Cabinet Office

New ESRI Working Paper No.75

# How Does CPTPP Make Impact on Goods Trade Flows Among Its Member Countries?

**Nobunori Kuga and Ken Itakura**

December 2024

Economic and Social Research Institute

Cabinet Office

Tokyo, Japan

# How Does CPTPP Make Impact on Goods Trade Flows Among Its Member Countries?[1]

Nobunori Kuga[2] and Ken Itakura[3]

## ABSTRACT

More than five years have passed since the CPTPP came into force in December 2018. Although the agreement is expected to boost goods trade flows among member countries, our knowledge about the trade impacts of the CPTPP is limited, mainly because of the contraction in international trade caused by the intensification of the U.S.–China trade dispute and the spread of COVID–19. This paper sheds light on the CPTPP's impacts on bilateral goods trade flows among member countries. Two different methods, the gravity model and the difference-in-differences combined with propensity score matching (PSM-DID), are used to quantify these impacts to complement and cross-validate the estimated results. Both methods demonstrate that the CPTPP has positive and statistically significant trade effects for country pairs that signed the CPTPP as their first free trade agreement (FTA). However, for CPTPP country pairs with pre-existing FTAs, the agreement does not show statistically robust positive effects. Overall, the PSM-DID results indicate that the CPTPP increased bilateral trade among members by an average of 9.1%, while the gravity model indicates the heterogeneity of the trade effect among the CPTPP country pairs.

[1] The views expressed in this paper are those of the authors and do not necessarily represent the views of the institutions with which they are affiliated.

[2] Economic and Social Research Institute, Cabinet Office.

[3] Graduate School of Economics, Nagoya City University, and Economic and Social Research Institute.

# 1. Introduction

## 1.1. Background of CPTPP

The Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) is a free trade agreement among various countries around the Pacific Rim. Eleven countries ratified the agreement as of December 2023 (Australia, Brunei, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore and Vietnam).

The CPTPP is recognized as a significant evolution in the scope of trade agreements, compared to previous free trade agreements (FTAs). It covers not only goods and services, but also investment, intellectual property, labor, environment and so on. It also includes provisions on digital trade, state-owned enterprises, labor, and the environment that previous FTAs did not fully address (Cimino-Isaacs, 2023). The CPTPP also has ambitious tariff reduction schedules. Its tariff reduction commitments would eliminate more than 95% of tariff lines in each country (Fergusson and Williams, 2018). Suominen (2024) points out that one of the pioneering aspects of the CPTPP is its comprehensive provisions on e-commerce. These include rules to facilitate cross-border data flows, prohibit server localization, safeguard source code, and enhance data privacy and consumer protection. These characteristics have resulted in the CPTPP being called "an ambitious and high-standard free trade agreement" (Government of Canada, 2023).

The CPTPP originated from the Trans-Pacific Partnership (TPP). The idea of the TPP was initially proposed by Chile, New Zealand, Singapore and Brunei in 2005 to promote economic integration among Pacific Rim countries. After the proposal, other countries participated the negotiations to establish the TPP, including Australia, Canada, Japan, Malaysia, Mexico, Peru, the United States and Vietnam.

Although the TPP was signed by the 12 countries in 2016, the United States withdrew from it under President Donald Trump. Despite the hardship, the other signed countries agreed to sign a new agreement, CPTPP, which takes over most of the TPP's provisions. Following the signing the CPTPP in 2018, seven countries (Australia, Canada, Japan, Mexico, New Zealand, Singapore and Vietnam) ratified it in the same year. Since then, Brunei, Chile, Malaysia and Peru have ratified it as of the end of 2023.

## 1.2. Characteristics of international trade in CPTPP countries

The CPTPP region had already experienced vigorous trade activities before the implementation of the CPPTPP. Figure 1 shows the total value of goods traded by the initial member countries of the CPTPP (Australia, Canada, Japan, Mexico, New Zealand, Singapore and Vietnam). While the values had fluctuated probably due to global economic shocks, including the 2008 financial crisis and the 2020 COVID-19 pandemic, they reached around 2.6 trillion USD in 2018 for export and import.

The export and import markets in the CPTPP countries account for a relatively large share of world trade. As Figure 2 indicates, the shares of the total trade by the CPTPP countries in the world trade were stable at around 12% and 13% for exports and imports, respectively, from 2010 to 2020.

