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Evaluation of the Policy Effects of Free Trade Agreements: New Evidence from the Korea-China FTA*

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Abstract

Purpose – The policy implications of free trade agreements have traditionally been a matter of debate among economists. The official signing of the Korea-China Free Trade Agreement provides economists with a quasi-natural experiment to analyze the FTA's policy effects. This article aims to more accurately understand the impact of Korea's FTA accession on the macro economy.

Design/methodology – This study adopts the counterfactual method based on panel data to find common factors in the generation process of macro data to fit the counterfactual path, to accurately evaluate the effect of the macro policy.

Findings – Our research results show that the signing of the Korea-China FTA has a relatively significant short-term positive effect on Korea's economic growth. On average, Korea's real GDP growth rate has increased by 2.1%. This study finds evidence in support of FTA signing not having a significant impact on Korea's GDP growth in the long run. Additionally, we evaluated the impact of the FTA on Korea's imports and exports and found that it had a significant positive impact in the short term, but the trade effect of the FTA is significantly affected by the external macro-environment.

Originality/value – First, this study uses macro panel data at the national level to examine the impact of the Korea-China FTA on Korea, and more accurately describes the policy effect of the FTA. Second, our empirical results show that the Korea-China FTA policy impact is subject to occasional changes in the external environment, such as the geopolitical conflict (crisis) between Korea and China, and the US-China trade war. Finally, the analysis shows that the short-term effect of FTA is significant but the long-term is uncertain, which provides empirical evidence for the debate on whether joining FTA can promote national economic growth.

Keywords: Counterfactual Method, Korea-China FTA, Treatment Effects
JEL Classifications: D12, F14, O53

1. Introduction

International economists have debated whether free trade agreements(FTAs) would promote or diminish economic welfare since Viner (1950). However, there is consensus on a policy issue that the proliferation of FTAs has led to Bhagwati and Panagariya (1996)'s "spaghetti bowl" of tariffs, where a country may charge a different tariff on the same product

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based on its origin. But today's economies are all part of the global value chain, and it is sometimes difficult to accurately distinguish the rules of origin, which directly leads to the difficulty of evaluating the effect of the Korea-China FTA. Therefore, we need to carefully evaluate the policy effect of the FTA. On June 1, 2015, The Korea-China FTA was formally signed, which also provided economists with a quasi-natural experiment opportunity to analyze the policy effects of the FTA. Korea-China economic cooperation has achieved rapid quantitative and qualitative development through the establishment of a close production network, but it is facing a new inflection point due to changes in the internal and external environment such as the advancement of the Chinese manufacturing industry and intensifying U.S.-China strategic competition. Therefore, an accurate assessment of the policy effects of the Korea-China FTA will not only help clarify the policy debate of the FTA but also have important implications for further cooperation between the two countries in the future.

Based on the above problems, this paper selects the panel data-based counterfactual evaluation method (hereinafter referred to as the HCW method) proposed by Hsiao et al. (2012). It uses the information of other individuals in the control group not subject to policy intervention to predict the information of individuals in the experimental group when the policy does not occur and relies on the correlation between sections in the panel system to construct a "counterfactual" of the treatment group. The HCW method ascribes the link or dependency across cross-sections to the presence of common causes, resulting in distinct outcome variables in each cross-section. The HCW method considers these common factors to be similar to the time trend effect in panel data. It assumes that this effect is implicit in the data generation process and cannot be observed, and assigns a coefficient vector to each of these common factors. But there is no need to estimate this vector, because the influence mechanism of these common factors on each section unit will not have a substantial impact on the construction of "counterfactuals", and they will all be reflected in the fitted counterfactual equation. Therefore, we may use comprehensive indicators such as economic growth rate to replace unobservable or difficult-to-collect common factors, which can solve the problem of insufficient data and make the estimation process simple. Due to the small sample characteristics of macro data, this method has unique advantages and can accurately assess the policy effects under small samples. As long as there is a cross-sectional correlation between economies, more robust results can be obtained. Due to the small sample characteristics of macro data, this method has unique advantages and can accurately assess the policy effects under small samples.

This paper may supplement the existing literature in the following aspects: First, we use national-level macro panel data to study the impact of the FTA on Korea's GDP and imports and exports, and more comprehensively describe the policy effect of the FTA. To satisfy the core assumptions of the HCW method, the paper constructs an index to evaluate policy exogeneity and selects the control group countries to fit the "counterfactual" path.

This paper is organized as follows. Section 2 provides an overview of the literature. Section 3 examines the HCW approach in detail. Section 4 processes macro data at the national and regional level to fit the core assumptions of the HCW approach. Section 5 empirically analyzes the long- and short-term effects of the Korea-China FTA on Korea's macroeconomy and conducts a placebo test and robustness test. Section 6 concludes.

2. Literature Review

The "three-commodity model" proposed by Meade (1955) is the basic theory of FTA, Meade explores the impact of preferential trade on global welfare in this model. Archibald and Lipsey (1958) analyzed the effect of preferential trade on member countries in the context of small alliances based on Meade, which is very influential in the international trade literature. The Meade-Lipsey model is useful, however, it does not provide detailed findings on welfare improvement after the fact. According to Bhagwati and Panagariya (1999), the influence of the two nations' free trade agreement on common welfare is dependent on total production computed at global prices. The empirical results show that when two small countries with relatively balanced bilateral trade enter into a free trade agreement, losses may be greater for states with higher tariffs. This conclusion contradicts the natural trading partner hypothesis, proposed by Wonnacott and Lutz (1989), which was backed by De Long and Summers (1991) and Krugman (1993). According to this assumption, the greater the trade interactions between the two countries with the world, the more advantageous it is for the two countries to establish the FTA.

In the follow-up, many scholars explored the effect of FTA from geographical factors and scale factors. They argue that FTAs are often formed between geographically close countries and that lower transportation costs make FTAs beneficial to both parties. However, Viner (1950) pointed out that in the 19th century, commercial agreements between European countries deviated from the most-favored-nation principle, and there is no basis for considering distance when evaluating FTA, which also shows that the gravity model in the empirical research may be biased. Bhagwati and Panagariya (1996) also proved that FTA between close countries is not better than that between distant countries. Corden (1972) first analyzed the impact of economies of scale on trade agreements. He argues that economies of scale could offset the loss of income caused by trade diversion. However, Baldwin and Venables (1995) carefully discussed the scale and cost effects of free trade agreements and identified the transmission process, but did not draw a clear welfare effect.

