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28

Assessment of the ASEAN–Korea FTA: findings on ASEAN-5 manufacturing and high-tech exports

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Abstract

Purpose – The ASEAN–Korea Free Trade Agreement (FTA) was signed in 2006 and took effect the following year. This research seeks to determine whether the implementation of the ASEAN–Korea FTA has been satisfactory for ASEAN-5 total and high-tech manufactured exports.

Design/methodology/approach – Manufacturing export flows between the ASEAN-5 and Korea are analyzed using the synthetic control method. This approach allows us to develop a counterfactual unit for manufacturing exports in a scenario in which no FTA would have been implemented.

Findings – Our results reveal that the ASEAN–Korea FTA has had a significantly positive impact on manufactured exports from the ASEAN-5 countries, both at the country and aggregate levels. Furthermore, it is observed that this positive outcome has also held for high-tech manufactured exports.

Originality/value – This research expands the literature in the field of trade agreement evaluation. Given the important economic implications of high-tech exports, this paper assesses the consequences that the ASEAN–Korea FTA has for such manufactured ASEAN exports. Moreover, this research studies whether the synthetic indicator is a good predictor of exports for the period before the FTA, analyzing the stochastic properties of the difference between these variables.

Keywords Integration effects, Synthetic counterfactual, ASEAN–Korea FTA

Paper type Research article

1. Introduction

Historically, ASEAN and Korea have developed close relations in a wide range of fields, marked, not least, by a willingness to deepen trade integration. Thus, since 1991, Korea has become a full dialog partner of ASEAN, and through various forums for dialog and cooperation, such as the Asia–Pacific Economic Cooperation forum and the ASEAN Plus Three scheme, among others, international, economic and trade relations between the two partners have been strengthened. After several rounds of negotiation, the ASEAN–Korea Free Trade Agreement (FTA) was signed in 2006 and took effect the following year.

According to UNCTADstat data, bilateral exports between ASEAN and Korea reached USD 23 billion in 1998, USD 70 billion in 2007 and USD 203 billion in 2022. In the first five years after the ASEAN–Korea FTA came into force, the average annual increase in total exports between the two parties increased by 15%, compared to 9% in the five years before the agreement came into effect. Among the main goods that Korea exports to ASEAN are ships, boats and floating structures, internal combustion piston engines and cathode valves and tubes,

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while the main items that ASEAN exports to Korea include machinery, cathode valves, measuring, analyzing and controlling apparatus and perfumery and cosmetics. Tariff lines within the ASEAN–Korea FTA are categorized into two differentiated tracks, namely the normal track and the sensitive track, with goods included in the normal track covering almost 90% of the total. In the ASEAN-5 countries (Singapore, Malaysia, Indonesia, Thailand and the Philippines), tariff dismantling was gradual in the first three years following the agreement's entry into force, with the largest reduction reported in 2007.

Economic integration models have analyzed the impact of such integration on the countries involved from a theoretical standpoint. With regard to trade flows, these models suggest that economic integration has a positive impact on trade between the countries involved. In this context and from an empirical perspective, this research seeks to determine whether the implementation of the ASEAN–Korea FTA has been satisfactory for ASEAN-manufactured exports, particularly for high-tech goods. The analysis of the performance assessment of the ASEAN–Korea FTA is limited to ASEAN-5 nations, due to the fact that these countries make up a large share of ASEAN's export capacity, accounting for an average of 85% of the trading bloc's total manufactured exports to Korea during the period 1995–2022, according to the UNCTADstat database. In addition, there is greater homogeneity in the level of economic development and market structures among these countries than among the rest of the ASEAN members. Since it is a stylized fact that the high-tech content of exports has a major impact on long-term economic growth and total factor productivity (Crespo and Wörz, 2005; Falk, 2009; Jarreau and Poncet, 2012), it is particularly relevant to consider the technological upgrading of goods traded within the analysis in evaluating the performance of the FTA. Recently, research focusing on ASEAN-centered agreements showed that they are critical for export-driven development, notably in high-tech sectors. In addition, these trade agreements have fostered, and played a central role in, the region's digital integration, which has been a key element in its technological advancement and the development of the high-tech sector (Mishra and Palacio-Valencia, 2023). The integration and cooperation process among ASEAN countries has also been strengthened by Korea's new political strategies, which explicitly link participation in FTAs with foreign direct investment and high-tech industrial development in ASEAN markets (Meeryung, 2025).