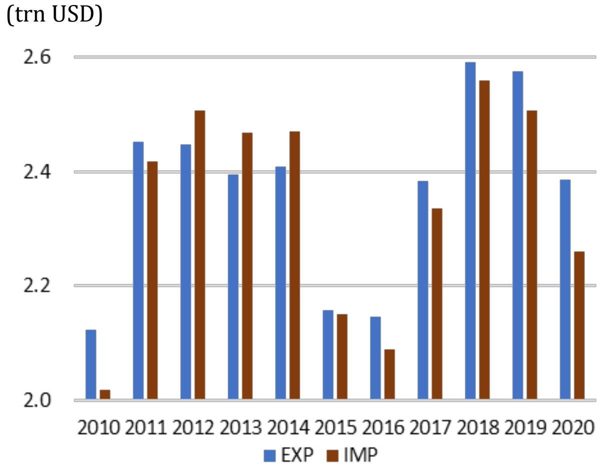



**Figure. 1.** Total export/import values of CPTPP countries. **Notes**: Australia, Canada, Japan, Mexico, New Zealand, Singapore and Vietnam are included in the CPTPP countries. **Source**: The World Integrated Trade Solution (WITS).

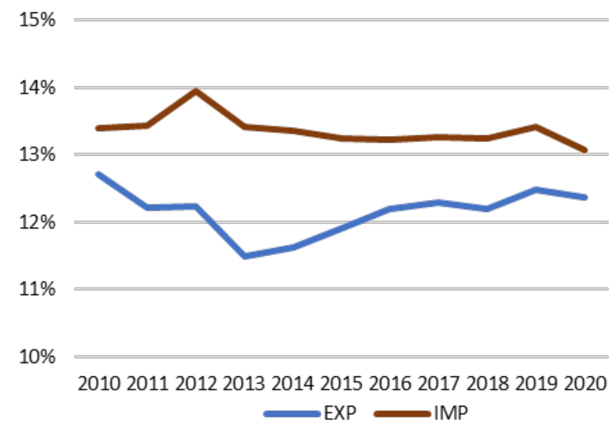



**Figure. 2**. Share of total export/import values of CPTPP countries in world trade. **Source**: The World Integrated Trade Solution (WITS).

The active trade in the CPTPP region has partly resulted from the promotion of free trade agreements (FTAs). As Table 1 shows, more than half of the combinations of the initial CPTPP member country pairs (11 combinations out of 21) have already ratified FTAs before 2018.

**Table 1**
Major FTAs ratified by initial CPTPP members before 2018

| FTA name | Ratifying countries | Year of entry into force |
|---|---|---|
| ANZCERTA | **AUS**, **NZL** | 1989 |
| NAFTA | **CAN**, **MEX** and USA | 1994 |
| NZSCEP | **NZL**, **SGP** | 2001 |
| JSEPA | **JPN**, **SGP** | 2002 |
| SAFTA | **AUS**, **SGP** | 2003 |
| JMXFTA | **JPN**, **MEX** | 2005 |
| TPSEP | **NZL**, **SGP** and other 2 countries | 2006 |
| ACFTA | CHN, **SGP**, **VNM** and 8 other countries | 2007 |
| AJCEP | **JPN**, **SGP**, **VNM** and 8 other countries | 2008 |
| JVEPA | **JPN**, **VNM** | 2009 |
| AFTA | **SGP**, **VNM** and 8 other countries | 2010 |
| AANZFTA | **AUS**, **NZL**, **SGP**, **VNM** and 8 other countries | 2010 |
| AKFTA | KOR, **SGP**, **VNM** and 8 other countries | 2010 |
| JAEPA | **AUS**, **JPN** | 2015 |
| AIFTA | IND, **SGP**, **VNM** and 8 other countries | 2015 |

Source: WTO Regional Trade Agreement Database.

### 1.3. Identification strategy to estimate CPTPP's impact

Reliable bilateral trade data are available up to 2020 as of the time of this writing. We therefore focus on the CPTPP trade effects only among the countries that ratified the agreement before 2020: Australia, Canada, Japan, Mexico, New Zealand, Singapore and Vietnam. Other ratified countries cannot be analyzed because of a lack of data.

Two different methods, the gravity equation and the difference-in-differences combined with propensity score matching (PSM-DID), are used to quantify the CPTPP trade impact for the purpose of complementing and cross-validating the estimated results.

Previous studies point out that the treatment of FTAs as random term is not appropriate since unobserved heterogeneity exists among county pairs (Baier and Bergstrand, 2007). We then address this issue by including the three-way fixed effects in the gravity models, and using PSM to mitigate such selection bias.

## 2. Data and model specifications

### 2.1. Gravity equation approach

For this section, we attempt to evaluate the trade effect of free trade agreements (FTAs), including the CPTPP, by estimating a gravity model of international trade with the bilateral import data for 2000–2020.

There exists a vast amount of empirical literature using a gravity model to estimate the effect of trade agreements on bilateral trade flows, originating from the seminal work by Tinbergen (1962). A historical overview of applications and theoretical foundations of the gravity model can be found, for example, in Baier and Bergstrand (2007), Head and Mayer (2014), and Yotov (2022). For the recent application to Japan's FTAs, Yamanouchi (2019) and Ando, Urata, and Yamanouchi (2022) examine the effect of FTAs of which Japan is a member country, employing the data up to 2016 that is a few years before the CPTPP. Hayakawa et al. (2022) quantify the trade effect of CPTPP with the data covering the period up to 2021. They find that the trade effect is negative and statistically significant because non-tariff measures may act against as Hayakawa et al. (2022) suggest.