Later new trade theories proved that countries could gain from free trade. Krugman (1980)'s model proves that trade liberalization enables consumers to obtain a wider choice of imported products, resulting in diversification benefits. In addition, Melitz (2003)'s heterogeneous firm model argues that trade liberalization forces the least productive firms out of production thereby increasing domestic productivity. These theoretical contributions have inspired a flood of empirical literature to measure the resulting marginal benefits. For example, according to Broda et al. (2017), the variety of imported products available to U.S. consumers increased between 1972 and 2001. Trefler (2004) showed that manufacturing productivity in Canada rose significantly after the Canada-US Free Trade Agreement, as a result of the exit of low-productivity firms. Therefore, the new trade theory argues that FTA brings broad marginal benefits to the contracting parties, which improves the country's economic growth. However, Hsieh et al. (2020) argued that the measured gains in import diversification would be offset by the loss of alternative domestic products, and the resulting increase in domestic productivity would also be offset by the gains in alternative import productivity. To offset the losses, they estimated the policy effect of the Canada-U.S. Free Trade Agreement, which showed that Canada suffered a net loss on the trade. Hsieh et al. (2019) constructed a semi-endogenous growth model with decreasing returns to the stock of ideas, and argue that lowering tariffs can only temporarily stimulate growth, because lower tariffs make ideas spread faster, increasing the productivity of each country. However, facilitation becomes weaker as countries get close to the technological frontier. They use data to prove that countries with strong innovation capability will export more ideas to countries with low innovation skills so that countries with low innovation ability will grow faster, but the impact on countries with strong innovation ability is not obvious. So in the classic literature, the macro effect of FTA on countries is still highly debated.

In current empirical research, the primary model used by researchers to measure the impact of FTA is still the "gravity model" by Tinbergen (1962), who used the gravity model to analyze the effect of dummy factors associated with FTA on trade. Since then, this model has been employed by most economists to estimate the aftereffects of FTA. However, these studies have been controversial from the beginning. Brada and Mendez (1985) argue that trade flows between members have an economic and statistically significant effect. However, Frankel et al. (1995) found no significant effect. Some scholars also use the dynamic CGE model to evaluate policy effects (Cheong, 2014; Jung and Kim, 2019). Although this calibration approach may be used to evaluate policy effects, the parameters upon which it is based are rather unstable. The result is strongly reliant on the special function form and parameter setting values used in modeling. For example, the resulting conclusions are quite different when the Stone-Geary utility function, the CES utility function, or the linear expenditure system are used to describe demand. This form of the model has significant difficulty describing the causal relationship and effect. Additionally, it is hard to determine the accuracy of the result (Angrist and Pischke, 2010).

Emerging treatment effects methods provide new tools for analyzing the impact of endogenous bilateral trade policies on international trade flows, but there are also some problems. First, Bai and Ng (2002) suggested estimating the latent factor model, but this approach is only suitable when the cross-section and time-series dimensions are sufficient. Due to the high volume of data when analyzing a macroeconomic policy, it is difficult to generate an unbiased assessment. Second, Kang and Jeon (2020) suggested evaluating micro policies using the DID technique. Although the DID method is subject to some strict assumptions, DID's primary premise is that policies are random. However, macro policies are often established with purpose, and there is almost no randomness. Furthermore, different regions have distinct populations, cultures, economies, and political systems. Without considering this cross-sectional heterogeneity, estimates would be heavily biased. Third, Shen et al. (2019) used SEMs to evaluate the effect of FTA. In using the SEMs to analyze policy effects, it is necessary to have a thorough knowledge of the policy mechanism, choose appropriate variables based on this knowledge, choose an appropriate model form, and establish a correct theoretical model. Generally, the function of the policy shows itself in the result variable through the transmission of several intermediate factors. The mechanism through which these variables are transmitted may be rather complex. As a result, when a simple structural equation model is used, the policy cannot be described clearly and correctly. However, when large-scale SEMs models are used for the estimate, some variables may become unavailable, resulting in endogenous problems or high estimation costs.

Traditional regression analysis methods demand a large number of samples and many observations when examining the effect of policies. As a result, they are often insufficient for estimating the impact of policies on the aggregate amount (Abadie, 2021). It becomes complicated when time-series techniques are utilized to estimate the long-term effects of a policy. In addition to treatment effects, there are also influences on other impacts, resulting in biased estimates. Therefore, Abadie and Gardeazabal (2003) suggested the synthetic control approach, which is often used for evaluating macroeconomic policies. Billmeier and Nannicini (2013) used this method to assess the impact of economic liberalization on the GDP of various countries. On the other hand, the synthetic control method assumes that the weight is non-negative. The aggregate is designed to help the Constrained quadratic optimization problem solution, necessitating a positive correlation between the sample's variation trend. It significantly reduces the degree of heterogeneity in macroeconomic variations among nations.

Recently, the HCW method has been used to estimate the effects of macroeconomic policies. No common trend assumption is necessary throughout the fitting process since linear panel regression equations take full advantage of linear equation extrapolation. As long as the fluctuation frequency of the macro component is consistent, even if the fluctuations are negatively correlated, the consistency estimate can be obtained. Hsiao et al. (2012) used the HCW approach to estimate Hong Kong's economic and political integration with China. Zhang et al. (2015) evaluated the macroeconomic effects of the U.S.-Canada Free Trade Agreement. Jordan et al. (2014) discuss the impact of trade agreements on the global economy. According to Chen et al. (2018), China's "One Belt, One Road" policy has short-term and long-term macroeconomic effects. Bai et al. (2014) analyzed new regulations on housing prices, Ouyang and Peng (2015) discuss the macroeconomic effects of economic stimulus programs. Du and Zhang (2015) developed the HCW approach by selecting the control group using cross-validation methods. Carvalho et al. (2018) discussed the HCW approach's applicability to high-dimensional data and suggested that the LASSO method determines the control group.

