as wholes to explore their influences on related industry indicators, which could also serve as part of a robustness check. To this end, following the research methodology by Feenstra, et al. [24] import and export exposures' impact proportions on employment in related manufacturing sectors are defined from the perspectives of intensive margins and extensive margins. Here, the intensive margin refers to the change in the average number of employees in related manufacturing companies, while the extensive margin represents the change in the number of related manufacturing companies. Thus, the explained variables are set as total employment, the number of related manufacturing firms, and average employment per firm, with experimental results presented in columns (1) to (3) of Table 3.

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Table 3.
Regression Results for Other Indicators.

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	2SLS	**2SLS**	**2SLS**	**2SLS**	**2SLS**
	Total Employment	**Number of Enterprises**	**Average Employment**	**Overall Wage Income Level**	**Average Wage Income**
$Var_{ind,t}^{global,cn}$	-1.55^{**} (0.64)	-0.76 (0.50)	-0.79^{*} (0.41)	-1.80^{**} (0.82)	-0.25 (0.40)
$Var_{ind,t}^{cn,global}$	1.34^{**} (0.61)	0.58^{*} (0.34)	0.76^{**} (0.34)	1.58^{*} (0.89)	0.24 (0.34)
N	101	101	101	101	101
Id FE	√	√	√	√	√
Year FE	√	√	√	√	√
R2	0.97	0.98	0.91	0.97	0.95
	(6)	(7)	(8)	(9)	
	2SLS	2SLS	2SLS	2SLS	
	Total Output Value	Operating Revenue	Total Assets	Proportion of Foreign Investment	
$Var_{ind,t}^{global,cn}$	-0.49 (0.40)	-0.39 (0.38)	-1.53^{**} (0.63)	-0.06 (0.05)	
$Var_{ind,t}^{cn,global}$	0.79^{***} (0.26)	0.87^{***} (0.30)	1.04^{***} (0.38)	0.08^{***} (0.03)	
N	101	101	101	101	
Id FE	√	√	√	√	
Year FE	√	√	√	√	
R2	0.99	0.99	0.99	0.90	

Note: Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$。

From both a holistic perspective and when considering intensive and extensive margins, imports exert a significant constraining effect on employment indicators in related manufacturing, while exports have a notable promoting effect on these employment indicators. The extensive margin's impact of imports on employment is similar to that of the intensive margin, with the estimated coefficient for the extensive margin at -0.76 and for the intensive margin at -0.79. In terms of exports, the influence on employment is weighted more toward the intensive margin, with approximately 43% attributed to the extensive margin and 57% to the intensive margin. Similarly, by comparing columns (1), (4), and (5), one can examine the impact of trade exposure on wage income levels in China's related manufacturing sectors from the perspectives of intensive and extensive margins, where the intensive margin reflects changes in the average wage levels of related manufacturing firms, and the extensive margin represents changes in employment numbers. In column (4), it is shown that import trade significantly lowers the overall wage income levels at the industry level, with the extensive margin (reduction in employment) accounting for 86%, while the intensive margin (reduction in average wages) accounts for 14%. Conversely, export trade significantly increases overall wage income levels, with the extensive margin continuing to be the predominant influencing factor. Columns (6) to (9) illustrate the effects of China's foreign trade on other indicators in related manufacturing sectors, such as total industry output, revenue, total assets, and the proportion of foreign investment. Imports negatively impact all four indicators significantly, while exports positively influence all four, with only the positive impact on total industry assets being statistically significant.

To further validate the robustness of the experimental results, alternative regression methods and adjustments to the time period were employed. Specifically, for the two-stage instrumental variable regression, the Limited Information Maximum Likelihood (LIML) estimation method—which is less sensitive to weak instruments and more suitable for small samples—was used in place of the previous Two-Stage Least Squares (2SLS) method. Adjusting the time period primarily considered the potential impact of the financial crisis that began at the end of 2007 on the experimental results; thus, the periods of 2007-2011 and 2011-2014 were excluded, focusing exclusively on 1998-2007 to observe the effects of trade exposure on employment in China's related manufacturing sectors. Given that the sample sizes at both the industry level and provincial level in this study are relatively small and involve multiple endogenous variables requiring corresponding instrumental variables, higher demands are placed on the instruments. For the small sample model with multiple instruments, the LIML method was first implemented for industry-level regression, with the results as follows:

Table 4.
Industry-Level LIML Regression Results.

