Journal of Korea Trade Vol. 23, No. 5, August 2019, 27-44
https://doi.org/10.35611/jkt.2019.23.5.27
ISSN 1229-828X

Does the China-Korea Free Trade Area Promote the Green Total Factor Productivity of China's Manufacturing Industry?

JKT 23(5)

Received 1 July 2019
Revised 2 August 2019
Accepted 14 August 2019

Zuan-Kuo Liu
Business School, Shandong Normal University, Jinan Shandong,China
Fei-Fei Cao[†]
Business School, Shandong Normal University, Jinan Shandong,China
Bolayog Dennis
Business School, Shandong Normal University, Jinan Shandong,China

Abstract

Purpose – The purpose of this paper is to analyze the net effect of the green total factor productivity (GTFP) of China's manufacturing industry from the China-Korea Free Trade Area (China-Korea FTA) quantitatively.

Design/methodology – Firstly, the Global Malmquist-Luenberger (GML) index based on the SBM directional distance function is used to measure the GTFP of China's manufacturing and analyze the driving force for its growth. Secondly, the regression discontinuity quantitative analysis is used to determine the impact of the China-Korea FTA on China's manufacturing GTFP.

Findings – Our main findings can be summarized as follows: the China-Korea FTA has promoted the GTFP of China's manufacturing with an effect evaluation mainly resulting from green technology progress. And there is industry heterogeneity in the policy effect on the manufacturing GTFP due to the China-Korea FTA. Namely, policy promotion from the China-Korea FTA is more effective on the GTFP of equipment manufacturing than it is on those of other industries.

Originality/value – First, an evaluation and analysis of the GTFP development of China's manufacturing that employs GML index based on SBM directional distance function. Second, a quantitative estimate of China-Korea FTA's net effect on China's manufacturing industrial GTFP that uses regression discontinuity analysis, which is considered to be the closest method to natural experiments and superior to other causal inference methods. Third, an in-depth discussion of the practical steps that China's manufacturing can take to improve GTFP development and integrate China-Korea FTA construction into economic development.

Keywords: China-Korea Free Trade Area, GML Index, GTFP, Regression Discontinuity, SBM Directional Distance Function
JEL Classifications: C33, F92, O14

1. Introduction

In the aftermath of the Doha Round of World Trade Talks in 2006 and the financial crisis in 2008, trade protectionism has been rising globally. As a result, the World Trade Organization (WTO) has experienced difficulty promoting economic globalization and trade liberalization. The WTO's negotiations are inadequate, and the functions of the multilateral mechanism and WTO have been weakened. Relatedly, regional economic integration, which is a more flexible option, is more popular among countries, and Free Trade Areas have

[†]**Corresponding author:** cff19931029@163.com

become the main method for implementing this. As the second largest economy in the world, China is promoting the construction of Free Trade Areas to accelerate its participation in regional economic integration. The China-Korea Free Trade Area (China-Korea FTA) has the highest international trade volume of any Free Trade Area and is also the largest trade area in China so far. In view of the new theory of economic growth, Free Trade Areas can improve the productivity of participating countries and optimize the high-quality development of the industry by optimizing resource allocation, promoting technological progress, and accelerating market integration (Grossman and Krueger, 1995). Manufacturing is the main driver of China's economy, making it vital for promoting high-quality economic development. By enhancing bilateral openings and implementing scale economy, in addition to the other benefits of Free Trade Areas previously mentioned, the China-Korea FTA will promote the transformation of related industries in China, especially the manufacturing industry that represents the country's advanced productivity.

The general manufacturing industry of China is being operated in a model of low efficiency of "high energy consumption, high emission and heavy pollution". In 2018, the labor productivity of China's manufacturing was 27382.27 dollars for each person. However, that of Japan and Korea is 3.62 and 3.17 times as China's respectively (Lv Tie, 2019). The key to promoting high-quality manufacturing development and improving the industry's economic and environmental efficiency is enhancing the green total factor productivity (GTFP). In contrast to total factor productivity, GTFP includes resource consumption and environmental pollution in its computation, which is important for showing how sustainable and healthy the economy is and evaluating the comprehensive competitiveness of the industry. Numerous questions are raised by this analysis, including how the GTFP of China's current manufacturing industry developed and what is the main driving force of its development? The China-Korea FTA was established almost four years ago, has it promoted the GTFP of China's manufacturing? Is there heterogeneity of industry in the effect evaluation of the GTFP from the China-Korea FTA? And in the context of regional economic integration, what should be done to deepen the cooperation of participants within the China-Korea FTA and improve the GTFP of China's manufacturing?

This paper is organized on the basis of the questions above. Firstly, the Global Malmquist-Luenberger (GML) index based on the SBM directional distance function is used to measure the GTFP of China's manufacturing and analyze the driving force for its growth. Secondly, the regression discontinuity quantitative analysis is used to determine the impact of the China-Korea FTA on China's manufacturing GTFP. Thirdly, the author discusses how the construction of the China-Korea FTA can be expanded and the practical development of the GTFP of China's manufacturing can be further promoted. On the one hand, it enriches the relevant theory about the policy of Free Trade Areas and the green economy growth of manufacturing industry, providing new evidence for popularizing and applying regional economic integration. On the other hand, it also provides new scientific guidance for deepening the construction of the China-Korea FTA and promoting the green development of the industries of China and Korea. The novelties of this paper lie in the following attributes: 1) An evaluation and analysis of the GTFP development of China's manufacturing that employs GML index based on SBM directional distance function. 2) A quantitative estimate of China-Korea FTA's net effect on China's manufacturing industrial GTFP that uses regression discontinuity analysis, which is considered to be the closest method to natural experiments and superior to other causal inference methods. 3) An in-depth discussion of the practical steps that China's manufacturing can take to improve GTFP development and integrate China-Korea FTA construction into economic development.

2. Literature Review

Matching economic benefits with environmental benefits during the development of an industry is growing in importance under the rising restrictions on resources and environment (Wang Min et al., 2019). How to develop in an environmentally friendly way has become a heated topic among scholars (Liu Zuan-Kuo and Xin Li, 2019). Theoretically, trade liberalization can help realize the green and sustainable development of economies by improving the efficiency of resource consumption, forming a scale economy, and accelerating technological progress. The current research is summarized below.