#### 2.1.1. Specification of gravity models

We specify estimating equations of a gravity model following Anderson and van Wincoop (2003), Baier and Bergstrand (2007), and Mayer, Vicard, and Zignago (2019). Anderson and van Wincoop (2003) introduced the multilateral resistance terms which correspond to the country–year fixed effects for importer and exporter in our estimating equations. Baier and Bergstrand (2007) point out that the FTAs are not exogenous random events, so the endogeneity associated with the formation of an FTA needs to be controlled by introducing country-pair fixed effects in a gravity model. While these country-pair fixed effects contain time-invariant heterogeneity, we introduce a linear time trend specific to each country-pair, as suggested by Larch et al. (2019).

We use the Poisson pseudo maximum likelihood (PPML) estimator (Santos Silva and Tenreyro, 2006, 2022) to deal with zero trade flows. As Mayer et al. (2019) point out that the PPML estimator gives more weight to large trade flows in levels, bilateral import shares are also used in our estimation.

Our estimating equations of the gravity model of bilateral imports are as follows;

$$M_{ijt} = \exp\left(\gamma_{it} + \gamma_{jt} + \log\left(Dist_{ij}\right) + FTA_{ijt}\right)\epsilon_{ijt} \qquad (1)$$
$$M_{ijt} = \exp\left(\gamma_{ij} + \gamma_{it} + \gamma_{jt} + FTA_{ijt}\right)\epsilon_{ijt} \qquad (2)$$

where bilateral imports ($M$) between country $i$ and $j$ in year $t$ are valued in the current U.S. dollar, and $Dist$ is the geographical distance between $i$ and $j$ in kilometers, and a dummy variable for trade agreement ($FTA$) takes 1 if a country pair of $i$ and $j$ has at least one trade accord for that year and 0 otherwise. When we consider the effect of CPTPP, we extract $CPTPP$ from the $FTA$ and make the rest as $OtherFTAs$. $CPTPP$ takes 1 for the bilateral imports among the seven CPTPP countries[4] for 2019 and 2020. Fixed effects $\gamma_{it}$ and $\gamma_{jt}$ are for the multilateral resistance terms (Anderson and van Wincoop 2003), and they are exporter-year and importer-year fixed effects in panel data. When these fixed effects are included in the model specification, we call them two-way fixed effects. Following Baier and Bergstrand (2007), we add country-pair fixed effects, $\gamma_{ij}$, to control time-invariant heterogeneity, and they constitute three-way fixed effects in addition to the exporter-year and the importer-year fixed effects.

$Trend$ is obtained for each country pair by estimating the following equation linear in time by the PPML estimator;

$$M_t = \exp(\alpha + \beta T)\mu_t \qquad (3)$$

where $T$ is a linear time trend, $T = 1,2, \dots ,21$, and the fitted value of $\widehat{\ln M_t}$ is added to Equation (2) as $Trend_{ijt}$. Due to computational limitation, it is not feasible to directly include the interaction term, $\gamma_{ij} \times T$, to account for the time trend in each country pair. Following Mayer et al. (2019), bilateral import shares, defined as $M_{ijt}/\sum_i M_{ijt}$, is used for the dependent variable to account for the difference in size of import in level. When estimating on the bilateral import share, we include the time trend computed for the import shares.

Bilateral import data used for the estimation are obtained from the U.N. COMTRADE database for 2000–2020, and the data on distance between countries are computed from Wolfram Research, Inc. (2022). Data for $FTA$ are collected from Claudia et al. (2017) and the WTO Regional Trade Agreements Database[5].

---

[4] They are Australia (AUS), Canada (CAN), Japan (JPN), Mexico (MEX), New Zealand (NZL), Singapore (SGP), and Viet Nam (VNM).

[5] accessed on Sep. 8, 2021 to https://rtais.wto.org/UI/PublicMaintainRTAHome.aspx

**Table 2**
Data Summary

| | N | mean | s.d. |
|---|---|---|---|
| Import ($US, million) | 535,956 | 536.56 | 5490.37 |
| Dist (kilometer) | 535,956 | 7621.81 | 4528.88 |

### 2.1.2. Results for the gravity models

Estimation results are reported in Table 3. As in the previous literature's findings, we confirm that the distance reduces trade, about $-0.84$ in our results under the model (G1) and (G2). The country pairs with at least one FTA, the coefficient on FTAs, has approximately 1.5 ($\exp(0.3824) \approx 1.465798$) times larger trade than those without an FTA. When the CPTPP is explicitly considered under (G2), trade among the CPTPP countries is 1.4 ($\exp(0.3224) \approx 1.380437$) times larger than the country pairs sans FTA.