This research fills the gap in the literature by identifying the ASEAN–Korea FTA treatment effect, considering ASEAN total manufacturing and high-tech exports to Korea, supported by recent methodological developments and with thoughtful bias correction and robust validation. Accordingly, manufacturing export flows between the ASEAN-5 and Korea are analyzed using the synthetic control method (SCM). A panel data analysis is carried out by comparing the actual scenario with the counterfactual, i.e., the scenario that would have occurred if the FTA had not been launched, and the gains linked to it. Overall, we find that the ASEAN–Korea FTA has had a significant positive impact on the ASEAN-5 countries for both total manufacturing and high-tech exports.

2. Literature review

Since Abadie and Gardeazabal (2003) proposed an extended SCM approach, many disciplines have implemented this technique in the analysis of treatment effects to evaluate socioeconomic programs.

Nannicini and Billmeier's (2011) work is among the first to use the SCM in trade to study the effect of trade openness on economic growth in transition countries. The results suggest that trade liberalization tends to have a positive effect on the evolution of real GDP per capita, and not opening to trade significantly hampers growth in transition countries. Following this work, several authors have applied this methodology to study the effect of FTAs or trade liberalization measures. Hannan (2017) analyzes the impact of trade agreements made in Latin America during the period 1989–1996 and concluded that trade agreements have increased exports in Latin America by an average of 76%. Colla-De-Robertis and Garduno (2021) used

the SCM to estimate the effects of concluding an FTA with the United States on the GDP per capita of the countries that join the agreement. They showed that the impact of this type of treaty is heterogeneous, being positive for some countries (e.g., Chile and Jordan) but not significant or even negative for others (e.g., Mexico). Adarov (2023) studied the effect of the establishment, in 2010, by Belarus, Kazakhstan and Russia of the Eurasian Customs Union and its further development into the Eurasian Economic Union, which would also include Armenia and Kyrgyzstan. Both measures, moving beyond a preferential trade agreement by creating a common customs area, had a significant impact on trade creation. Zhou and Su (2021) studied the effect of 11 free trade zones in China–and the trade effect of each one was analyzed separately using the SCM–and found that the free trade zone has an obvious trade promotion effect on both total and export trade, but not on import trade.

Several studies using the SCM also provide evidence of the effect of different trade agreements impacting ASEAN and Korea. López *et al.* (2022) analyzed Chile's performance in the Trans–Pacific FTA with Korea, finding a positive outcome of increase, diversification and added value for Chilean exports during the study period. Likewise, using the SCM, Muñoz *et al.* (2023) analyzed the impact of the Chile–Korea FTA on extensive and intensive bilateral trade margins and discovered a positive effect on bilateral trade flows. Nie *et al.* (2022) studied the effect of the bilateral agreement between China and ASEAN on the use of environment-related inputs by analyzing the evolution of fertilizer use in export agriculture in China. Their results indicate that the agreement had a significant effect on China's use of fertilizer for exported agricultural products, with a greater impact on exports to the initial ASEAN countries than to those that joined later.

3. Data and methodology

The current research is carried out using data on ASEAN's manufacturing and high-tech goods exports to Korea. The data are sourced from the UN Comtrade database, the World Bank database and UNCTADstat, covering the period 1995–2022.

To assess the impact on ASEAN-5 exports to Korea after the completion of the FTA, the SCM proposed by Abadie and Gardeazabal (2003) is applied by comparing the actual scenario with what would have occurred if the FTA had not been launched.