The influence of trade liberalization on productivity has been explored by researchers, with most scholars acknowledging that trade liberalization can promote productivity. They believe that trade liberalization achieves this through a more definitive division of labor, more optimized resource allocation, and lower tariffs among participant countries (Kim Jong-Hwa, 2010; Ko Jong-Hwan, 2014; Ko Jong-Hwan and Ito, 2017; Wang Shu-Yun, 2018; Yenokyan, Seater and Arabshahi, 2014). Some scholars have expounded further and provided evidence for this idea from the perspective of micro enterprises—they found that trade liberalization can improve the efficiency and productivity of enterprise (Jang Yong-Joon, Cho Mee-Jin and Kim Han-Sung, 2015; Kim Gi-Hing, 2009; Son Ji-Yoon and Kim Soo-Wook, 2017). Some other scholars, however, believe that the construction of Free Trade Areas will restrain participant countries' productivity improvements (Hu Albert-Guangzhou and Liu Zheng-Ning, 2014). Research regarding the influence of trade liberalization on productivity are abundant, but as to whether trade liberalization is conducive to productivity increases, there hasn't been a consensus yet. More efforts are needed to reach such a conclusion.

Another important aspect of the literature focuses on the influence of trade liberalization on green development. The function of the current literature in this subject area can be classified into the following three categories. Firstly, it acknowledges that trade liberalization can promote green development. Kumar (2006) conducted research about the panel data of 41 countries and found that trade liberalization can promote green development significantly. Secondly, it points out that trade liberalization will restrain the green development. Talbertha and Boharab (2006) performed research about the panel data of 8 countries and found that there is negative-going non-linearity and correlation between economic opening and green Gross Domestic Product (GDP). Thirdly, it states that the influence of Free Trade Areas on green development is restricted by other conditions. Grossman and Kryeger (1991) conducted research about the influence of the North American Free Trade Area on the environment of Mexico based on the computable equalizing model. The results showed that the influence changes as the national income of Mexico fluctuates. As a result, the influence of trade liberalization on green development needs to be further discussed.

In summary, the research findings on the influence of trade liberalization on productivity and green development are abundant, which provide significant support for this paper. However, there is also a divergence of views in the current literature about the relationship between trade liberalization and the growth of green economies. Further, there is little literature about the effect evaluation of Free Trade Areas on GTFP from the perspective of manufacturing in China. Based on these facts, this paper intends to make the analysis of the GTFP of China's manufacturing as research objective. Firstly, the development and driving force of the GTFP of China's manufacturing is measured and analyzed. Secondly, the regression discontinuity quantitative analysis is practiced to expound the policy effect of the China-Korea FTA on the GTFP of China's manufacturing. Thirdly, the policy suggestions for deepening the construction of the China-Korea FTA and increasing the GTFP of China's manufacturing are discussed. Compared with the previous research, the main contributions of this paper are as follows: Firstly, the GML index and SBM directional distance function are used to measure the GTFP of China's manufacturing, which avoids errors in computation under the data envelopment analysis(DEA) model. Secondly, the regression discontinuity quantitative analysis is applied to find out the net effect evaluation of the GTFP from the China-Korea FTA. Thirdly, the combination of the analysis of China's manufacturing GTFP and the construction of Free Trade Areas can enrich the theories about policy of Free Trade Areas and green economies, providing scientific guidance for expanding and promoting the development of the China-Korea FTA.

3. Methodology and Data

3.1. Methods

3.1.1. The Measurement Model of GTFP

Malmquist-Luenberger (ML) index is applied in most current literature to measure GTFP. However, this index is only suitable for the analysis of the change in productivity of consecutive periods in a short time without cyclicity or transitivity. It can't accurately reflect the long-term trend of the change in productivity when measuring over-period directional distance function. And there may be no answer in linear programming. But the GML index can overcome the aforementioned obstacles and avoid the possible "technological retrogression" (Aparicio, Pastor and Zofio, 2013). Additionally, SBM directional distance function can reduce the calculating errors caused by the wrong choice of radial direction or angle. Therefore, combining the SBM directional distance function with the GML index can make up for the inadequacy of ML index, and is now the method commonly used by most scholars.

a) The Global Production Possibility Set

A manufacturing industry K as DMU_k , and it uses N inputs: $x=(x_1,\cdots,x_n)\in R_N^+$ and produces M desirable outputs: $y=(y_1,\cdots,y_n)\in R_M^+$ and I undesirable outputs: $b=(b_1,\cdots,b_n)\in R_I^+$. Therefore, the t period of inputs and outputs of DMU_k can be expressed a (x^{kt},y^{kt},b^{kt}) . The GML index emphasizes the consistency of the production frontier reference set, and its defined the global production probability set is expressed as:

$$P^G(x)=\left\{(y^t,b^t):\sum_{t=1}^{T}\sum_{k=1}^{K}z_k^t y_{km}^t \geq y_{km}^t,\forall m;\sum_{t=1}^{T}\sum_{k=1}^{K}z_k^t b_{ki}^t = b_{ki}^t,\forall i;\right.$$
$$\left.\sum_{t=1}^{T}\sum_{k=1}^{K}z_k^t x_{kn}^t \leq x_{kn}^t,\forall n;\sum_{t=1}^{T}\sum_{k=1}^{K}z_k^t = 1, z_k^t \geq 0,\forall k\right\} \tag{1}$$

Where $z_k^t \geq 0$ denotes the weight of each cross-section. If $z_k^t \geq 0$ indicates constant returns to scale(CRS), then $\sum_{k=1}^{K} z_k^t = 1, z_k^t \geq 0$ indicates variable returns to scale(VRS).

b) The SBM Directional Distance Function

This globality can reduce the measurement error due to the differences in the production frontier in different periods. At the same time, to avoid neglecting the slack variables of input and output for high estimation results, this paper adopts the global production possibility set to use the relevant method of defining the SBM direction distance function as:

$$S_V^G(x^{t,k}, y^{t,k}, b^{t,k}, g^x, g^y, g^b) = \max_{s^x, s^y, s^b} \frac{\frac{1}{N}\sum_{n=1}^{N}\frac{s_n^x}{g_n^x} + \frac{1}{M+I}\left(\sum_{m=1}^{M}\frac{s_m^y}{g_m^y} + \sum_{i=1}^{I}\frac{s_i^b}{g_i^b}\right)}{2}$$

$$s.t. \quad \sum_{t=1}^{T}\sum_{k=1}^{K} z_k^t x_{kn}^t + s_n^x = x_{k'n}^t, \forall n; \quad \sum_{t=1}^{T}\sum_{k=1}^{K} z_k^t y_{km}^t - s_m^y = y_{k'm}^t, \forall m;$$

$$\sum_{t=1}^{T}\sum_{k=1}^{K} z_k^t b_{ki}^t + s_i^b = b_{k'i}^t, \forall i; \quad \sum_{k=1}^{K} z_k^t = 1, z_k^t \geq 0, \forall k; \; s_m^y \geq 0, \forall m; \; s_i^b \geq 0, \forall i \tag{2}$$

Where (g^x, g^y, g^b) denotes the direction vectors for decreasing inputs, increasing desirable outputs and decreasing undesirable outputs, respectively, and (s_n^x, s_m^y, s_i^b) denotes the slack variable for input, desirable output and undesirable output. When this is greater than 0, it means that the input and undesirable output are more than the input and undesired output of the production frontier, and the expected output is less than the production frontier output.