When heterogeneity among the country-pairs is controlled with the three-way fixed effects under the model from (G3) to (G6), the effects of FTAs and CPTPP are considerably dampened. These changes can be seen in the recent literature, and our results are similar in magnitude to them, for example, Heid et al. (2021) and Borchert et al. (2022). The coefficient on other FTAs remains statistically significant for the models (G3) to (G6), while the effect of CPTPP becomes insignificant. Linear time trend is added to the models (G5) as explanatory variable and (G6), and bilateral import shares are used as the dependent variable in (G6). The time trend is considered only for the country pairs with complete data set over 2000-2020, so the size of observations is reduced for (G5) and (G6). The coefficient on other FTAs is consistent across (G4) to (G6)[6]. The effect of CPTPP is influenced by the inclusion of the time trend and the use of import shares as the dependent variable.

[6] Pseudo R-squared reported in Table 3 is based on the McFadden's pseudo $R^2$, the ratio of log-likelihoods. According to McFadden (1977), the value of 0.3 represents a good fit.

**Table 3**
Gravity Model Estimation Results

| Model: | (G1) | (G2) | (G3) | (G4) | (G5) Trend | (G6) Share |
|---|---|---|---|---|---|---|
| *Variables* | | | | | | |
| *log(Dist)* | -0.8414*** | -0.8413*** | | | | |
| | (0.0527) | (0.0527) | | | | |
| *FTAs* | 0.3824*** | | 0.0639** | | | |
| | (0.0728) | | (0.0286) | | | |
| *OtherFTAs* | | 0.3826*** | | 0.0648** | 0.0651** | 0.0776*** |
| | | (0.0727) | | (0.0286) | (0.0294) | (0.0213) |
| *CPTPP* | | 0.3224*** | | -0.0284 | 0.0358 | 0.0795 |
| | | (0.0853) | | (0.0642) | (0.0591) | (0.0846) |
| *Fixed-effects* | | | | | | |
| Exporter-Year | Yes | Yes | Yes | Yes | Yes | Yes |
| Importer-Year | Yes | Yes | Yes | Yes | Yes | Yes |
| Exporter-Importer | | | Yes | Yes | Yes | Yes |
| *Fit statistics* | | | | | | |
| Observations | 535,956 | 535,956 | 535,955 | 535,955 | 260,421 | 260,421 |
| Squared Correlation | 0.88625 | 0.88625 | 0.99191 | 0.99196 | 0.99206 | 0.96221 |
| PseudoR-squared | 0.93493 | 0.93493 | 0.99266 | 0.99266 | 0.99225 | 0.34507 |
| BIC | $1.26\times10^{14}$ | $1.26\times10^{14}$ | $1.42\times10^{13}$ | $1.42\times10^{13}$ | $1.2\times10^{13}$ | 257,890.5 |

Note: Clustered (Exporter-Importer) standard errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

### 2.1.3. Division of results into new and old group among CPTPP members

We divide the CPTPP variable in Table 3 into two groups, CPTPP_new and CPTPP_old, to reflect the fact that for some countries the CPTPP is the first free trade agreement with other member countries while others have already established a trade agreement before the CPTPP. For example, Australia and Canada have entered into the first free trade accord with the CPTPP, and there has been the Japan-Australia Economic Partnership Agreement since January 2015. To account for the existing trade agreements prior to the CPTPP, we define the CPTPP_old variable for the member country pairs with at least one existing trade accord, and the CPTPP_new for other pairs. With this grouping, we re-estimate the model (G4) to (G6) and report the results in Table 4.

The CPTPP_new variable shows the positive trade effect under the model (G4-1), (G5-1), and (G6-1), and they are statistically significant. As the model incorporates time trend and trade shares, the coefficient on the CPTPP_new become larger. Although this change can be observed for the CPTPP_old variable, the trade effect on the CPTPP_old does not appear with statistical significance. These results on the new and old group in the CPTPP may explain in part the insignificance at the CPTPP as a whole as reported in Table 3.