Following Abadie (2021) and Wiltshire (2022), a panel data analysis is carried out with $J + 1$ units or countries. We assume that the first unit ($j = 1$) is the treated unit (affected by the FTA) and $j = 2, \ldots, J + 1$ are the donor pool (untreated units not affected by the FTA). Let T_0 be the number of preintervention periods (without the FTA) and $T - T_0 > 0$ treated periods (with the FTA). For each country j and time t, we observe the outcome Y_{jt}:

$$Y_{jt} = Y_{jt}^{N} + \theta_{jt} D_{jt}$$

D_{jt} is a binary variable that takes the value one if unit j is exposed to the intervention (FTA) at time t and takes the value zero otherwise. $\theta_{jt} = Y_{jt}^{Imp} - Y_{jt}^{N}$ is the effect of the FTA in country j at time t, with Y_{jt}^{Imp} being a random variable representing the eventual outcome given the FTA's implementation and Y_{jt}^{N} being a random variable representing the potential outcome without the FTA.

Y_{jt}^{N} is given by a factorial equation, which is a generalization of the difference-in-difference (fixed effects) approach (Abadie *et al.*, 2010):

$$Y_{jt}^{N} = \delta_t + \varphi_t Z_j + \rho_t \omega_j + \mu_{jt}$$

where δ_t is an unknown common factor with constant factor loadings across units, Z_j is a $(r \times 1)$ vector of observed covariates not affected by the intervention, φ_t is a $(1 \times r)$ vector of unknown parameters, ρ_t is a $(1 \times F)$ vector of unobserved common factors, ω_j is a $(F \times 1)$ vector of

unknown factor loadings and μ_{jt} is the error term that follows the classical assumption and measures unobserved transitory shocks at the country level with zero mean.

Since the potential response under the FTA is observable, estimating the effect of the FTA is reduced to estimating the potential response without it. Therefore, the synthetic control (SC) is defined as a weighted average of the units in the donor sample and can be represented by a $J\times1$ vector of weights, $W=(w_2,w_3,\ldots,w_{j+1})'$, with $w_j\geq0$, $\sum w_j=1$. Each value of the vector W represents a potential SC and the value of the outcome variable for each SC, which is indexed by W, is given by:

$$\sum_{j=2}^{J+1} w_j Y_{jt}=\delta_t+\varphi_t\sum_{j=2}^{J+1} w_j Z_j+\rho_t\sum_{j=2}^{J+1} w_j\omega_j+\sum_{j=2}^{J+1} w_j\mu_{jt}$$

Considering $(w_2^*,w_3^*,\ldots,w_{J+1}^*)$ such that:

$$\sum_{j=2}^{J+1} w_j^* Y_{1t}=Y_{11},\sum_{j=2}^{J+1} w_j^* Y_{2t}=Y_{12},\sum_{j=2}^{J+1} w_j^* Y_{3t}=Y_{13},\ldots$$

$$\sum_{j=2}^{J+1} w_j^* Y_{jT_0}=Y_{1T_0}\text{ and }\sum_{j=2}^{J+1} w_j^* Z_j=Z_1$$

Considering that $\sum_{t=1}^{T_0}\rho_n'\rho_n$ is nonsingular,

$$Y_{1t}^N-\sum_{j=2}^{J+1} w_j^* Y_{jt}=\sum_{j=2}^{J+1} w_j^*\sum_{s=1}^{T_o}\rho_t\left(\sum_{t=1}^{T_o}\rho_n'\rho_n\right)^{-1}\rho_s'\left(\mu_{js}-\mu_{1s}\right)-\sum_{j=2}^{J+1} w_j^*\left(\mu_{js}-\mu_{1t}\right)$$

The mean of $\sum_{j=2}^{J+1} w_j^*\sum_{s=1}^{T_0}\rho_t(\sum_{n=1}^{T_0}\rho_n'\rho_n)^{-1}\rho_s'(\mu_{js}-\mu_{1s})-\sum_{j=2}^{J+1} w_j^*(\mu_{js}-\mu_{1t})$ is close to zero because the number of preintervention periods is high when compared to the magnitude of the transitory shocks. Thus, for the country affected by the FTA, $j=1$, the SC estimators of Y_{jt}^N and θ_{jt} are:

$$\widehat{Y}_{1t}^N=\sum_{j=2}^{J+1} w_j Y_{jt}\,\forall t$$

$$\widehat{\theta}_{1t}=Y_{1t}-\widehat{Y}_{1t}^N$$

$W_j^*=(w_2,w_3,\ldots,w_{j+1})'$ minimizes the distance between j and its donor pool countries.