	(1)		*(2)*		*(3)*		*(4)*
	LIML		**LIML**		**LIML**		**LIML**
	$\Delta \ln(Numlar_{ind,t})$						
$Var_{ind,t}^{global,cn}$			-0.19* (0.11)				-0.18* (0.11)
$Var_{ind,t}^{us,cn}$	0.85 (0.95)				0.81 (0.77)		
$Var_{ind,t}^{row,cn}$	-0.19* (0.11)				-0.19* (0.11)		
$Var_{ind,t}^{cn,global}$					0.08*** (0.03)		0.11*** (0.03)
$Var_{ind,t}^{cn,us}$	0.16** (0.08)		0.15* (0.09)				
$Var_{ind,t}^{cn,row}$	0.00 (0.07)		0.04 (0.05)				
IV	8		8		8		8

Note: Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$。

Columns (1) to (4) of Table 4 correspond to the 2SLS regression results from columns (2) to (5) of Table 2. Notably, columns (2) and (4) of Table 4 restrict the import parameter, treating imports as a whole to examine their impact on employment in China's related manufacturing sectors. This approach is taken because the instrumental variables for imports as a whole demonstrate a good explanatory capacity in the 2SLS regression results. In column (2) of Table 4, the negative impact of import trade on employment in related manufacturing is slightly larger than that indicated by the 2SLS regression results. In terms of export trade, the effects of exports to the U.S. and to other countries on employment in related manufacturing are consistent with the 2SLS regression results, matching to two decimal places. The regression results in column (4) of Table 4 are also entirely consistent with the corresponding 2SLS regression results, again matching to two decimal places. This confirms that import trade has a significant negative impact on employment in China's related manufacturing sectors, while exports positively and significantly influence employment. The LIML regression results effectively substantiate the robustness of the 2SLS regression outcomes in the industry-level baseline equations, particularly the robustness and accuracy of the experimental results when imports are treated as a whole, as seen in columns (3) and (5) of Table 2.

Taking into account the potential impact of the financial crisis on the experimental results, the research time period was adjusted to 1998-2007, which encompasses three sub-periods: 1998-2001, 2001-2004, and 2004-2007. This adjustment allows for an examination of the effects of foreign trade on employment in China's related manufacturing sectors during the revised time frame, including both industry-level and provincial-level analyses. The specific results are as follows:

Table 5.
Industry-Level Regression Results — 1998-2007.

	(1)		*(2)*		*(3)*
	OLS		**2SLS**		**2SLS**
	被解释变量：$\Delta\ln(Numlar_{ind,t})$				
$Var_{ind,t}^{global,cn}$			-0.06 (0.11)		-0.07 (0.10)
$Var_{ind,t}^{us,cn}$	-0.62 (0.57)				
$Var_{ind,t}^{row,cn}$	-0.02 (0.06)				
$Var_{ind,t}^{cn,global}$					0.07*** (0.02)
$Var_{ind,t}^{cn,us}$	0.23* (0.13)		0.13** (0.07)		
$Var_{ind,t}^{cn,row}$	0.00 (0.05)		0.01 (0.04)		
N	63		63		63
IV			8		8
KP rk LM p			0.02		0.02
KP F			4.68		10.44
Min S-W F			6.72		12.67
S-Y (10%)			11.39		11.39
Hansen-J p			0.09		0.13

Note: Standard errors in parentheses， * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$。