c) GML Index

The research of scholar Oh (2010) shows that the GML index based on SBM directional distance function can be resolved into the technological efficiency change index GEC and the technological progress change index GTC. GEC mainly represents the improvement in management rules and resource allocation, while GTC represents the enhancement in production and manufacturing technology. The concrete details are as follows:

$$GML_t^{t+1} = \frac{1 + S_V^G(x^t, y^t, b^t; g)}{1 + S_V^G(x^{t+1}, y^{t+1}, b^{t+1}; g)} = GEC_t^{t+1} \cdot GTC_t^{t+1} \tag{3}$$

$$GEC_t^{t+1} = \frac{1 + S_V^t(x^t, y^t, b^t; g)}{1 + S_V^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}; g)} \tag{4}$$

$$GTC_t^{t+1} = \frac{[1 + S_V^G(x^t, y^t, b^t; g)]/[1 + S_V^t(x^t, y^t, b^t; g)]}{[1 + S_V^G(x^{t+1}, y^{t+1}, b^{t+1}; g)]/[1 + S_V^{t+1}(x^{t+1}, y^{t+1}, b^{t+1}; g)]} \tag{5}$$

GML index represents the change of $t+1$ period compared to t period. If the index is more than 1, it means that GTFP has increased. If it is less than 1, it means that GTFP has decreased. And if it equals 1, it means that GTFP is stable, as are the GEC and GTC.

3.1.2. The Model of Regression Discontinuity

Regression discontinuity (RD) analysis is similar to random experiment, and it is the most convincible among the quasi-experiment methods. This method can overcome the endogeneity problems of parameter estimation and accurately show the causal relationship between variables, which is applied widely in evaluating the effect of policy. The basic idea of RD analysis is to treat the implementation of policy (that of the China-Korea FTA in this paper) as a processing variable that is controlled by whether some continuous variable (driving variable, time in this paper) exceeds the cut-off point. The other variables can be defined as having no significant change before and after the cut-off point. The aim of applying RD analysis is to distinguish the influence of a processing variable from that of continuous variables. It can be identified by observing the influence of the local average treatment effect near the cut-off point on policy. The research objective of RD analysis usually includes the sample influenced by policy, namely the experiment group, and the sample not influenced by policy, i.e., the control group. In this research, the GTFP of China's manufacturing before the establishment of the China-Korea FTA is the control group and the GTFP after establishment is the experiment group. RD analysis can be divided into sharp regression discontinuity (SRD) and fuzzy regression discontinuity (FRD). During the practice of the China-Korea FTA, the step-by-step pilot method of different areas and different industries was implemented. Therefore, to simulate the process of the China-Korea FTA pilot, FRD has been applied for this paper.

Due to the conditions of the research and the perspective of Lee and Lemieuxa (2010), the cut-off point has been set as 2016. The China-Korea FTA was not signed into effect until June 2015, although the negotiations began in May 2012. In December 2015, the China-Korea FTA went into effect officially. Thus, setting the cut-off point to 2016 is more consistent with the reality. FRD can be determined through non-parametric instrumental variable (IV) estimation or parametric Two-stage least squares (2SLS) method estimation, which are equivalent (Cook, 2008). The parametric 2SLS estimation is used in this paper with a structural formula of estimation as follows:

$$Y_i = \alpha_0 + \alpha_1 D_i + \alpha_2(x_i - c) + \alpha_3 D_i(x_i - c) + \alpha_4 Z_i + u_i \tag{6}$$

Y_i is the GTFP of the various industries of China's manufacturing, α_1 is the processing effect that is the subject of much attention by this research, D_i is the processing variable representing the probability of China's manufacturing entering into the China-Korea FTA, with the indicating variable T_i as its tool variable, $T_i=1 \quad (x_i \geq c)$, $D_i(x_i - c)$ is the interactive item, representing that the regression line can have different rates of slope in the two sides of the cut-off point, and Z_i is the covariant.

3.2. Variables and Measurements

The statistics data from Customs show that the main trade products between China and Korea are from the 12 manufacturing industries (Table 1), including the pharmaceutical industry and chemical materials and chemicals manufacturing, etc. Total related products account for 74 percent of the total export-import bilateral trade volume of China's and Korea's manufacturing. As a result, this paper makes classifications based on different national economic industries and selects the data of 12 related manufacturing industries in China from 2003—2017 to research the influence from the China-Korea FTA on the GTFP of China's manufacturing. The fundamental trade statistics of China's and Korea's manufacturing come from the Korea International Trade Association database (https://www.kita.net/), with the China-related statistics originating from the General Administration of Customs for the People's Republic of China. The fundamental statistics for the other indicators come from *China Industry Statistical Yearbook, China Energy Statistical Yearbook, and China Statistical Yearbook.*

Table 1. The Classification of National Economic Industries

Code	Name of Industry	Code	Name of Industry
A	Oil Processing, Coking & Nuclear Fuel Processing	G	Universal Equipment Manufacturing
B	Chemical Materials & Chemicals Manufacturing	H	Special Equipment Manufacturing
C	Pharmaceutical Manufacturing	I	Transportation Equipment Manufacturing
D	Ferrous Metal Smelting and Calendaring Processing	J	Electromechanical Equipment Manufacturing
E	Nonferrous Metal Smelting and Calendaring Processing	K	Communication Apparatus, Computer and other Electronic Equipment Manufacturing
F	Fabricated Metal Industry	L	Instrument and Culture and Office Supplies Manufacturing

Source: Industrial Classification for National Economic Activities (2002).

3.2.1. Input Indicators

Most scholars use the input indicators of labor, capital, and energy to measure GTFP (Chen Zheng-Ling et al., 2019; Li Bin and Wu Shu-Sheng, 2017; Wang Xue-Li et al., 2018). For labor input, the annual average number of employees in each manufacturing industry is used in most relative research, and this paper follows this idea. For capital input, this paper draws on the Perpetual Inventory Method (PIM) adopted by most scholars to calculate. The formula is as follows:

$$K_t = K_{t-1}(1-\delta_t) + I_t \tag{7}$$

K_t , K_{t-1} represents the capital stock of the year of t and the year of t - 1 respectively, δ_t represents the depreciation rate of capital stock, and the unified rate of 10.96 percent used by most scholars is also applied in this paper, and I_t represents the investment on fixed assets in each manufacturing industry. To ensure the continuity and comparability of the statistics, they are converted into the 2003 base period using the fixed asset investment index. For energy input, it is calculated by converting the total energy consumption of each industry by the standard coal method.