**Table 4**
Results of new and old group in CPTPP members

| Model: | (G4-1) | (G5-1) Trend | (G6-1) Share |
|---|---|---|---|
| *Variables* | | | |
| *Other FTAs* | 0.0677** | 0.0619** | 0.0713*** |
| | (0.0272) | (0.0297) | (0.0213) |
| *CPTPP_new* | 0.1216** | 0.1838** | 0.2424* |
| | (0.0538) | (0.0798) | (0.1247) |
| *CPTPP_old* | -0.0158 | 0.0140 | 0.1751 |
| | (0.0715) | (0.0794) | (0.1429) |
| *Fixed-effects* | | | |
| Exporter-Year | Yes | Yes | Yes |
| Importer-Year | Yes | Yes | Yes |
| Exporter-Importer | Yes | Yes | Yes |
| *Fit statistics* | | | |
| Observations | 535,955 | 260,421 | 260,421 |
| Squared Correlation | 0.99193 | 0.99207 | 0.96222 |
| PseudoR-squared | 0.99266 | 0.99225 | 0.34507 |
| BIC | $1.42\times10^{13}$ | $1.2\times10^{13}$ | 257,902.9 |

Note: Clustered (Exporter-Importer) standard errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

### 2.1.4. Decomposition of results into each bilateral trade among CPTPP members

We decompose the CPTPP variable in Table 3 into each CPTPP member country's bilateral trade, and we re-estimate the model (G6) in Table 3. Results are reported in Table 5. Australia's import shares from Canada and Viet Nam after the formation of CPTPP show positive effects, while the import shares from other CPTPP member countries do not. In the case of Japan as an importer, all the import shares from the member countries exhibit positive effects except for Australia.

As the results for all CPTPP member country's bilateral trade are reported in Table 5, we can observe that Canada has positive effects on import shares from most of the CPTPP members, except for Mexico and Viet Nam. The results seem reasonable since the CPTPP is the Canada's first free trade agreement to be implemented for the partner countries, except for Mexico, which has been a trading partner in the NAFTA. Mexico's import shares from Singapore are positively affected by the CPTPP, but a negative effect is observed for Australia and Viet Nam. The effects for New Zealand are modest as their import shares become higher for the three partner countries. Import shares of Singapore are positively affected by the CPTPP, except for Mexico and New Zealand. The results for Viet Nam are a mix of the positive effect of Australia and Japan, and the negative effect of Mexico and Singapore. In summary, there are variations in the effect of the CPTPP on its member country's bilateral trade, which may explain in part the statistically insignificant effects of the CPTPP defined as a whole group reported in Table 3.

**Table 5**
Results of CPTPP's Bilateral Trade

| | Importer | | | | | | |
|---|---|---|---|---|---|---|---|
| | AUS | CAN | JPN | MEX | NZL | SGP | VNM |
| Exporter | | | | | | | |
| AUS | | 0.3007*** | -0.1854* | -0.6825*** | 0.1096 | 0.2280* | 0.2413** |
| | | (0.1086) | (0.1026) | (0.1119) | (0.1141) | (0.1173) | (0.1069) |
| CAN | 0.3602*** | | 0.3732*** | 0.1179 | 0.1992* | 0.4973*** | 0.0809 |
| | (0.1100) | | (0.1052) | (0.1031) | (0.1018) | (0.1071) | (0.0978) |
| JPN | 0.1386 | 0.2037** | | 0.0770 | 0.1896** | 0.3271*** | 0.1928** |
| | (0.0979) | (0.0904) | | (0.0922) | (0.0927) | (0.1110) | (0.0939) |
| MEX | -0.0501 | 0.1052 | 0.2738*** | | 0.3599*** | -0.0672 | -1.228*** |
| | (0.0818) | (0.0789) | (0.0867) | | (0.0785) | (0.0790) | (0.0748) |
| NZL | 0.1071 | 0.4923*** | 0.3822*** | 0.2053 | | 0.0868 | 0.1681 |
| | (0.1320) | (0.1252) | (0.1310) | (0.1309) | | (0.1216) | (0.1332) |
| SGP | -0.2163 | 0.2842* | 0.4173** | 0.4934*** | -0.2541* | | -0.7017*** |
| | (0.1603) | (0.1662) | (0.1653) | (0.1760) | (0.1496) | | (0.1864) |
| VNM | 0.3748*** | -0.0308 | 0.1875* | -0.2207** | 0.0359 | 0.4414*** | |
| | (0.1071) | (0.1101) | (0.1090) | (0.1112) | (0.1141) | (0.1067) | |

Note: Clustered (Exporter-Importer) standard errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

## 2.2. Difference-in-differences combined with propensity score matching

To estimate the sole effect of the CPTPP implementation, we focus on the average of the individual trade effects of the CPTPP among the ratified countries. We use a difference-in-differences combined with propensity score matching (PSM-DID) to estimate the average difference in bilateral trade flows among the CPTPP countries and those among non-CPTPP countries that are almost identical to the CPTPP countries. It means that we estimate the average CPTPP trade effect only for a country that has chosen to ratify the CPTPP.