Table 5 presents the regression results regarding the impact of foreign trade on employment in China's related manufacturing sectors from 1998 to 2007. Column (1) reports the regression results without using instrumental variables. During the three sub-periods from 1998 to 2007, the trade exposure from imports from the U.S. showed a negative impact on employment in related manufacturing, although this was not statistically significant, which contrasts with the results from the 1998-2014 period. The impact of imports from other countries (excluding the U.S.) on employment was also negative but not significant, consistent in direction with the findings from the 1998-2014 period, although the effect was smaller in magnitude. The effects of exports on employment in related manufacturing were similar to those observed during the 1998-2014 period. Therefore, the results indicating the influence of import trade on employment in related manufacturing from the OLS regression should be interpreted with caution, while the results concerning the impact of export trade on employment appear to be more robust. In column (2), imports are treated as a whole, and the regression results using data from the 1998-2007 period indicate that the impact of import trade on employment in related manufacturing is slightly smaller compared to the results from the 1998-2014 period, but still negative. The impact of exports to the U.S. on related employment remains similar to the results from the 1998-2014 period, while exports to other countries (excluding the U.S.) show a smaller positive impact than in the earlier period, though they remain positive overall. The export trade to the U.S. demonstrates a good degree of robustness in its effect on employment. In column (3), the overall impacts of total imports and total exports on employment in related manufacturing are slightly lower than the regression results from the 1998-2014 period. Nonetheless, import trade consistently shows a suppressive effect on employment, while export trade continues to promote employment.

6. Conclusion and Policy Implications

During the research period, China's foreign trade exhibited steady growth, with Sino-U.S. trade remaining an important component. Some emerging economies showed similarities in their foreign trade situations with China. Firstly, China's foreign trade experienced phases of rapid growth followed by periods of slowdown during the study period. Secondly, although the proportion of Sino-U.S. trade in China's overall foreign trade has decreased amid fluctuations, it remains significantly important. Even during phases of declining manufacturing imports, trade with the U.S. in manufacturing continued to grow steadily. Furthermore, the share of exports to the U.S. in total exports remains higher than that of imports from the U.S. in total imports, indicating that Sino-U.S. trade maintains a consistent pattern in manufacturing as well. Additionally, several emerging economies display notable similarities in their foreign trade, including trade with the U.S., which further reflects the relationship between external factors and the rapid development of China's foreign trade. Foreign trade has a significant impact on employment in related manufacturing in China, with imports overall suppressing employment and exports promoting it. Moreover, there are correlations between foreign trade and various indices within the manufacturing sector: imports negatively affect the average number of employees in related manufacturing firms, overall wage income levels in the industry, and total assets; exports, on the other hand, positively influence the number of firms, average employment per firm, overall wage income levels, total output value, operating revenue, total assets, and the proportion of foreign investment.

Based on the current internal and external situations facing China, and in conjunction with the findings of this study, the following key policy recommendations are proposed: Promote Trade Development and Optimize Trade Structure. Given the multifaceted impact of foreign trade on national employment and economic development, its stable growth is crucial for China's rapid and healthy economic development. Despite the current complex and challenging external environment, stabilizing foreign trade remains a primary objective of China's foreign policy. The stable development of foreign trade and the external trade sector plays a key role in ensuring steady economic operations. Additionally, China should implement policies to guide the continuous optimization of its trade structure. Optimizing the import and export structure will help better meet the overall supply and demand balance and effectively reduce the likelihood of trade friction. Improving the product structure of trade can better adapt to domestic industrial restructuring and deepening economic reforms. Diversifying trade partners can promote an increase in trade volume and enhance international division of labor, while also effectively mitigating potential external risks caused by over-concentration on specific trading partners. Actively Participate in Negotiations to Address Trade Friction. The tariffs imposed due to trade frictions obstruct trade and subsequently impact the development of relevant industries and employment. Therefore, in response to such trade frictions, China should actively engage in negotiations with concerned countries. By basing discussions on mutual respect and benefit, China can strive to reconcile differences and identify mutually acceptable solutions to trade issues. Furthermore, China can enhance its participation in trade discussions through various multilateral and bilateral negotiations, engage with international organizations, and conduct comprehensive diplomatic activities, thereby increasing its voice and participation in trade and global governance and actively seeking a leading role in the reform of global trade rules. Focus on Dual Circulation to Stabilize Domestic Employment. Given the increasing uncertainties and risks in the external environment, effectively implementing the dual circulation development framework and promoting relevant policy formulation and implementation is crucial for national economic development and stable employment. The dual circulation model emphasizes domestic circulation as the primary driver of economic activity. Regardless of external environmental changes, the domestic circulation serves as a foundational force in promoting healthy national economic development and ensuring the stability of the labor market. Simultaneously, this model allows the economy to seize external opportunities at a more robust level while effectively buffering against external risks. Thus, based on the dual circulation development strategy, it is important to optimize and adjust the domestic employment structure to shield national employment from excessive external shocks.

Transparency:
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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