3.2.2. Output Indicators

The output indicators includes desirable output (Long Xing-Le, Zhao Xi-Cang and Chen Fa-Xin, 2015) and undesirable output (Yao Xi-Long et al., 2018). The main business income in each manufacturing is attributed to desirable output and the producer price index for industrial products (2003=100) is used as deflator in this paper. Undesirable outputs uses energy carbon emissions based on seven major energy consumptions of raw coal, gasoline, kerosene, diesel, fuel oil, electricity, and natural gas. The calculation method is based on the calculation formula in the national greenhouse gas inventory of the Intergovernmental Panel on Climate Change (IPCC).

3.2.3. Covariants of Regression Discontinuity

The following covariants have been added to this paper to ensure the stability of the results.

1) Industry Average Scale (IAS): The industry average scale of manufacturing is important for influencing the GTFP of the industry. For one thing, relatively large scales of industry are conducive to the autonomous supervision of the industry and the improvement of polluted environments. For the other thing, they are conducive to improvements in the levels of specialization and productivity and are shown by the ratio of the main business income of the entire industry to the number of companies.

2) Human Capital (HC): Human capital is the strategic resource for developing low-carbon economies as well as the comprehensive performance of the productive, technological level, the management of enterprises and the proficiency and positivity of labor. Human capital is expressed by the ratio of the main business income of each industry to the annual average number of employees.

3) Ownership Structure (OS): In the structure of ownership, the development of non-state economies, especially that of private enterprise and foreign-investment enterprise, is beneficial for forming diverse competitive subjects, promoting the competition among enterprises of different ownership structures, and promoting the GTFP of the industry's continuous development. For this paper, the total proportion of non-state assets of the entire industry has been selected for measuring the ownership structure.

In order to avoid the problem of multicollinearity, Variance Inflation Factor (VIF) test is performed on the model variables in this paper. The results show that VIFs are all less than 10, indicating that there is no multicollinearity between the variables.

4. Methodology and Data

4.1. Development Status of China's Manufacturing GTFP

Table 2 shows that the GML index of all industries in the table exceeds 1 except that of electromechanical equipment manufacturing, whose index is slightly less than 1. This shows that the GTFP of manufacturing is rising overall. The GTFP ranking shows that the top 3 of 12 industries are chemical materials and chemicals manufacturing, ferrous metal smelting and calendaring processing, and nonferrous metal smelting and calendaring processing with the GML average index of 1.1506, 1.0961, and 1.0933, respectively. This shows that the average GTFP growth rate of the three industries from 2003—2017 is 15.16 percent, 9.61 percent, and 9.33 percent, respectively. Compared with those of these three industries, the GML index of equipment manufacturing[1]—including universal equipment manufacturing, special equipment manufacturing, and transportation equipment manufacturing, etc—is lower, which means that the goal of making use of the China-Korea FTA to promote green and efficient development of equipment manufacturing is still a long way off.

The change and explanation of the GTFP for each sector of China's manufacturing from 2003—2017 (Fig. 1) is also included in this paper to analyze the characteristics of the gradual

---

[1] The Classification and Code of Chinese National Economy Industry (GB/T 4754-2002) shows that equipment manufacturing includes: Fabricated Metal Industry, Universal Equipment Manufacturing, Special Equipment Manufacturing, Transportation Equipment Manufacturing, Electromechanical Equipment Manufacturing, Communication Apparatus, Computer and other Electronic Equipment Manufacturing Instrument and Culture and Office Supplies Manufacturing.

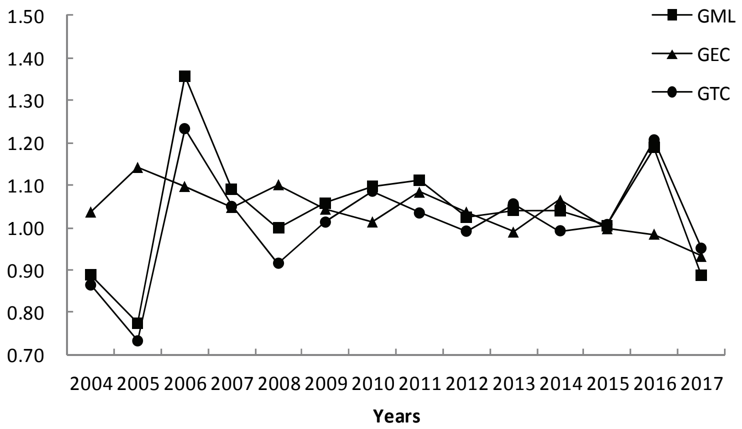
process and driving force of China's manufacturing GTFP in a penetrating way. From the perspective of time trend, the GTFP of China's manufacturing generally presents a rising pattern, especially in 2015, when both the GTFP and the progression of green technology increased significantly. From the perspective of the driving force of the development of GTFP, the GTFP is consistent with green technology progress to a large extent but is not correlated with green technology efficiency-this means that green technology progress has contributed more to the development of the GTFP of China's manufacturing than green technology efficiency. Therefore, in order to promote the growth of China's manufacturing GTFP, relevant industries must not only maximize science and technology progression and innovation and continue to explore the space for green technology progress, but also optimize the structure of industry continuously, improve management and the efficiency of resource allocation, and stimulate the potential for development and the driving force of green technology efficiency.

Table 2. The Status Quo of the GTFP of Each Manufacturing Industry

Industry	GEC	GTC	GML	Ranking	Industry	GEC	GTC	GML	Ranking
A	1.0000	1.0203	1.0203	6	G	1.0072	1.0026	1.0067	10
B	1.1473	0.9973	1.1506	1	H	1.0367	1.0029	1.0360	5
C	1.0477	1.0008	1.0463	4	I	1.0199	1.0039	1.0164	7
D	1.1366	1.0473	1.0961	2	J	0.9876	1.0133	0.9928	12
E	1.0919	1.0115	1.0933	3	K	1.0000	1.0106	1.0106	8
F	1.0118	1.0007	1.0103	9	L	1.0000	1.0029	1.0029	11

Source: China Industry Statistical Yearbook (2017), China Energy Statistical Yearbook (2017) and China Statistical Yearbook (2017).

Fig. 1. The Explanation of the Development and Driving Force of the GTFP of China's Manufacturing



Source: Authors' calculation using China Industry Statistical Yearbook, China Energy Statistical Yearbook, and China Statistical Yearbook data.

4.2. The Influence of China-Korea FTA on the GTFP of China's Manufacturing

4.2.1. Theoretical Analysis

Accelerating the establishment of Free Trade Areas is important in the new round of opening up of China. The 17th National Congress of the Communist Party of China upgraded the construction of Free Trade Areas as a national strategy. In the Third Plenary Session of the 18th Central Committee, accelerating the implementation of Free Trade Areas in the surrounding areas and forming a high-standard Free Trade Area network for the whole world was proposed. In the 13th Five-Year Plan, the following was proposed: improve the strategic layout of opening to the outside world, promote two-way opening; propel orderly flow of domestic and international elements and efficient allocation of resources, deeply integrate markets, accelerate the development of advanced manufacturing industry, improve the quality of economic growth, and promote the growth of GTFP.