PSM-DID approaches have been applied to estimate the effects of several trade agreements. Baghdadi et al. (2013) examine how a regional trade agreement (RTA) can reduce carbon dioxide emissions using PSM-DID. They found that RTAs with environmental provisions encourage participants to converge to lower emission levels by comparison with RTAs without such provisions. Regarding the trade impact of a trade agreement, Sorgho and Tharakan (2019) investigate the effects of non-reciprocal preferential trade agreements on African countries, namely the EU's Everything But Arms (EBA) and the US's African Growth and Opportunity Act (AGOA). They use PSM-DID and find that African beneficiary countries had positive trade impacts fifteen years after EBA and AGOA implementations. Chi et al. (2022) also use PSM-DID to evaluate the average treatment effect of the preferential trade agreements (PTAs) on fishery trade. They show PTAs yield an increase in the average import values of specific tuna species, while negative import effects due to PTAs are found in several OECD countries.

Our study uses propensity score matching (PSM) to create a control group that includes comparable non-CPTPP countries to the CPTPP members. We calculate a propensity score of each country pair, which is the probability of joining the CPTPP of each pair, based on data on its economic and social characteristics. Country pairs to form the control group are then chosen by matching based on propensity scores. After creating the control group, we use a difference-in-differences (DID) to compare the average change in bilateral trade values between the treatment group (CPTPP member country pairs) and the control group. Any differences in the trade values after the CPTPP implementation can be attributed to the CPTPP.

The following steps detail the analytical approaches applied in our study.

### 2.2.1. Definitions of treatment group, pre- and post-treatment periods

We focus on the countries that initially ratified the CPTPP: Australia, Canada, Japan, Mexico, New Zealand, Singapore and Vietnam. The first six countries ratified the CPTPP in December 2018, and Vietnam did in January 2019. Then, we define the bilateral pairs of these seven countries as the treatment group (42 country pairs). Considering the ratification timings of these countries, the early impact of the CPTPP on trade flows can be detected in the annual trade data for 2019. Regarding the time horizon for the analysis, we focus on the period from 2015 to 2020 since a tentative agreement of the TPP (the former version of CPTPP) was reached among TPP negotiating countries (including the six countries mentioned above) in 2015. We regard this tentative agreement as a starting point of the CPTPP implementation. We, therefore, define the years from 2015 to 2017 as a pre-treatment period and the years 2019 and 2020 as a post-treatment period.

### 2.2.2. Construction of propensity score matched control group

The control group should consist of non-CPTPP country pairs comparable to the treatment group (CPTPP country pairs). To identify the matching country pairs, propensity scores, which may be interpreted as the probability of receiving treatment, are used (Rosenbaum, 1983; Gertler, 2016). In the case of our study, the likelihood of signing the CPTPP for each country pair is estimated by propensity score. Such scores enable us to choose comparable non-CPTPP country pairs in their baseline characteristics to the CPTPP country pairs. We perform the following steps to construct the control group.

#### *2.2.2.1. Estimation of propensity scores*

The following regression model is used to calculate the propensity scores for each bilateral trade flow.

$$\Pr\left(CPTPP_{ij,t} = 1 \middle| X_{ij,t}\right) = \frac{1}{1+exp(-X_{ij,t})} \tag{4}$$

The left-hand side of eq. (4) represents the probability of signing the CPTPP in 2018 and 2019 between countries i and j given the linear combination of the variables and coefficients ($X_{ij,t}$). The right-hand side is the logistic function transforming the variables $X_{ij,t}$ into a probability value between 0 and 1. The equation below defines $X_{ij,t}$ using key determinants that influence the decision to sign FTAs, following the previous studies (Brookheart et al., 2006; Sorgho and Tharakan, 2019; Moyo et al., 2018; Baghdadi, 2013).

$$X_{ij,t} = \beta_0 + \beta_1 log(trd) + \beta_2 log(dst) + \beta_3 log(GDP_i) + \beta_4 log(GDP_j) \\ +\beta_5 D_{fta} + \beta_6 D_{contig} + \beta_7 D_{comlang} + \beta_8 D_{comcl} + \beta_9 D_{col45} \quad (5)$$

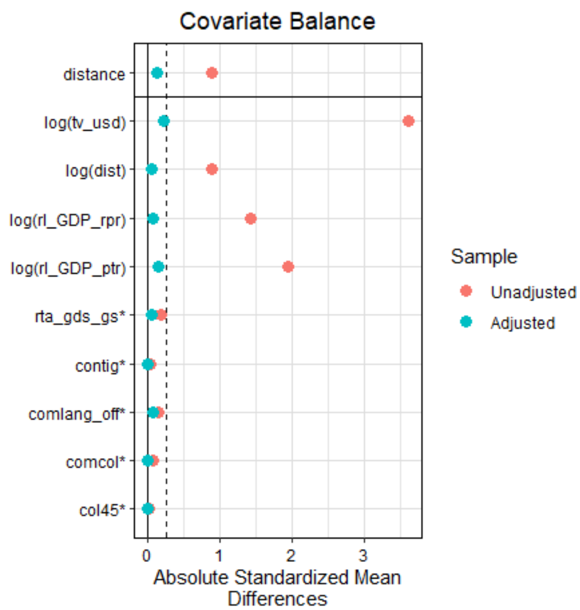
where $\beta_0$ through $\beta_9$ are the coefficients for each independent variable; *trd* and *dst* are the total import volume from country *j* to *i*, and geographical distance between *i* and *j*; *GDPi*, *GDPj* are real GDP of country *i* and *j* respectively (constant 2015 USD); $D_{fta}$ through $D_{col45}$ are dummy variables indicating the bilateral characteristics, namely the FTA between *i* and *j*, geographic proximity, common official languages, common colonizers after 1945 and colonial relationship after 1945 respectively. "log ( · )" in the equation indicate logarithmic conversions of dependent variables.