In line with the above research methods and previous studies, this study analyzes the effect of the Korea-China FTA on Korea's macroeconomics using the HCW approach. This paper offers an empirical foundation for analyzing the policy effects of FTAs and provides empirical support for Korea taking full advantage of the Korea-China FTA.

3. Methodology

The Korea-China FTA was officially signed on June 1, 2015 and its primary provisions include origin regulations, tariff reductions on products and service trade. The paper uses the opportunities that arose by the signing of the China-Korea FTA to empirically examine the influence of the FTA on bilateral trade and regional economic growth. The paper applies the HCW panel data approach to estimate the policy impact of FTA. According to Hsiao et al. (2012), many macroeconomic variables influence individuals throughout cross-sections. These variables have varying degrees of effect on individuals, but they all contribute to the correlation of cross-sections. For example, there are several variables that affect economic growth, but there will be certain common factors (the subprime mortgage crisis in 2008). These shocks will cause similar macroeconomic volatility in various countries. HCW is a method for capturing these commonalities throughout the data generation process.

Assume the equation to be approximated has the following basic matrix form:

$$\vec{y}_t^0 = B\vec{f}_t + \vec{\alpha} + \vec{\varepsilon}_t \tag{1}$$

where $\vec{y}_t^0 = (y_{1t}^0, \ldots, y_{Nt}^0)', \vec{\alpha} = (\alpha_1, \ldots, \alpha_N)', \vec{\varepsilon}_t = (\varepsilon_{1t}, \ldots, \varepsilon_{Nt})', B_{N\times K} = (\vec{b}_1, \ldots \vec{b}_N)'$ is the loading matrix for the components and satisfies the following assumptions:

Assumption 1: $||\vec{b}_i'|| = c < \infty$, for all i.

Assumption 2: $\vec{\varepsilon}_t$is a stationary sequence, with a mean value of zero and a variance of V, where V is a constant diagonal matrix.

Assumption 3: $E\vec{\varepsilon}_t(\vec{f}_t)' = \vec{0}$.

Assumption 4: The rank of the element loading matrix $B_{N\times K}$ is K.

The above assumptions are fundamental ones that are typically satisfied automatically during the estimation process. By these assumption equation (1) assumes that individual performance is divided into two components: the common factor $\vec{f}$ that varies over time and the individual-specific component, which includes the individual fixed effect α_i and random factor ε_{it}. Also, it assumes that the random factors of different individuals are irrelevant, Hence $E(\varepsilon_{it}\varepsilon_{jt}) = 0$. Common factors can only explain correlations between individuals from different cross-sections $\vec{f}$. But the influence of the common factor $\vec{f}$ on different individuals can be different, that is, $\vec{b}_i \neq \vec{b}_j$. Equation (1) makes no assumptions about the time-series properties of $\vec{f}$. It may be moveable or stationary. Assumption 4 implies that the number of observable cross-sectional elements N is higher than the number of common time-varying factors $\vec{f}$. Sargent and Sims (1977), Forni et al. (2009), and Stock and Watson (2009) all supported the rationality of this idea. In other words, just a few public variables can explain macroeconomic data volatility.

Let y_{it}^1 denote the outcome of the ith unit at time t under treatment or intervention andy_{it}^0 denote the outcome of the ith unit in the absence of treatment or intervention at time t. Then the treatment

effect for the ith unit at time t is $\Delta_{it} = y_{it}^1 - y_{it}^0$. However, often we do not simultaneously observey_{it}^1 and y_{it}^0 only the data at time t can be observed:

$$y_{it} = d_{it}y_{it}^1 + (1 - d_{it})y_{it}^0 \tag{2}$$

Where, d_{it} is an indicator variable, such that $d_{it} = 1$ indicates that at time t, the person i accepts treatment. So, we only need to estimate $y_{it}^0\ (t \in (T_1, T))$, the result is the counterfactual path.

Assumption 5: Assume that the unique components of individual j and d are independent of each other, $E(\varepsilon_{js} \mid d_{it}) = 0\ (j \neq i)$.

This implies that whether or not an individual *i* accept policy intervention does not affect the specific cross-section factor ε_{js} at any time for individual *j*, which is the fundamental premise for generating a "counterfactual."

Here, Assumption 5 does not specify the relationship between ε_{it} and d_{it}. If they are correlated, the selection bias generated by unobservable variables will impact the observable data. If irrelevant, such observable data satisfy the conditional independence assumption Rosenbaum and Rubin (1983) mentioned. In terms of macro data, the irrelevance between the two cannot be satisfied in general, implying that micro-policy assessment approaches may provide biased results. The HCW method just needs to establish that cross-sectional specific variable ε_{js} and d_{it} of individual j are independent. In other words, whether or not individuals accept policy treatment does not influence the rest of the cross-section. This assumption is weaker than that of macro-policy evaluation methods, and it is easier to satisfy with macro-data. Furthermore, if the process given by equation (1) satisfies Assumption 1-5, Hsiao's theoretical model may ignore the selection bias.

Under the assumptions 1- 5, if $\vec{b}_1'$, $\vec{f}_t$, α_1 can be identified. Then, using equation (3), we may predict the counterfactual y_{1t}^0 :

$$\hat{y}_{1t}^0 = \alpha_1 + \vec{b}_1'\vec{f}_t, t = T_1 + 1, \cdots, T \tag{3}$$

When working with microdata, N and T are often sufficient. Maximum likelihood estimation may be used to estimate the number of common factors K in Equation (1) and its coefficient vector $\vec{f}$, and then $\hat{y}_{1t}^0$ can be predicted. However, in the macroeconomy, time series data after policy application is often limited, and there are insufficient cross-sections to contrast. N and T are insufficiently big, making K and $\vec{f}$ unidentifiable. Hsiao et al. (2012) argue that because similar factors exist between cross-sections, there is often a significant correlation between groups, and so the linear prediction value of the counterfactual group may be used to substitute y_{1t}^0, This is the core of this model. Additionally, this substitution enables the HCW method to solve the VAR model's estimate bias when there is a ripple effect between the treatment and control groups after the treatment period.