As an opening platform at a high level, the China-Korea FTA conforms to the development concept of greening and opening. It can promote the development of the GTFP of China's manufacturing firstly through the effect of resource allocation. In support of the China-Korea FTA, the manufacturing companies can arrange the production and sales activity in a wider area. Resource, capital, talent, and management can flow within a larger range. The manufacturing companies can also improve the efficiency of production factors, reduce production cost, improve the quality of service, and propel the application and transfer of the new technology between the two countries. These steps can both increase the production efficiency of China's manufacturing and relieve the strain on the environment.

Secondly, the China-Korea FTA promotes GTFP development through the effects of scale economy. According to the theory of division of labor, a larger market is conducive to promoting a deepening of the division of labor and the professionalization of production. It can also help form scale economy and improve production efficiency. As an important measure to open China to the world, the China-Korea FTA can increase the global demands for products from the Chinese manufacturing industry and increase market capacity. In this way, the effects of scale economy will improve the efficiency of technology and boost GTFP.

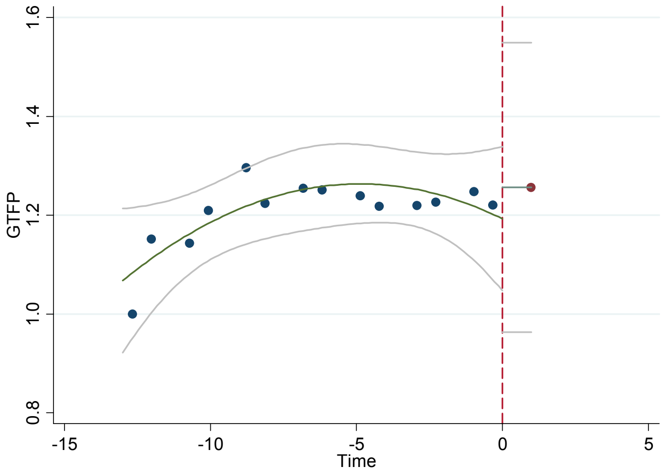
Thirdly, the China-Korea FTA produces the positive effect of spillover in technology. Trade liberalization can improve the productivity and economy through these technological spillover effects (Coe and Helpmann, 1995). Since the establishment of the China-Korea FTA, non-export enterprises can learn about advanced productive technologies and management experiences of the export enterprises through the industrial link with them. In this way, they can improve their GTFP. For the export enterprises, they can promote the upstream and downstream enterprises to make progress in technology, improve management efficiency, reduce production costs, and improve production efficiency to enhance the GTFP of the entire manufacturing industry.

4.2.2. The Analysis of the Results of Regression Discontinuity

a) Graphic Analysis

The difference of the GTFP of China's manufacturing at the cut-off point is fitted through graphic analysis before the empirical study in this paper, which helps the author ascertain the influence of the China-Korea FTA on the GTFP of China's manufacturing. Fig. 2 shows that the GTFP of China's manufacturing increases significantly at the cut-off point, revealing that around the cut-off point, the GTFP of the experiment group is much higher than that of the control group. This means that the China-Korea FTA can promote the GTFP of China's manufacturing to some extent.

Fig. 2. The change of the GTFP of China's Manufacturing before and after the Cut-off Point



Source: Authors' calculation using China Industry Statistical Yearbook, China Energy Statistical Yearbook, and China Statistical Yearbook data.

b) Results of the Regression Discontinuity Analysis

Fig. 2 shows that the China-Korea FTA causes the discontinuous change of the GTFP of China's manufacturing, which initially shows that the China-Korea FTA has promoted an increase in the GTFP. However, the specific effect of this promotion still needs to be based on the results of further empirical analysis. In this paper, the processing effects of the China-Korea FTA on the GTFP of China's manufacturing are analyzed above all else, and this study further introduces the covariants of average scale of the industry, human capital, and ownership structure to test such processing effects. The details of this test are displayed in Table 3.

The results of Table 3 (1) show that the influence coefficient of the China-Korea FTA on the GTFP of China's manufacturing is 0.280, and its level of significance is 5 percent. This means that the China-Korea FTA has promoted the improvement of the GTFP of China's manufacturing. Table 3 (2) – (4) shows the results of the regression discontinuity after adding to the covariants. The processing variable D does not change with or without the covariants, reflecting the objectivity and stability of the models in this paper. Thus, we can conclude that reasonable resource allocation and technological progress brought on by the effects of resource allocation, scale economy, and technological spillover in the China-Korea FTA have promoted the GTFP of China's manufacturing.

Among all the covariants, the industry average scale has significant positive effects on the GTFP of China's manufacturing. The main reason for this is that a larger industry average scale will help the industry solve the problem of environmental pollution more thoroughly. Further, the scale effects will help the company reduce costs and develop a scale economy. As a result, larger industry average scales and higher intensity will help increase the GTFP and promote efficient, green manufacturing development.

The influence effects of the human capital on the GTFP of China's industry is significantly positive. Human capital is the main factor of technological progress, and the intensive advanced technological, innovative and industrial talents of different levels can help the transferring of implicit knowledge like the sharing of knowledge and the spillover of technology, which provides great intelligent support for the green development of the manufacturing. And different types of human capital can contribute their own competitive benefits, strengthen the effects of cooperation, and improve the productivity of the enterprise.

The main effects of the ownership structure on the GTFP of China's manufacturing is negative but it is not significant-this is because the current standards for protecting the environment are different for state and non-state enterprises. Awareness of environmentally friendly practices among state enterprises is higher than that of non-state enterprises, and that makes the ownership structure have negative effects on the GTFP of the manufacturing industry.

Table 3. The Influence of the China-Korea FTA on the GTFP of China's Manufacturing

Variables	(1)	(2)	(3)	(4)
D	0.280** (2.07)	0.301** (2.33)	0.276** (2.27)	0.273** (2.23)
$(x_i - c)$	0.059*** (6.82)	0.044*** (4.99)	0.006 (0.50)	0.007 (0.53)
$D_i(x_i - c)$	-0.459*** (-2.78)	-0.457*** (-2.90)	-0.415*** (-2.79)	-0.416*** (-2.79)
IAS		0.019*** (4.35)	0.018*** (4.34)	0.018*** (4.33)
HC			50.171*** (4.51)	50.924*** (4.53)
OS				-0.070 (-0.29)
cons	1.556*** (9.68)	1.359*** (8.71)	0.699*** (3.23)	0.741*** (2.66)
R^2	0.3353	0.3946	0.4670	0.4680
Wald	83.24	110.26	143.50	143.56

Note: The z value in brackets, *, ** and *** indicate that the statistical value is significant at 10%, 5% and 1%, respectively.