Having $\widehat{\theta}_{1t}=Y_{1t}-\sum_{j=2}^{J+1} w_j^* Y_{jt}$ for the unit-level treatment effect, θ_{1t} and $\widehat{\theta}=\frac{1}{j}\sum_{j=1}^{j}[Y_{jt}-\sum_{j+1}^{j} w_j^* Y_{jt}]$ for the average effect on the treated, θ.

Therefore, $\widehat{\theta}_{1t}$ is an unbiased estimator of θ_{jt} in terms of the causal effect of treatment on the outcome in each $\{j,t\}$ (Wiltshire, 2022).

We create the SC by averaging untreated countries in a way that best matches pre-FTA trends within the treated unit (Billmeier and Nannicini, 2013). This method singles out weights to ensure that the combination obtained is as close as possible to the values of the predictors of the outcome variable for the treated unit during the pretreatment period. The SCM results in a non-FTA counterfactual, which is based on the convex combination of ASEAN-5 exports to

other countries, so that the weights minimize the distance between the counterfactual and the pre-FTA actual exports for ASEAN-5 (Abadie, 2021; Wiltshire, 2022; Mancini *et al.*, 2024).

Several assumptions must be met for the SCM to be a suitable tool for estimating causal treatment effects (Abadie, 2021; Wiltshire, 2022), whose fulfillment in our case will be analyzed throughout the paper. The assumptions are as follows:

(1) Low outcome volatility and sufficient treatment effect size.

(2) Availability of a comparison group (donor pool). It is required to have a group of countries like the treated unit, but not treated.

(3) No interference or stable unit treatment value assumption. This assumption implies that the treatment of one country should not affect the outcome of others.

(4) Convex hull condition. It is important that the SC matches as closely as possible the outcome trajectory of the treated unit before treatment.

(5) No anticipation. To avoid bias in the estimation of the treatment effect, economic agents can not have anticipated the FTA before its implementation.

(6) Time horizon. A sufficiently long post-treatment period is required to capture the effect of the FTA. Since data are available up to 2022 and the FTA came into force in 2007, the post-treatment period studied in this analysis is sufficiently long and, as the results show, allows the effect of the treatment to be captured.

One of the assumptions above is to have a donor pool of countries not affected by the treatment. The surveyed countries not affected by the FTA are Canada, France, Germany, Norway, Switzerland, the United Kingdom, the USA, Italy, Spain, the Netherlands, Sweden, Uruguay, Belgium and Taiwan. The selection of the donor pool countries is based on fulfilling the assumption that control units in the donor pool do not receive treatment and an approximation of the covariates of the ASEAN-5 and the donor countries. Moreover, as regards income level, ASEAN-5 are mainly high- and upper-middle-income countries and Korea is a high-income nation. Results show that the trajectory of the SC outcome obtained from this donor pool is in line with that of the outcome of the treated unit; therefore, the convex hull condition can be considered fulfilled. Countries in the donor pool have also been selected to ensure that the noninterference condition is met and, therefore, that their outcome would not be affected by the implementation of the FTA on the treated unit.

The selected covariates are the main drivers of exports generally accepted in the literature and are handy units when making cross-comparisons between potential FTA partners, such as economic performance, economic size, trade cost, exogenous innovation and trade openness. Therefore, in line with the literature, we have the following set of covariates:

(1) GDP per capita measured in US dollars and sourced from UNCTADstat (Hannan, 2017; López *et al.*, 2022; Adarov, 2023; Muñoz *et al.*, 2023).

(2) Population is the total population measured in thousands and sourced from UNCTADstat (Hannan, 2017; López *et al.*, 2022).

(3) Distance is measured in kilometers, sourced from CEPII (Hannan, 2017; López *et al.*, 2022; Adarov, 2023; Muñoz *et al.*, 2023).

(4) Stock of foreign direct investment is measured in millions of US dollars and sourced from UNCTADstat (Colla-De-Robertis and Garduno, 2021; Zhou and Su, 2021).