Before the policy application, the empirical analysis may be applied to produce a model that fits the performance of unaffected individuals within the same period. If the fitting effect is sufficient, the model fitted in the previous step may be used to predict the individual's counterfactual $\hat{y}_{1t}^0$ in the absence of policy treatment. Abadie (2021) observed that if the time preceding intervention is too short or the shock is too large, the HCW approach will be unable to adequately fit the counterfactual, resulting in overfitting and potential bias. Therefore, the empirical methodology must highlight these two factors.

4. The Data

First, we select the samples representing counterfactual analysis to validate that the HCW method's exogeneity condition is satisfied. Second, we use this collection to create Korea's counterfactual path after the FTA's adoption. The discrepancy between observable data and predicted counterfactuals shows the macroeconomic policy effect of the FTA.

To satisfy the sample time condition of the HCW method, i.e., the longer the period before policy implementation, the more accurate the fitting, we picked 45 countries or regions from the OCED database that had complete real quarterly GDP growth rate data from 2000Q1 to 2020Q1. There were 61 datasets (1 , T_1) before the adoption of the Korea-China FTA and 20 data points $\left(T_1 , T_2\right)$ after the signing of the Korea-China FTA. $T_1 > T_2$ satisfies the sample interval condition of the HCW method.

The HCW method highlights that the exogenous criterion's hypothesis 5 is valid, and the violation will lead to biased results. In reality, countries or regions are more intimately connected, making it difficult to determine which countries or regions are completely exogenous to the signing of the Korea-China FTA; therefore, we can only choose countries or regions that are relatively exogenous to policy intervention via bilateral trade relations with Korea. As a result, we developed an indicator to estimate exogeneity using the technique by Ouyang and Peng (2015). The country's imports from Korea accounted for the proportion of total imports. There is no need to consider the percentage of Korea's imports from other countries or regions in terms of total imports while generating this statistic. Even if this percentage is high, it will have no impact on our results since we avoid Korea and the control group. The Korea-China FTA signed in 2015, is mainly aimed at tariff-free, which is relatively low-level cooperation in the free trade agreements. So, we do not need to remove all countries or regions that have signed an FTA with Korea from the control group.

On this basis, we filtered the 2016 trade statistics of 46 countries or regions with Korea. By calculating the proportion of imports from Korea to the country's total imports as an evaluation standard, if the country's imports from Korea accounted for more than 3% of its total imports in 2016, it means that the country has a certain reliance on Korean goods. However, the signing of the Korea-China FTA may affect the country so that it does not satisfy Assumption 5 and should be removed from the control group. We removed 17 countries or regions from the data set, such as Australia, China, Brazil, Hong Kong, India, Greece, Malaysia, Mexico, New Zealand, Russia, Saudi Arabia, Slovakia, Turkey, Indonesia, Japan, the United States, and Singapore, and the remaining 29 countries or regions make up our set of a potential control group. The data is shown in Table 1.

Table 1. Exogeneity Measure: Trade Relations between the Control Group and Korea in 2016

Countries	Import Share	Countries	Import Share	Countries	Import Share
ARG	1.59	CAN	1.99	DEU	0.81
AUS	4.28*	CHL	2.97	GRC	4.16*
AUT	0.56	CHN	10.01*	HUN	1.08
BLR	3.96*	HKG	4.71*	IND	3.42*
BGR	0.43	FRA	0.64	COL	1.98
CZK	2.46	DNK	0.43	EST	0.51
FIN	0.96	LTU	0.66	LUX	0.46
MYS	5.25*	MEX	3.52*	NLD	0.81
NZL	4.52*	NOR	2.8	POL	1.77
PRT	0.53	ROU	0.76	RUS	3.00*
SAU	4.37*	SVK	5.83*	SVN	1.61
ZAF	1.34	ESP	0.84	SWE	0.60
CHE	0.32	TUR	3.20*	IDN	4.92*
IRL	1.20	ISR	2.00	ITA	0.81
JPA	4.12*	GBR	0.93	USA	3.2*
SGP	5.83*				

Notes: 1. This table reports the import from Korea as a ratio of each country's total imports for the countries.
2. *indicates that the ratio exceeds the threshold value of 3% and violates the exogeneity criterion.

Source: Authors' calculation using UN Comtrade data.

5. Empirical Analysis

In this section, we use the HCW method to estimate the influence of the Korea-China FTA on Korea's short-term macroeconomy and the policy's long-term effects.

5.1. The Short-term Impact on GDP

To correctly evaluate the influence of the Korea-China FTA on Korea's real GDP, we generated counterfactual predictions using the 29 countries or regions mentioned above as possible control groups. We then fitted data from 2000Q1 to 2015Q1 to the counterfactual growth rate in Korea before the Korea-China FTA's signing, and data from 2015Q2 to 2020Q1 to the counterfactual growth rate during the policy evaluation period. And during the policy evaluation period, we have twenty periods of observation covering more than four years, which implies we have a large enough sample size to estimate the Korea-China FTA's long-term effect.

We choose the right number of countries or regions for the optimal control group using the method described in Section 2. Our strategy for selecting control groups is divided into two steps: First, we select a number of countries or regions to describe the potential control group, fit the actual GDP of Korea and then determine its goodness of fit and significance of the coefficient. If the coefficient is not significant, we remove the country from the control group; we repeat regression until all countries have significant fitting coefficients to Korea. Second, we select the number of specific countries or regions in the control group according to AIC, BIC, or AICC criteria. We assume that $\vec{y}_t$ is generated by equation (1). Hsiao et al. (2012) used Monte Carlo simulation to examine the predicted mean square error (PMSE) of prediction after policy intervention (out-of-sample) and to evaluate the efficacy of AIC, BIC, and AICC. They believe that AICC is more successful in the long run.

To generate Korea's counterfactual growth path, we used AICC criteria to choose 12 countries, including CZE, ZAF, CHN, FIN, CHE, CAN, ESP, GBR, LTU, ISR, SWE, and CHL. The OLS regression weights and t values for 12 countries or regions from 2000Q1 to 2015Q1 are shown in Table 2. The countries or regions chosen are all statistically significant at the 10% level, and R^2 is 0.915, which indicates that the equation fits well. It satisfies the fitting equation conditions of the counterfactual by Abadie (2021).