Source: China Industry Statistical Yearbook (2017), China Energy Statistical Yearbook (2017) and China Statistical Yearbook (2017).

The effects of China-Korea FTA on the technological progress and technological efficiency of the China's manufacturing GTFP decomposition index is further studied in this paper. Table 4 shows that the China-Korea FTA has promoted green technology progress with an influence coefficient of 0.176, and the coefficient of processing variable D does not change significantly with or without the covariant. However, there is no significant positive relationship between the China-Korea FTA and green technology efficiency, namely because the China-Korea FTA is not strong enough to advocate for the reform of Chinese manufacturing companies' management systems and thus cannot fully enhance the GTFP of the industry. This shows that promotion from the China-Korea FTA to the GTFP of China's manufacturing is realized through green technology progress. Green technology progress is the driving force of the GTFP, and the green technology progress brought by the China-Korea FTA will further promote the GTFP of China's manufacturing. Thus, in order to maximize the GTFP of China's manufacturing, the industry must make full use of the scientific and innovative effects of the China-Korea FTA to further technological progress. The industry should also strengthen the China-Korea FTA's promotion of manufacturing management systems and resource allocation to stimulate the developmental potential, technological efficiency, and environmentally friendliness of China's manufacturing industry.

Table 4. The influence of the China-Korea FTA on the GTC and GEC of China's manufacturing

Variables	GTC				GEC			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
D	0.176***	0.177***	0.175***	0.177***	-0.129	-0.121	-0.149	-0.149
	(3.96)	(3.95)	(3.93)	(3.97)	(-0.74)	(-0.69)	(-0.88)	(-0.87)
$(x_i - c)$	-0.003	-0.003	-0.006*	-0.008*	0.081***	0.076***	0.034**	0.034*
	(-0.89)	(-1.00)	(-1.72)	(-1.89)	(7.29)	(6.28)	(2.03)	(1.90)
$D_i(x_i - c)$	-0.054	-0.054	-0.051	-0.049	-0.241	-0.240	-0.194	-0.0194
	(-1.00)	(-0.99)	(-0.94)	(-0.90)	(-1.13)	(-1.12)	(-0.94)	(-0.93)
IAS		0.001	0.001	0.001		0.007	0.005	0.005
		(0.52)	(0.52)	(0.61)		(1.13)	(0.93)	(0.89)
HC			4.151	4.917*			55.443***	55.797***
			(1.52)	(1.70)			(3.53)	(3.52)
OS				0.060				0.021
				(0.83)				(0.06)
cons	0.778**	0.771***	0.715***	0.659***	2.075***	2.005***	1.280***	1.262***
	(27.91)	(25.91)	(15.36)	(7.97)	(8.50)	(8.66)	(4.05)	(3.16)
R^2	0.1170	0.1258	0.1419	0.1372	0.2782	0.2785	0.3326	0.3328
Wald	21.87	21.85	24.59	25.20	63.61	64.00	81.17	81.09

Note: The z value in brackets, *, ** and *** indicate that the statistical value is significant at 10%, 5% and 1%, respectively.
Source: China Industry Statistical Yearbook (2017), China Energy Statistical Yearbook (2017) and China Statistical Yearbook (2017).

4.2.3. The Analysis of the Heterogeneity of Industry

Equipment manufacturing is the foundation and core of manufacturing overall, and advanced equipment manufacturing is an important driver of optimization and upgrades in the industry. This reflects the status of the country in terms of economic globalization. The green transformation of China's manufacturing industry has accelerated in recent years, which has necessitated stricter requirements for equipment manufacturing. In "Made in China 2025," it has been proposed that the country should cultivate and develop a high-end, technologically innovative equipment manufacturing industry and make full use of various resources in society. "Planning Analysis of Standardization and Quality Improvement of Equipment Manufacturing Industry" closely meets the needs of "Made in China 2025," and it has been proposed that China should improve the developmental quality of the equipment manufacturing industry.

In order to further explore the impact of the China-Korea FTA on GTFP in different industries, this paper divides the manufacturing industry into the equipment manufacturing industry and other manufacturing industries and makes a comparative analysis of the policy effects of the China-Korea FTA on the two industries. Table 5 shows that the China-Korea FTA has significantly positive effects on the GTFP and green technology progress of both the equipment manufacturing and other manufacturing industries of China. However, the effects on the GTFP of China's equipment manufacturing and green technology progress (with influence coefficients of 0.147 and 0.207, respectively) are more significant than that of other manufacturing industries. This proves that the China-Korea FTA has brought practical benefits for China's manufacturing, especially the equipment manufacturing industry. Compared with that of other manufacturing industries, the annual average growth rate of the equipment manufacturing GTFP is lower, but the positive promotion of the China-Korea FTA is more significant. This is because the China-Korea FTA can promote the GTFP of China's equipment manufacturing and the optimization and upgrade of the industry's structure to realize the high-quality development of manufacturing and meet the urgent need for green and efficient manufacturing development in China. As a result, China should accelerate the second period of negotiation regarding the China-Korea FTA, deepen cooperation, and strengthen the macro policy coordination to promote the development of the GTFP of equipment manufacturing. After all the covariants have been added in turn, the direction and significance of the coefficient of the processing effects do not change significantly, which shows the effectiveness and stability of the results of the estimation.

Table 5. The Results of the Heterogeneity of Industry of the Policy Effects of the China-Korea FTA

Variables	Equipment Manufacturing				Other Manufacturing Industries			
	GTFP		GTC		GTFP		GTC	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
D	0.147**	0.170***	0.207***	0.153***	0.465*	0.419*	0.133*	0.148*
	(2.26)	(3.06)	(4.73)	(3.58)	(1.76)	(1.82)	(1.81)	(1.67)
$(x_i - c)$	0.020***	-0.033***	-0.003	-0.024***	0.114***	0.174***	-0.002	-0.020**
	(4.69)	(-4.60)	(-0.95)	(-3.78)	(6.76)	(4.91)	(-0.42)	(-2.07)
$(x_i - c)D_i$	-0.148*	-0.065	-0.040	0.007	-0.894***	-0.923**	-0.075	-0.067
	(-1.86)	(-1.13)	(-0.74)	(0.14)	(-2.78)	(-2.29)	(-0.70)	(-0.62)
IAS		0.030***		-0.001		0.007		0.005
		(6.61)		(-0.29)		(1.46)		(0.36)
HC		89.162***		46.803***		-43.563***		10.864***
		(6.62)		(4.08)		(-3.22)		(2.83)
OS		-0.058		-0.014		-0.594		0.136
		(-0.38)		(-0.11)		(-1.32)		(1.13)
cons	1.014***	0.128	0.791***	0.410***	2.315***	3.473***	0.758***	0.440***
	(13.35)	(0.71)	(27.11)	(2.71)	(8.60)	(6.02)	(14.50)	(2.83)
R^2	0.3500	0.7239	0.2725	0.4107	0.5359	0.5301	0. 0364	0.0808
Wald	51.14	213.82	35.58	59.24	77.19	66.95	2.53	11.00

Note: The z value in brackets, *, ** and *** indicate that the statistical value is significant at 10%, 5% and 1%, respectively.