(5) Imports are the total countries' imports measured in millions of US dollars and sourced from UNCTADstat (Adarov, 2023; Muñoz *et al.*, 2023).

(6) Trade openness is defined as the ratio of exports plus imports over GDP and is sourced from UNCTADstat (López *et al.*, 2022; Muñoz *et al.*, 2023).

4. Empirical results

4.1 Total ASEAN-5 manufacturing exports

The above inferential technique employs an SC to estimate how ASEAN-5 exports to Korea would have performed in the absence of the FTA. Weights of each donor country in the SC for ASEAN-5 exports show that manufacturing export flows before the FTA are best replicated by a combination of Germany, the Netherlands, Uruguay and Taiwan (Table A1 [1], column I); therefore, the remaining countries in the donor pool are given zero weight.

Figure A1 [1] shows the treated unit and the SC unit for the period 1995–2022. Trends in ASEAN-5 exports to Korea and their counterfactual exhibit a very close development in the years before the establishment of the FTA, as indicated in the figure by the vertical line, while after the establishment of the FTA, the trends diverge. This provides evidence of the positive impact of the implementation of the FTA on exports, without the anticipation effect before it came into force in 2007. Likewise, the close development of ASEAN-5 and SC exports in the years before the establishment of the FTA is evidence of the suitability of the selected pool of donors. Low volatility is also observed in ASEAN-5 exports, which reinforces the validity of the analysis performed.

Figure A1 [1] shows that the impact of the FTA remains throughout the post-treatment period, with no differences being observed between the short and long term. An average annual increase of 23.6% is estimated for ASEAN-5 total manufactured exports to Korea over the period 2007–2022 (see the impact results since the treatment year in Table A2 [1], column I).

4.1.1 Robustness checks. The validity of the SC is conditional on its ability to approximate ASEAN-5 exports to Korea before the FTA came into force. As a starting point for studying the robustness of the results, we explore whether the SC is a good predictor of exports for the period before the FTA came into force, analyzing the stochastic properties of the difference between these variables. If the fit of ASEAN-5 exports with the SC for ASEAN-5 exports is tight, the difference between these variables should show evidence of being white noise. On the other hand, if the entry into force of the FTA significantly modifies the evolution of exports, evidence should be found against the difference being white noise. For the 1995–2006 period, the difference between exports and the SC does not have a mean significantly different from zero, and the Ljung–Box test shows evidence of no autocorrelation, which is an indicator of white noise (Table A3 [1], column I). Furthermore, if we compare the standard error (SE) of these differences with that of the residual obtained by fitting a simple trend model (constant and trend) to the variable ASEAN-5 exports (Table A4 [1], column I), this SE is 44.80% lower for total ASEAN-5 exports. In short, there seems to be clear empirical evidence that for the period 1995–2006, the fit of the SC to exports is good.

With regard to robustness checks, Abadie (2021) suggests two alternative tests: the "in-time placebo test" (Abadie *et al*., 2015) and carrying out the estimations by eliminating countries one by one from the donor panel (or the "leave-one-out" test). The "in-time placebo test" consists of setting the year of treatment before the pretreatment period, enabling the treated synthetic unit to deviate from the actual values. The result of estimating the effect of the FTA by bringing forward its implementation to 2006 with no deviation before the actual time of treatment confirms the accuracy of our results (Figure A4 [1]).

With regard to the second robustness method indicated above, i.e., removing countries one by one from the donor panel to study the robustness of the results to changes in the SC design, the result prevails when eliminating donor countries one by one–i.e., both curves, for ASEAN-5 exports and for the SC, show a parallel evolution, while following the FTA, a positive outcome is observed, led by the FTA (see Figure A5 [1]).