Eqs. (4) and (5) estimate probabilities as of years 2015, 2016 and 2017 that a country pair will join the CPTPP.

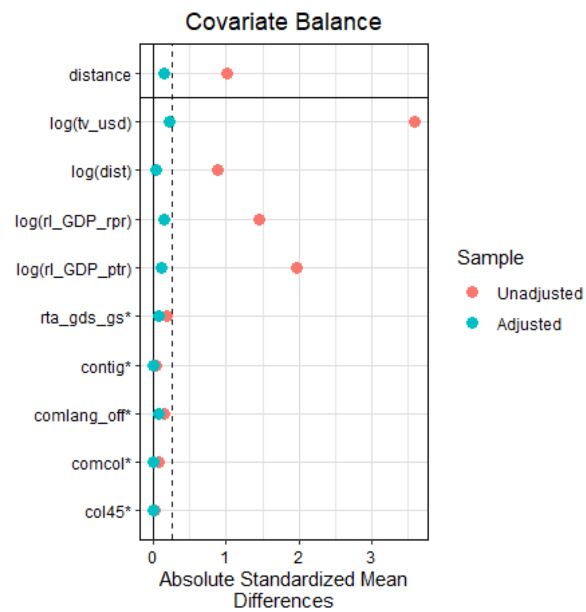
For the estimation, aggregated bilateral trade flow data are obtained from the U.N. Comtrade database, while the data on bilateral geographic distance and the types of FTAs signed by each country pair before 2017 are obtained from the Gravity database of CEPII (Centre d'Etudes Prospectives et d'Informations Internationales). The data on GDP and population come from the IMF World Economic Outlook database and the U.N. World Population Prospects database respectively. These data span from 2015 to 2017 covering the pre-treatment period and all the data available are used except for those with zero trade data.

#### *2.2.2.2. matching procedure*

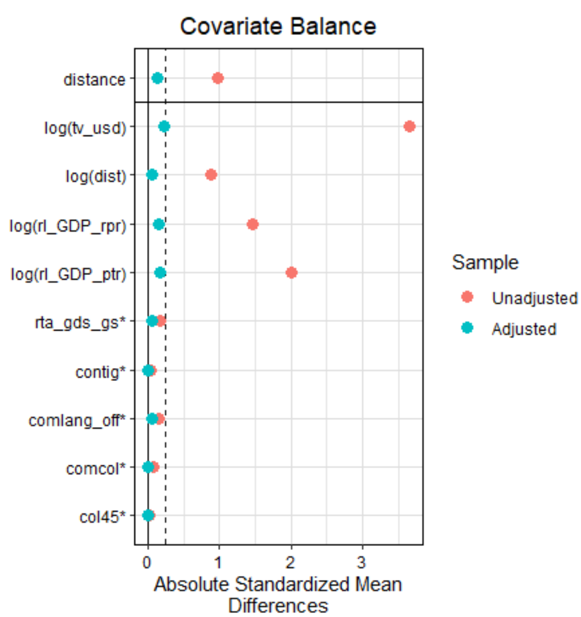
For the matching procedure, we use optimal matching method of propensity scores which minimizes the total distance across all country pairs (Greifer, 2023). To maximize the number of country pairs in the control group with ensuring that treatment and control group members are well-balanced on the variables in $X_{ij,t}$, we perform variable k:1 matching which pairs k control units with each treatment unit. At the same time, each treatment unit is matched multiple control units (more than 4 units) in each year. To make sure to get appropriate balance of covariate distribution between the treatment group and the control group, we adjust the ratio k to make standardized mean difference (SMD) of each covariate distribution lower than 0.25, following the proposal by Austin (2011). Figure. 3 shows the balance improvements before and after the matching procedure.