Source: China Industry Statistical Yearbook (2017), China Energy Statistical Yearbook (2017) and China Statistical Yearbook (2017).

4.3. Validity Test

The implicit hypothesis of RD is that the conditional density of the covariant is continuous at the cut-off point to prove that the change of the GTFP of China's manufacturing has been caused by the China-Korea FTA. To verify this hypothesis, whether the conditional density of the covariant is continuous needs to be tested. The results of the test are displayed in Table 6, which shows that all the covariants are continuous at the cut-off point and experience no significant increase at the cut-off point. Namely, this means that the change of the GTFP of China's manufacturing at the cut-off point is caused by the China-Korea FTA, verifying the causal relationship between the China-Korea FTA and the GTFP of China's manufacturing.

Table 6. The Test of the Continuity of the Covariants

Covariant	Bandwidth	
	1 times	2 times
IAS	-0.06	-0.22
HC	0.15	0.07
OS	-0.18	-0.75

Source: China Industry Statistical Yearbook (2017), China Energy Statistical Yearbook (2017) and China Statistical Yearbook (2017).

Table 7. The Influence of the China-Korea FTA on the GTFP and GTC of China's Manufacturing in Different Bandwidths

Variables	[-10,2]				[-9,2]			
	GTFP	GTFP	GTC	GTC	GTC	GTFP	GTC	GTC
D	0.242*	0.248**	0.127***	0.130***	0.243*	0.246**	0.119***	0.123***
	(1.92)	(2.06)	(3.16)	(3.22)	(1.89)	(1.99)	(2.94)	(3.01)
$(x_i - c)$	0.066***	0.015	0.008**	0.003	0.066***	0.012*	0.010**	0.006
	(5.74)	(0.88)	(2.16)	(0.64)	(4.93)	(0.59)	(2.39)	(0.99)
$(x_i - c)D_i$	-0.466***	-0.422***	-0.06	-0.061	-0.466***	-0.417**	-0.067	-0.063
	(-3.14)	(-3.00)	(-1.38)	(-1.28)	(-3.16)	(-2.95)	(-1.45)	(-1.34)
IAS		0.014***		0.009		0.012**		0.001
		(2.85)		(0.74)		(2.16)		(0.10)
HC		48.698***		3.013		54.356***		2.999
		(3.23)		(1.01)		(3.28)		(1.04)
OS		-0.075		0.087		-0.098		0.080
		(-0.31)		(1.25)		(-0.40)		(1.14)
cons	1.593***	0.4832***	0.827***	0.711***	1.593***	0.792**	0.835***	0.731***
	(8.30)	(2.57)	(28.31)	(8.65)	(7.89)	(2.28)	(28.63)	(8.64)
R^2	0.3364	0.4123	0.2207	0.2337	0.3114	0.3842	0.2431	0.2436
Wald	65.40	90.62	36.53	38.46	52.90	72.30	37.59	38.75

Note: the z value in brackets, *, ** and *** indicate that the statistical value is significant at 10%, 5% and 1%, respectively.

Source: China Industry Statistical Yearbook (2017), China Energy Statistical Yearbook (2017) and China Statistical Yearbook (2017).

Additionally, there must be some criteria for the bandwidth to ensure the effectiveness of the analysis of RD. When analyzing the RD, the smaller the bandwidth, the more accurate the identification of jump-but the sample on the two sides of the cut-off point will be lower, and the error in estimation will be higher. The bandwidth used in the previous empirical study is [-13,2], and the bandwidth is set at [-10,2] and [-9,2], respectively, to make estimations to further ensure the reliability of the results (Table 7).

Table 7 shows that the China-Korea FTA has positive effects on the GTFP of China's manufacturing and the green technology progress in different bandwidths, and the coefficient and significance of all covariants are basically consistent with those detailed in previous sections of this paper. This once again verifies the effectiveness and stability of the results of the estimation. In this paper, the cut-off point has been set in 2015 to ensure its uniqueness and test the influence effects of the China-Korea FTA on the GTFP of China's manufacturing and green technology progress. The results show that the influence of the China-Korea FTA is not significant on the GTFP of China's manufacturing when using 2015 as a cut-off point, but the influence on green technology progress is significantly positive, with a slight decrease compared to estimation using 2016 as the cut-off point.

5. Conclusion and Policy Recommendations

5.1. Conclusions

Accelerating the establishment of Free Trade Areas is important in the new round of opening up of China. This paper believes that Free Trade Areas will improve Chinese development environment through enhancing bilateral opening, optimizing resource allocation, improving technological progress and implementing scale economy, and further promote the development of advanced manufacturing and increase green production efficiency of China's manufacturing industry. Therefore, the GTFP of China's manufacturing industry was measured by applying SBM directional distance function and the GML index. The RD analysis was used to research the mechanism and approach of the influence from the China-Korea FTA on the GTFP of China's manufacturing in this paper. The results of the research shows:

First, the results of the research show that the influence coefficient of the GTFP of China's manufacturing from the China-Korea FTA is 0.280, and its level of significance is 5 percent. Therefore, the reasonable resource allocation and technological progress brought by the effects of resource allocation, scale economy, and technological spillover from the China-Korea FTA have promoted the GTFP of China's manufacturing.

Second, the annual average growth rate of China's equipment manufacturing GTFP is lower than that of other industries. Yet the positive promotion from the China-Korea FTA to the GTFP of China's equipment manufacturing is more significant, namely that the China-Korea FTA can promote the growth of the GTFP of China's equipment manufacturing, propel the optimization and upgrade of the industry's structure, realize the high-quality development of manufacturing, and meet the urgent demands of green and efficient development of China's manufacturing at present.

Third, the China-Korea FTA can promote the green technology progress of China's manufacturing effectively, but it cannot influence the green technology efficiency significantly, which shows that it is through green technology progress that the China-Korea FTA can promote the GTFP of China's manufacturing.

5.2. Policy Recommendations

First, strengthen the construction of the China-Korea FTA and promote the cooperation of global value chain and supply chains. It is recommended to propel the construction of the China-Korea FTA continuously, consolidate and upgrade the China-Korea FTA, establish and strengthen the negotiation and coordination mechanisms of the trade between the two countries. And solve the problem of market access for services trading and build a freer and more convenient environment for services trading and investment markets, provide good external conditions for the participation of China's manufacturing in the division of global value chains and promote China's manufacturing's move toward the upper part of global value chains.