As in any estimation, once the treatment effects have been estimated, it is appropriate to study statistical significance. In the case of the SCM, no standard errors are generated–i.e., standard procedures of an inference analysis are not calculated. Abadie *et al.* (2010) proposed an inference method called the "in-space placebo test" based on permutation techniques. To

assess the significance of the estimates, a round of placebo studies was carried out by repeatedly running the SCM used to estimate the effect of the ASEAN-5–Korea FTA on the remaining countries in the donor pool. Abadie *et al.* (2010) suggested calculating SC estimators for countries that have not been involved in the FTA, finding that no treatment effects are revealed for the untreated units, leading to the conclusion that the results are statistically significant. Figure A6 [1] shows the estimated dynamic effect path of the FTA for the treated unit and for each of the countries that are part of the donor pool, excluding those whose pretreatment mean squared prediction of the error (MSPE) exceeds twice that of the treated unit to ensure the validity of the test. The results show the significant effect of the FTA implementation on ASEAN-5 exports to Korea, due to its magnitude being higher than that of the placebo effects. Figure A7 [1] displays the right-sided *p*-values for the post-treatment period, and the results show a significant effect at 10% level.

Abadie *et al.* (2010) further proposed comparing the ratio of post-treatment MSPE to pretreatment MSPE of the treated unit with a placebo distribution of that ratio to analyze whether the treatment effect is significant. Figure A8 [1] shows that the ratio of post-treatment MSPE to pretreatment MSPE (RMSPE) of the treated unit is much higher than that of the donor pool, thus supporting the significance of the effect of the FTA on ASEAN-5 exports, with a probability of obtaining a higher RMSPE than that of the treated unit of 0.067 (1/15). Likewise, having calculated the RMSPE *p*-value, the results show a value of 0.08 from 2007 onwards–i.e., significant at 10% level and not significant for the period before the implementation of the FTA, the RMSPEs ranked second out of 15 runs.

Recently, significant progress has been made in diagnosing the errors generated in the SC estimations. Abadie and L'Hour (2021), Ben-Michael *et al.* (2022) and Wiltshire (2022), in order to tackle the mismatching of predictor variables with matching methods, suggest a bias correction technique based on the approach proposed by Abadie and Imbens (2011). Wiltshire (2022) suggests that issues of bias can still arise as a result of differences in the predictor variables between each treated unit and its SC donor. To address this potential issue, we employ the SC bias correction procedure developed by Wiltshire (2022).

Figure A9 [1] plots the paths of the classic and bias-corrected gaps between the treated unit outcome and the SC. We estimate the bias employing a net elastic regression *in lieu* of OLS (Wiltshire, 2021). Therefore, the results support the conclusions obtained regarding the positive results of the ASEAN–Korea FTA.

4.2 Manufacturing exports from ASEAN-5 countries: Singapore, Malaysia, Indonesia, Thailand and the Philippines

We now consider the implications of the FTA for the ASEAN-5 countries on a case-by-case basis. Columns II to VI in Table A1 [1] provide the weights of each donor country in the SC for each ASEAN-5 country. The weights indicate that Singapore's export flows before the FTA are best replicated by a combination of Germany, Switzerland and Taiwan. Malaysia is best replicated by a combination of France, Norway and the USA, while for Indonesia, it is the Netherlands, Sweden and Uruguay; for Thailand, it is Spain and Taiwan and for the Philippines, it is Norway, the Netherlands, Uruguay, Belgium and Taiwan.

Figure A2 [1] shows the treated unit and the SC unit for Singapore, Malaysia, Indonesia, Thailand and the Philippines for the period 1995–2022. The trend of exports from each ASEAN-5 country to Korea and its counterfactual shows a very close evolution in the years before the establishment of the FTA, represented in the figure by the vertical line, whereas after the establishment of the FTA, trajectories diverge.

Columns II to VI in Table A2 [1] exhibit the impact results in total exports for ASEAN-5 single countries since the year of treatment. We note that the impact of the FTA on exports to Korea is positive for the five countries, but it differs both in magnitude and in temporal distribution. While for Indonesia, the average annual increase of 27.6% is estimated for the total manufactured exports to Korea for the period 2007–2022, for Malaysia and Thailand, it

exceeds 30% and for Singapore and the Philippines, it is around 40%. Moreover, the impact is distributed differently over time. For example, for Malaysia, there is an increasing impact over time (9% in 2007 versus 61.3% in 2022), while for Singapore, there is a greater initial impact than thereafter. The heterogeneity in size and temporal distribution of the impact (short versus long term) of the FTA for each country is due to country-specific idiosyncratic factors.