Table 2. Weights of Control Groups for the Period 2000Q1 to 2015Q1

	Coef	**Std**	**t-value**
Constant	-0.015	0.008	-1.85
CZE	-1.124	0.142	-7.90
ZAF	0.909	0.240	3.78
CHN	0.463	0.091	5.08
FIN	0.323	0.115	2.80
CHE	0.314	0.136	2.30
CAN	0.459	0.183	2.51
ESP	0.557	0.153	3.64
GBR	0.645	0.169	3.82
LTU	-0.306	0.061	-5.03
ISR	-0.224	0.076	-2.94
SWE	0.198	0.099	2.01
CHL	-0.209	0.107	-1.94
R-squared: 0.915			
F-statistic: 43.29			
AICC： -563.523			

In the absence of the Korea-China FTA, we predict Korea's "counterfactual" growth path from Q2 2015 to Q1 2020. Table 3 shows the actual growth rate of Korea's GDP and the counterfactual growth rate. The difference between the two is the processing impact of the Korea-China FTA that we are concerned about. In this research, the period following the treatment is as long as 20 times, and there is enough data to determine the average treatment effect. Using the stationary series approach, we estimate that signing the Korea-China FTA from Q2 2015 to Q1 2020 would increase Korea's GDP growth rate by 2.1%. Our empirical result has evidence backing free trade to improve the country's economic development in the short run.

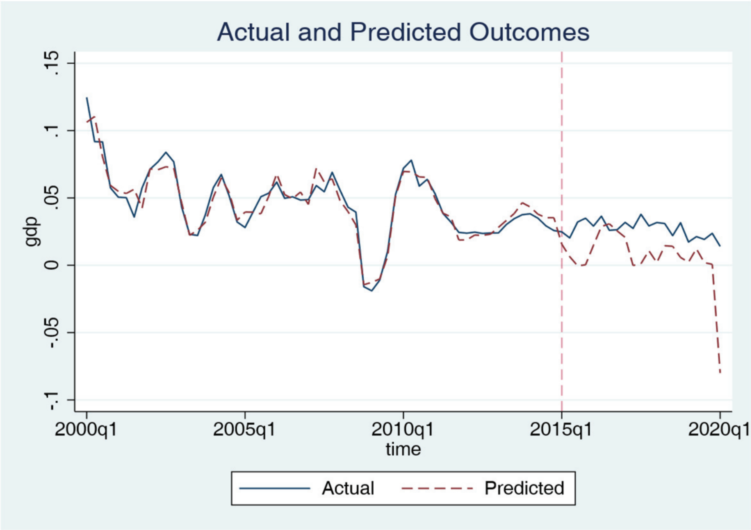
Fig. 1 displays the real and counterfactual growth paths of Korea from 2000Q1 to 2020Q1. The figure shows that our method fits Korea's growth path well before the signing of the Korea-China FTA and that some major inflection points are correctly fitted, confirming the HCW method's robustness. Fig. 2 describes the path of treatment effects.

Table 3 and Fig. 1 indicate that the actual growth rate after the signing of the Korea-China FTA is greater than the counterfactual growth rate, implying that the Korea-China FTA had a positive effect on Korea's actual GDP growth rate. The aforementioned results suggest that an FTA may increase the country's economic development in the short term. Therefore, there is the need to consider FTA's long term policy implications on GDP.

Table 3. Treatment Effect of FTA on GDP 2015Q2 to 2020Q1

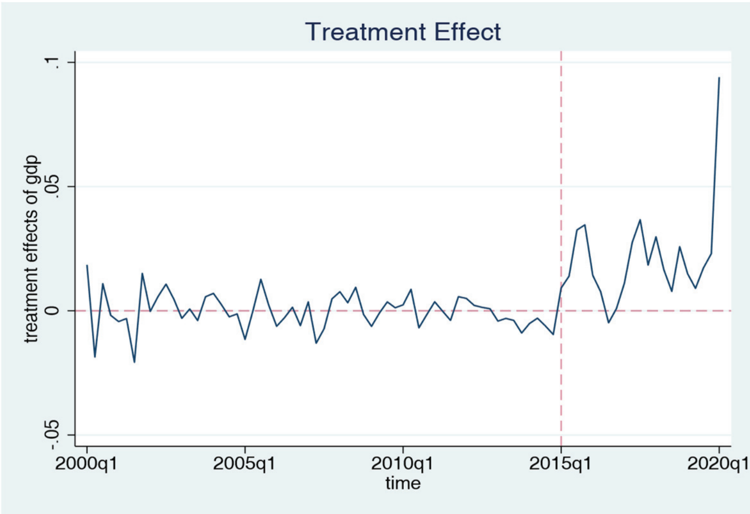
Time	Actual	Predicted	Treatment
2015Q2	0.020	0.006	0.014
2015Q3	0.032	0.000	0.033
2015Q4	0.035	0.000	0.035
2016Q1	0.029	0.015	0.014
2016Q2	0.036	0.029	0.008
2016Q3	0.026	0.031	-0.005
2016Q4	0.026	0.025	0.001
2017Q1	0.032	0.021	0.011
2017Q2	0.027	0.000	0.028
2017Q3	0.038	0.001	0.037
2017Q4	0.029	0.011	0.018
2018Q1	0.032	0.002	0.030
2018Q2	0.031	0.015	0.016
2018Q3	0.022	0.014	0.008
2018Q4	0.032	0.006	0.026
2019Q1	0.017	0.002	0.015
2019Q2	0.021	0.012	0.009
2019Q3	0.019	0.002	0.017
2019Q4	0.024	0.001	0.023
2020Q1	0.014	-0.080	0.094
Mean	0.027	0.006	0.021

Fig. 1. Actual and Predicted Real GDP from 2000Q1 to 2020Q1



Note: The third export markets indicate export destinations that include all countries except for two countries. The X axis is % of exports to the world while the Y axis is the ESI score measuring the export similarity (competition) between two countries.
Source: Authors' calculation using UN Comtrade data.

Fig. 2. Treatment effect from 2000Q1 to 2020Q1



Note: The third export markets indicate export destinations that include all countries except for two countries. The X axis is % of exports to the world while the Y axis is the ESI score measuring the export similarity (competition) between two countries.
Source: Authors' calculation using UN Comtrade data.