Second, promote all-around cooperation in manufacturing and propel the transformation and upgrade of China's manufacturing. Building the advanced equipment manufacturing industrial cluster and promoting the transformation and upgrade are important for the development of China's manufacturing. In regards to the manufacturing industry, it should make good use of the cooperative platform of the China-Korea FTA, seek cooperation with Korea in the activity of the two ends of the value chain, enhance the core competitiveness of equipment manufacturing and promote the transformation and upgrade of China's manufacturing.

Third, attach importance to the talents utility and foster new momentum for development. Human capital is the key factor for improving the competitiveness of enterprises. For manufacturing companies, they should pay much attention to fostering talents, improving the technology, and bringing the driving effects of the technological progress into full play. Additionally, the green management model of manufacturing enterprise should be reformed to make full use of talents, stimulate the potential for improving the technological efficiency, foster new momentum for development, and promote the green and efficient development of manufacturing.

As the enterprises is the main bodies of policy implementation, the productivity of the enterprise will largely influence the general development of the industry. As a result, the policy effect and the influence approach of the China-Korea FTA on micro enterprises can be expounded in follow-up research.

References

Aparicio, J., J. T. Pastor and J. L. Zofio (2013), "On the Inconsistency of the Malmquist-Luenberger Index", *European Journal of Operational Research*, 229(3), 738-742.

Chen, Zheng-Ling, Jin-Kai Li, Wei-Gang Zhao, Xiao-Chen Yuan and Guo-Liang Yang (2019), "Undesirable and Desirable Energy Congestion Measurements for Regional Coal-fired Power Generation Industry in China", *Energy Policy*, 125, 122-134.

Coe, D. T. and E. Helpman (1995), "International R&D Spillovers", *European Economic Review*, 39(5), 859-887.

Cook, T. D. (2008), "Waiting for Life to Arrive: A History of the Regression-Discontinuity Design in Psychology, Statistics and Economics", *Journal of Econometrics*, 142(2), 636-654.

Grossman, G. M. and A. B. Krueger (1995), "Economic Growth and Environment", *Quarterly Journal of Economics*, 110(2), 353-364.

Grossman, G. M. and A. B. Krueger (1991), "Environmental Impacts of A North American Free Trade Agreement", *Social Science Electronic Publishing*, 8(2), 223-250.

Hu, Albert-Guangzhou and Zheng-Ning Liu (2014), "Trade Liberalization and Firm Productivity: Evidence from Chinese Manufacturing Industries", *Review of International Economics*, 22(3), 488-512.

Jang, Yong-Joon, Mee-Jin Cho and Han-Sung Kim (2015), "Trade Liberalization and Firm Productivity: Evidence from Korea", *Journal of Korea Trade*, 19(4), 21-41.

Kim, Gi-Hing (2009), "The Economic Impact of Korea-Chile Free Trade Agreement on Korea's IT Manufacturing Industries with Focus on the Elasticity Analysis", *Journal of International Trade and Industry Studies*, 14(3), 25-53.

Kim, Jong-Hwa (2010), "A Study on the Economic Impacts of the Korea-Australia Free Trade Agreement", *Journal of Economics Studies*, 28(4), 253-273.

Ko, Jong-Hwan (2014), "A Study on the Economic Effects of the Korea-EU FTA Using a Dynamic CGE Model", *Journal of International Trade & Commerce*, 10(1), 225-250.

Ko, Jong-Hwan and S. Ito (2017), "Simulation for Japan-Korea FTA and Its Economic Impacts on Agriculture: A CGE Approach", *Journal of the Faculty of Agriculture Kyushu University*, 62(1), 283-294.

Kumar, S. (2006), "Environmentally Sensitive Productivity Growth: A Global Analysis Using Malmquist–Luenberger Index", *Ecological Economics*, 56(2), 280-293.

Lee, D. S. and T. Lemieuxa (2010), "Regression Discontinuity Designs in Economics", *Journal of Economic Literature*, 48(2), 281-355.

Li, Bin and Shu-Sheng Wu (2017), "Effects of Local and Civil Environmental Regulation on Green Total Factor Productivity in China: A Spatial Durbin Econometric Analysis", *Journal of Cleaner Production*, 153(1), 342-353.

Liu, Zuan-Kuo and Xin Li (2019), "Has China's Belt and Road Initiative Promoted Its Green Total Factor Productivity: Evidence From Primary Provinces Along the Route", *Energy Policy*, 129, 360-269.

Long, Xing-Le, Xi-Cang Zhao and Fa-Xin Cheng (2015), "The Comparison Analysis of Total Factor Productivity and Eco-Efficiency in China's Cement Manufactures", *Energy Policy* , 81, 61-66.

Lv, Tie (2019), "Basic Ideas and Measures for the High-quality Development of China's Manufacturing Industry", *Economic Daily*, 12.

Oh, D. H. (2010), "A Global Malmquist Luenberger Productivity and Index", *Journal of Productivity Analysis*, 34(3), 183-197.

Son, Ji-Yoon and Soo-Wook Kim (2017), "The Korea-EU Free Trade Agreement's Effect on Logistics Companies' Efficiency and Productivity", *Journal of the Korean Society of Supply Chain Management*, 17(2),165-177.

Talbertha, J. and A. K. Boharab (2006), "Economic Openness and Green GDP", *Ecological Economics*, 58(4), 743-758.

Wang, Min, Xian-Li Zhao, Quan-Xi Gong and Zhi-Geng Ji (2019), "Measurement of Region Green Economy Sustainable Development Ability Based on Entropy Weight-Topsis-Coupling Coordination Degree: A Case Study in Shandong Province, China", *Sustainability*, 11(1).

Wang, Shu-Yun (2018), "Developing Value Added Service of Cold Chain Logistics between China and Korea", *Journal of Korea Trade*, 22(3), 247-264.

Wang, Xue-Li, Cai-Zhi Sun, Song Wang, Zhing-Xiong Zhang and Wei Zou (2018), "Going Green or Going Away? A Spatial Empirical Examination of the Relationship between Environmental Regulations, Biased Technological Progress, and Green Total Factor Productivity", *International Journal of Environmental Research and Public Health*, 15(9).

Yao, Xi-Long, Wei Feng, Xiao-Ling Zhang, Wen-Xi Wang, Chen-Tao Zhang and Sha-Qiu You (2018), "Measurement and Decomposition of Industrial Green Total Factor Water Efficiency in China", *Journal of Cleaner Production*, 98, 1144-1156.

Yenokyan, K., J. J. Seater and M. Arabshahi (2014), "Economic Growth with Trade in Factors of Production", *International Economic Review*, 55(1), 223-254.