4.2.1 Robustness checks. We have performed the robustness tests suggested in Abadie (2021) for each ASEAN-5 countries. Figure A10 [1] shows the results by setting the treatment year to 2006, i.e., before the pretreatment period (in-time placebo test). The figure shows no deviation before the actual treatment time, thereby attesting to the reliability of our results.

Figure A11 [1] shows the trends in the case of the robustness method consisting of the one-by-one removal of countries from the donor panel for each of the ASEAN-5 countries. The results hold when removing, before the year the FTA was established, the donor countries one by one for the member countries of the ASEAN-5 group–i.e., the curves for each of the ASEAN-5 countries and its synthetic curve exhibit a parallel pattern, while after the FTA, the opposite is observed.

Figure A12 [1] shows, for each of the ASEAN-5 countries, the dynamic path of the estimated effect of the FTA for the treated unit and for each of the countries that are involved in the donor pool for each of the ASEAN-5 countries. The results show that the impact is higher than the placebo effects or is among the largest in magnitude.

Figure A13 [1] shows the classical and bias-corrected gap paths for each ASEAN-5 country. The bias is estimated using a net elastic regression, and it can be inferred that these outcomes robustly strengthen the conclusions obtained regarding the positive results of the ASEAN–Korea FTA for each ASEAN-5 country.

4.3 ASEAN-5 high-tech manufacturing exports

In this section, we focus on trade in high-tech manufactured goods between ASEAN-5 and Korea. High-tech manufacturing employs advanced technology with a high R&D input and requires the use of skilled labor capable of adapting to an ever-changing technological environment in the short term. Global value chains (GVCs) are a major force in the manufacturing of high-tech products.

The weights reveal that pre-FTA manufacturing export flows are best matched by a combination of Germany, Uruguay and Taiwan; therefore, the remaining countries in the donor pool are given zero weight (Table A1 [1], column VII).

Figure A3 [1] depicts clearly deviating trends of real and synthetic ASEAN-5 high-tech exports after treatment, revealing a large impact on high-tech manufactured exports from ASEAN-5 to Korea after the implementation of the FTA. On the one hand, Figure A3 [1] shows a great fit between the treated and the SC units during the pre-FTA period, but on the other hand, we observe a significant divergence in the trends, suggesting that implementing the treaty has strong implications. In addition, since the treated unit line is above the synthetic one, we can be certain that the outcome of the FTA has been positive in terms of ASEAN-5 high-tech manufacturing exports to Korea.

Column VII in Table A2 [1] shows the impact results for ASEAN-5 high-tech manufactured exports to Korea for the period 2007–2022. An average annual increase of 23% is estimated. We observe a significant impact on the short term, although it decreases over time, notably from 2014 onwards.

4.3.1 Robustness checks. As in the case of total exports, we analyze whether the SC is a good predictor of exports for the period before the FTA came into force by studying the stochastic properties of the difference between these variables. Column III in Table A3 [1] shows the estimates of the mean of the difference between exports and the SC for each of the two periods considered (1995–2006 and 2007–2022) for total ASEAN-5 high-tech exports. For the 1995–2006 period, these differences do not have a mean significantly different from zero and the Ljung–Box test shows evidence of no autocorrelation, which is an indication of

white noise. Moreover, when comparing the SE of these differences with that of the residual obtained by fitting a simple trend model to the variable ASEAN-5 high-tech exports (Table A4 [1], column II), this SE is 57.26% lower for total ASEAN-5 exports. In short, there seems to be clear empirical evidence that for the period 1995–2006, the fit of the SC to high-tech exports is good.

We analyze the robustness of the SCM by setting the year 2006 as the treatment year, i.e., one year before the actual year, to analyze the deviation. In Figure A14 [1], we observe that, as in the case of the total exported manufactured goods, there is no deviation, thus supporting the robustness of the conclusions drawn. Figure A15 [1] shows trends for the leave-one-out test, and when eliminating one by one the countries from the donor panel, the results remain unchanged.