5.2. The Long-term Impact on GDP

We used time-series approaches to analyze changes in processing effects over time to see whether FTA policies have long-term effects. The policy effect estimated by equation (3) changes with time, and time series may be used to examine the policy's effect in the long run. Bai et al. (2014) demonstrated that an AR method might approximate the long-term effect of the policy. Even when the sequence is a non-stationary first-order unit root process, a consensus estimate can be estimated.

Based on this, we estimate the first-order, second-order, and third-order autocorrelation models, respectively. According to the AIC criterion, we choose to fit an AR (1) model to explain the long-term effect of the treatment effect:

$$\begin{aligned} \widehat{\Delta}_{1t} &= 0\,.760 + 0.655\widehat{\Delta}_{1t-1} + e_t \\ &\quad\ (1.44) \quad (5.45) \end{aligned}$$

The standard error of the estimate is in parentheses. Box-Ljung-Pierce test found that e_t has no autocorrelation. As can be seen in the model above, the lag period coefficient of 0.655 indicates that the model will revert to its mean value after a shock. Because this model's constant term cannot be significantly different from zero, the model indicates that its long-term mean value is zero, showing that the long-term effect of FTA tends to be zero.

In summary, our analysis indicates that although the signing of the Korea-China Free Trade Agreement increased Korea's GDP growth rate by 2.1%, the FTA will have no long-term positive effect on Korea's real economic growth.

5.3. Placebo Studies

In counterfactual research, a placebo test is necessary to assess the credibility of our results. We redistributed the treatment effect to countries besides Korea and China or altered the timing of policy implementation to use a placebo examined data and compare it to our original data(Abadie, 2021; Abadie, et al., 2015). This method may get estimates of other nations' or areas' placebo effects and compare them to the FTA's policy impact on Korea. If the Korea-China FTA policy effect is greater than the placebo effect, we will consider the FTA to have a significant policy influence on Korea. Fig.3 reports the ratio of MSPE after the Korea-China FTA signing and MSPE before FTA signing between Korea and the control group countries. As shown in Fig.3, Korea has the greatest ratio of Post-treatment RMSPE to Pre-treatment RMSPE, indicating that FTA significantly impacts the country.

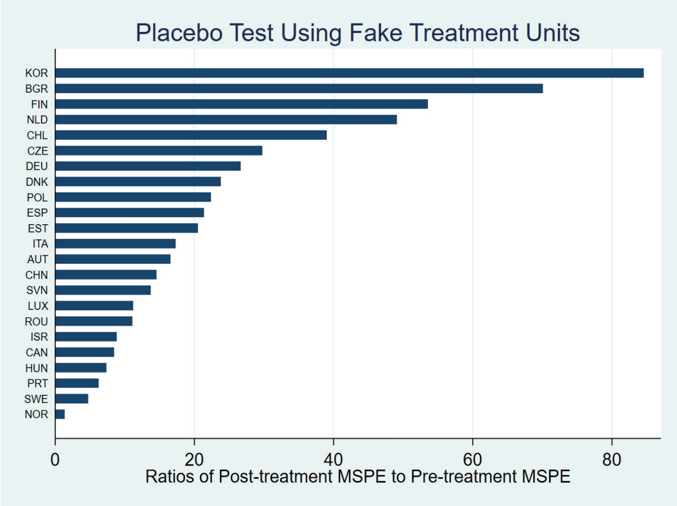
Additionally, we define a p-value, which indicates that the ratio of any country's MSPE after the FTA is signed to its MSPE before the signing has the same probability as Korea. We compute independently for each country, divide the processed MSPE by the RMSPE before treatment, and compare this value to Korea. The values are then averaged with weight. A small p-value indicates a significant treatment effect. In this paper, our computed p-value is 0.044 showing that Korea is significantly affected by FTA.

We may do a placebo test by altering the policy's time. We then re-estimated the model and pushed the policy occurrence time to Q3 2011, 15 quarters earlier than the actual event time to perform this placebo test. We estimate using the same approach as before.

The results of this placebo test are shown in Figure 4. The graph demonstrates that we have a good fit before Q3 of 2011 and the composite value path between Q3 of 2011 and Q2 of

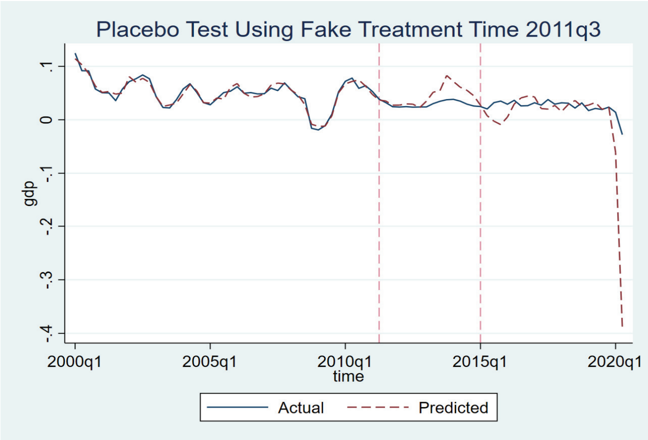
2015 is almost identical to the actual value path, demonstrating that the Korea-China FTA has had a significant effect.

Fig. 3. The Ratio of Post-treatment RMSPE to Pre-treatment RMSPE: KOR and Control Countries



Note: The third export markets indicate export destinations that include all countries except for two countries. The X axis is % of exports to the world while the Y axis is the ESI score measuring the export similarity (competition) between two countries.
Source: Authors' calculation using UN Comtrade data.

Fig. 4. Placebo Test Using Fake Treatment Time 2011Q3



Note: The third export markets indicate export destinations that include all countries except for two countries. The X axis is % of exports to the world while the Y axis is the ESI score measuring the export similarity (competition) between two countries.
Source: Authors' calculation using UN Comtrade data.