Figure A16 [1] shows the dynamic path of the estimated effect of the FTA for the treated unit and for each of the countries that are part of the donor pool, excluding those whose pretreatment MSPE exceeds twice that of the treated unit. Results show that, in the short term, the impact of the implementation of the FTA on ASEAN-5 high-tech exports to Korea is clearly significant, due to its magnitude being higher than that of placebo effects, but decreases from 2014 onwards. Focusing on the short term (Figures A17 [1] and A18 [1]), the estimated effect of the treated unit is higher than that of the donor pool and the right-sided *p*-values display a significant effect at 10% level. In addition, Figure A19 [1] shows that the RMSPE of the treated unit is higher than that of the donor pool, which supports the significance of the effect of the FTA on ASEAN-5 high-tech exports.

Figure A20 [1] plots the paths of the classic and bias-corrected gaps between the treated unit outcome and the SC, in which bias is estimated using net elastic regression. As in the previous cases studied in this research, the results reinforce the conclusions obtained regarding the positive results of the ASEAN–Korea FTA for high-tech manufacturing.

FTAs have the potential to encourage countries with comparative and competitive advantages in technology-intensive sectors to increase their exports of high-tech manufactured goods. GVCs are also key players in the production of high-technology products, and greater trade integration can promote efficiency in production processes, logistics, customs and legal certainty through policy coordination, among other things.

5. Concluding remarks

Recently, some trade policy measures have led to questioning the benefits of free trade and the rules that for decades have governed a large proportion of international trade under the umbrella of the World Trade Organization (WTO). Therefore, it is essential to assess the extent to which trade policies fulfill the objectives for which they were devised. It was envisaged that FTAs would enhance trade relations between trading partners with a view to increasing social welfare. Likewise, within the framework of the WTO, FTAs are a key exception to the most-favored-nation principle.

The ASEAN–Korea FTA is one of the main trade agreements in East Asia, and its assessment is necessary not only from an accountability standpoint but also as an identifier of potential pitfalls to avoid and improvements to undertake in future trade agreements. The aim of this research is to assess whether the ASEAN–Korea FTA has been successful for total and high-tech manufacturing exports for the ASEAN-5 countries.

This research is novel in the literature on the field in using SCM as a tool for evaluating total ASEAN-5 manufacturing exports to Korea under the ASEAN–Korea FTA, expanding the analysis to high-tech exports.

Overall, our results reveal that the ASEAN–Korea FTA has been significantly positive for manufactured exports from the ASEAN-5 countries, both at the country and aggregate levels. Moreover, it is observed that this positive outcome has also held for high-tech manufactured exports.

To avoid distortions, inefficiencies and welfare losses, greater trade integration between ASEAN and Korea should be linked to enhanced coordination within the economic policies in

the areas covered by the agreement, such as investment, digital trade, labor standards and intellectual property rights. Moreover, in the medium and long term, it is crucial to analyze the effects of the FTA on production networks and explore how FTA integration has shaped production structures due to regional trade dynamics.

The provision of coherent and well-enforced institutional, regulatory and legal frameworks aligned to the risks posed, and the potential gains offered, by FTAs is a crucial environment enabler for sustaining high-tech ecosystems across ASEAN. Suggested cross-cutting policy measures aimed at strengthening these ecosystems include promoting international cooperation among ASEAN researchers, companies and universities; encouraging the setting up and reinforcement of technology parks; fostering venture capital and angel investor ventures; favoring robust networks for knowledge creation and diffusion; developing frameworks that minimize roadblocks to knowledge creation in GVCs; and removing needless barriers in the import flow in GVCs, among others.

Future lines of research could focus on the sectoral analysis of manufacturing exports, and further analysis could be undertaken for those ASEAN countries not included in this analysis. It would also be worthwhile carrying out a more in-depth analysis to estimate the effects of the FTA in terms of common country characteristics. Likewise, it would be relevant to explore, in future studies, which specific factors (FDI, regulatory factors, etc.) underlie the changes in trade flows fueled by the FTA.

Supplementary material

The supplementary material for this article can be found online.

Note

1. Please see it on the Online Appendix.

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