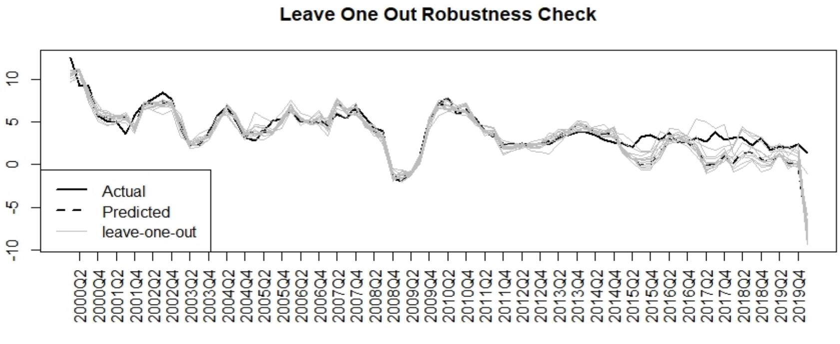
5.4. Robustness Test

Along with the placebo test for the treatment effect discussed above, it can only represent the robustness of the side results. Additional testing is required to validate the results' robustness. From an empirical research standpoint, regardless of the estimating technique employed in the study, the major results should demonstrate some degree of robustness to changes in the research design.

According to Zhang et al. (2015), to determine the research's robustness, it is required to assess if the signing of the Korea-China FTA marks the beginning of a structural change in Korea's relationship with the controlling country. If a structural break exists, it implies that the FTA is the primary factor explaining the difference between Korea's real GDP growth rate and the counterfactual. We chose two classic methods to test the structural points. First, we used the Chow test to determine if a structural change occurred at that moment under known time-point conditions. We selected 2015Q3 for the Chow test immediately after signing the FTA, and the results indicated that there was a structural change. The p-value is 0.004. Second, to further ensure the results' robustness, we use Andrews' (1993) SupF test, which searches for mutation points without giving a time point. We used the method to analyze real GDP data for Korea from 2000Q1 to 2020Q1 and discovered that the second quarter of 2015 had a structural change. The p-value is 0.0022. This closely corresponds to the time of the Korea-China free trade agreement signing. As a result, we have reasons to believe that the Korea-China FTA is the primary explanation for the difference between Korea's actual GDP and the counterfactual.

To further confirm the robustness, we use the ideas of Abadie et al. (2015) to test the estimated results' sensitivity to changes in country weights. We perform robustness tests using the Leave-one-out technique and repeatedly remove a unit from the control group to ensure if a particular unit has a significant effect on the result. Otherwise, it demonstrates that the outcome is robust. Fig.5 illustrates the results. The black solid and black dashed lines in the image (Fig. 5) have the same definitions as in Fig. 1, and the gray line shows the predicted value for Leave-One-Out. Fig. 5 demonstrates that our findings are robust, excluding the case in which a specific country influences the Korea-China FTA policy.

Fig. 5. Leave-one-out Robustness Check



Note: The third export markets indicate export destinations that include all countries except for two countries. The X axis is % of exports to the world while the Y axis is the ESI score measuring the export similarity (competition) between two countries.

Source: Authors' calculation using UN Comtrade data.

5.5. Impact on Export and Import

We discussed the effect of the Korea-China FTA on Korea's imports and exports in this section. Because we expect that the influence of free trade agreements on imports and exports is inconsistent, we fit two counterfactual paths independently and seek the FTA's heterogeneous effects on imports and exports. Additionally, we collected import and export statistics from the United Nations Comtrade database for the 29 nations indicated above. The sample interval is from 2006Q1 to 2019Q4, which also fits the sample interval conditions of the HCW method.

We used AICC standards to screen nine countries for matching the counterfactual export growth rate prior to the Korea-China FTA's signing: and 13 countries for matching with a counterfactual export growth path. Table 4 reports the weights of the regression equation, t statistics, and R^2. Fig. 6 depicts the actual and counterfactual export growth paths from 2006Q1 to 2019Q4, and Fig. 7 depicts the actual and counterfactual import growth paths from 2006Q1 to 2019Q4. As shown in Fig. 6 and Fig. 7, the two equations are well-matched, and the counterfactual path before the signing of the FTA is virtually identical to the actual path.

Table 4. Weights of Control Groups for the Period 2006Q1 to 2015Q2

	Export			Import	
	Coef.	**t-value**		**Coef.**	**t-value**
Argentina	0.383	7.105	Argentina	-0.272	-7.031
Belgium	2.777	7.293	Austria	0.375	3.153
Bulgaria	-0.580	-4.691	Canada	0.746	7.998
Denmark	2.565	5.253	Chile	0.369	7.994
Estonia	1.670	7.705	Czechia	0.117	1.252
Germany	-3.668	-6.387	Denmark	-0.314	-3.336
Hungary	1.387	7.437	Estonia	-0.081	-3.028
Ireland	-1.236	-5.494	Finland	-0.501	-6.035
Israel	-0.278	-4.283	Germany	1.209	8.771
			Ireland	0.209	4.272
			Israel	-0.180	-3.255
			Italy	-0.148	-1.415
			Luxembourg	0.049	1.524
R-squared: 0.986			R-squared:0.980		

Fig. 6. Actual and Predicated export from 2006Q1 to 2020Q4

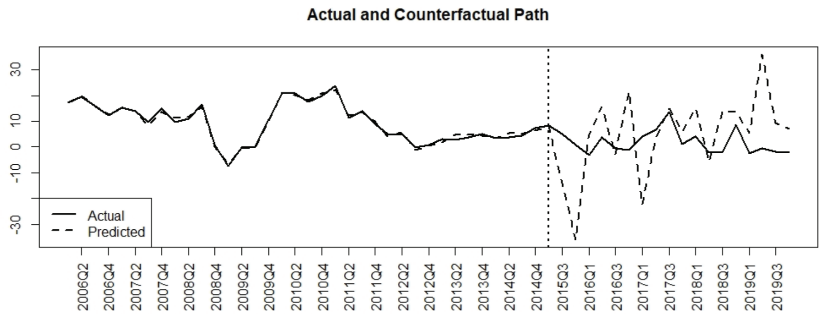
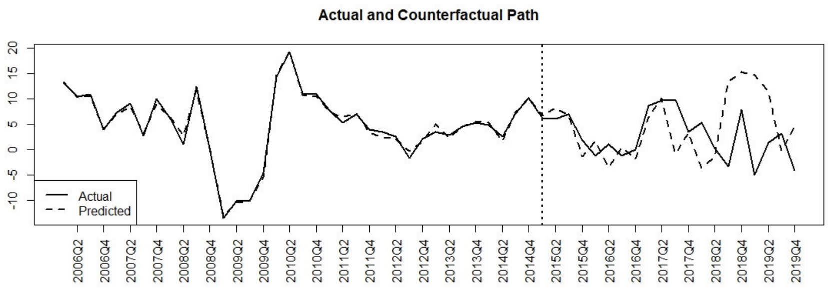


Fig. 7. Actual and Predicated import from 2006Q1 to 2020Q4



According to Table 5, the average treatment effect of the Korea-China FTA on exports is -1.241% over the treatment, while the estimated average treatment effect on imports is -1.747%. Between 2016Q1 and 2019Q4, the global political and economic environment remained uncertain, and several events had a substantial influence on Korea's trade relations. For example, the geopolitical crisis between China and Korea was precipitated by the 2016 THAAD issue or the Sino-US trade war that erupted in 2018. These crises have impacted the macroeconomic environment in which Korea confronts itself and will also result in erroneous estimations of the treatment effect.

Table 5. Treatment Effect of FTA on Export and Import 2015Q2 to 2019Q4

	Export				Import		
	Actual	Predicted	Treatment		Actual	Predicted	Treatment
2015Q2	2.884	-27.353	30.237	2015Q2	6.123	8.126	-2.002
2015Q3	5.001	-13.899	18.900	2015Q3	7.032	6.779	0.252
2015Q4	0.663	-35.997	36.660	2015Q4	1.801	-1.396	3.197
2016Q1	-3.152	4.740	-7.892	2016Q1	-1.300	1.616	-2.916
2016Q2	3.709	15.539	-11.830	2016Q2	0.975	-3.457	4.432
2016Q3	-0.417	-2.805	2.388	2016Q3	-1.274	0.457	-1.732
2016Q4	-1.124	21.571	-22.694	2016Q4	-0.045	-1.921	1.876
2017Q1	4.032	-22.403	26.435	2017Q1	8.694	6.317	2.377
2017Q2	6.699	3.431	3.269	2017Q2	9.685	10.221	-0.536
2017Q3	13.756	14.753	-0.997	2017Q3	9.842	-0.723	10.565
2017Q4	1.051	5.983	-4.932	2017Q4	3.453	3.307	0.147
2018Q1	3.944	14.826	-10.882	2018Q1	5.259	-3.611	8.870
2018Q2	-2.270	-5.961	3.691	2018Q2	0.273	-1.528	1.802
2018Q3	-2.326	13.926	-16.251	2018Q3	-3.374	13.579	-16.953
2018Q4	8.665	13.497	-4.832	2018Q4	7.848	15.330	-7.482
2019Q1	-2.442	5.302	-7.744	2019Q1	-5.051	14.661	-19.712
2019Q2	-0.436	35.970	-36.406	2019Q2	1.308	11.327	-10.019
2019Q3	-1.972	9.245	-11.217	2019Q3	3.158	-0.161	3.318
2019Q4	-2.316	7.165	-9.481	2019Q4	-4.190	4.484	-8.675
Mean	1.787	3.028	-1.241	Mean	2.643	4.390	-1.747

We argue that the impact of policy implementation is inextricably linked to the macro environment and that additional factors must be included to estimate macro-policy effects appropriately. This also demonstrates that using macro policy assessment methods directly to estimate macro-policy effects creates significant biases. This research uses the HCW method based on the influence of common variables since it provides for effective changes caused by numerous external environments and the generation of generally accurate conclusions. Fig. 6 and Fig. 7 show that counterfactual estimates of Korea's import and export growth rates have some credibility in the absence of the aforementioned exogenous shocks, so these exogenous environmental changes just caused unexpected fluctuations, this does not mean that the method is biased. According to the HCW method's timeline criteria, the period before policy treatment must be more than after treatment. The longer the time before treatment, the more accurate the fitting, so we can only discuss the three quarters just after the FTA's signing. It has a significant promoting effect, but the impact on imports is not significant, and the specific data are shown in Table 5.

6. Conclusions

In this research, we use Hsiao et al. (2012) to propose a counterfactual method to estimate the macroeconomic effect of the Korea-China FTA on Korea. We constructed a counterfactual path for the Korea-China FTA using macroeconomic panel data from 29 countries and discussed the short-term and long-term effects of joining the FTA on Korea's macroeconomy. The estimated results indicate that although Korea's real GDP growth rate improved by 2.1% in the short run after the signing of the Korea-China FTA, the long-term impact of our analysis using time series technology is insignificant. This result is in line with previous studies (Jung and Kim, 2019; Kang and Jeon, 2020; Kwak et al., 2020; Liu et al., 2019; Shen, et al., 2019). We performed a placebo test to check the results' reliability and robustness by redistributing the time and country at which the treatment effect occurred. Two structural mutation tests and leave-one-out approaches were used to test robustness. It proves that our conclusion is quite robust.

As a result of estimating the trade data, in the short run, we discovered that entering the FTA has a highly noticeable promotion effect on Korea's exports but has a negligible effect on imports. Kwak et al. (2020) showed that as industries in China and Korea developed, the initial form of trade based on finished products changed to one based on intermediate products such as semiconductors, bringing the two countries' industries closer together. They have combined to produce a rigid demand for Chinese products in Korea. In the long term, entering the FTA reduced Korean exports' quarterly year-on-year growth rate by 1.241%, while imports' quarterly year-on-year growth rate decreased by 1.747%. This is because, over time, the effects of policies will be influenced by external environmental shocks.

In the era after the signing of the Korea-China FTA, the global macro situation was turbulent, geopolitical crises occurred frequently and trade conflicts between major countries resurfaced. All of these factors diminish the stability of policy evaluation results, however, our results are reasonable and robust among existing evaluation methods, providing a reference point for macroeconomic policy evaluation methods. In addition, this also shows that the tariff effect of the Korea-China FTA does not fully reflect the reality of Korea's export structure centered on intermediate products. Therefore, considering the low utilization rate of the Korea-China FTA, the analysis results of this study have important implications for the second phase of the Korea-China FTA negotiation (including services, investment, and finance).

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