2015




2016




2017

**Figure. 3**. Comparison of covariate balance before and after propensity score matching in 2015, 2016 and 2017.

### 2.2.3. Application of DID framework

Using the treatment and control groups defined the above, the trade impact of the CPTPP implementation can be found by applying the following DID regression model.

$$log(M_{ij,t}) = \beta_0 + \beta_1 CPTPP_{ij} + \beta_2 Post_t + \beta_3 (CPTPP_{ij} \times Post_t) + (\gamma_t) + (\gamma_i) + (\gamma_j) + (\gamma_{ij}) + (\gamma_{it}) + (\gamma_{jt}) + \varepsilon_{ij,t} \quad (6)$$

Here $\beta_0$ through $\beta_3$ are the coefficients for each independent variable, $CPTPP_{ij}$ is a binary variable equaling 1 if both countries are CPTPP members, $Post_t$ is 1 if it is a year after 2018 (the CPTPP implementation year), and the interacting term ($CPTPP_{ij} \times Post_t$) is the DID term, whose coefficient ($\beta_3$) estimates the CPTPP trade effect.

Sorgho (2019) highlights that potential endogenous bias may persist in a control group even after a matching procedure due to unobservable characteristics. We then develop three models with varying fixed-effects specifications. The first model (D1) serves as a baseline with no fixed effects. The second model (D2) incorporates fixed effects for year, exporter, importer, and exporter-importer interaction($\gamma_t$, $\gamma_i$, $\gamma_j$, $\gamma_{ij}$), controlling for common temporal shocks (e.g., COVID-19) and time-invariant factors specific to each country and each bilateral pair, following Chen et al. (2018) and Tello (2015). The third model (D3) includes cross fixed effects (exporter*importer($\gamma_{ij}$), exporter*year($\gamma_{it}$), and importer*year($\gamma_{jt}$)) based on equation (2) to address bilateral time-invariant heterogeneity and multilateral resistance terms.

### 2.2.4. Estimation results

Table 6 reports the estimation results from PSM-DID. The estimates of the variable of interest ($CPTPP_{ij} \times Post_t$) in models (D1) and (D2) show statistically significant positive coefficients, indicating that the CPTPP resulted in a 9.1% higher average bilateral trade value among its initial member countries than it would have been without the agreement in 2019 and 2020. On the other hand, the DID coefficient in model (D3) shows a positive figure, but is not statistically significant.

**Table 6**
PSM-DID analysis of CPTPP trade effect.

| Model: | (D1) | (D2) | (D3) |
|---|---|---|---|
| *Variables* | | | |
| $CPTPP_{ij}$ | 0.583*** | – | – |
| | (0.214) | | |
| $Post_t$ | -0.020 | – | – |
| | (0.013) | | |
| $\boldsymbol{CPTPP_{ij} \times Post_t}$ | **0.091*** ** | **0.091*** ** | **0.160** |
| | (0.031) | (0.034) | (0.161) |
| *Fixed-effects* | | | |
| Year | | Yes | |
| Exporter | | Yes | |
| Importer | | Yes | |
| Exp × Imp | | Yes | Yes |
| Exp × Year | | | Yes |
| Imp × Year | | | Yes |
| *Fit statistics* | | | |
| Num.Obs. | 5388 | 5388 | 5388 |
| R2 Adj. | 0.005 | 0.973 | 0.983 |
| BIC | 20845.5 | 8256.0 | 12795.9 |

Note: Clustered (Exporter-Importer) standard errors in parentheses. The regressors $CPTPP_{ij}$ and $Post_t$ are excluded due to perfect multicollinearity that arise after introducing fixed effects in models (D2) and (D3).
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Among the three models presented in Table 5, model (D1) has a very low adjusted R-squared value, indicating poor explanatory power. Conversely, models (D2) and (D3) exhibit adjusted R-squared values exceeding 0.9, suggesting a significantly better fit than model (D1). Additionally, model (D2) has the lowest BIC value among the three models. At the same time, model (D3) has a higher BIC than model (D2), indicating potential overfitting. In fact, we found potential perfect collinearity issues regarding the fixed effects of exporter*year($\gamma_{it}$), and importer*year($\gamma_{jt}$), especially interactions between each of the CPTPP countries and year 2020. Given that the DID term focuses on CPTPP country pairs and years 2019 and 2020, this collinearity issue likely means that these fixed effects absorb the effects that the DID term is intended to capture.

Considering the adjusted R-squared, BIC and the collinearity issue, model (D2) achieves an optimal balance between complexity and goodness-of-fit, demonstrating its superiority over the other models.

### 2.2.5. Estimation results for two groups of CPTPP country pairs

We conduct an analogous analysis to that presented in section 2.1.3. Specifically, we categorize the CPTPP country pairs into two groups: (1) pairs for which the CPTPP represents their inaugural FTA, and (2) pairs that had established FTAs prior to signing the CPTPP. For both groups, we apply the regression analysis using model (D2). For the propensity score matching process for each of the two CPTPP country pair groups, we take the procedure described in sections 2.2.1 and 2.2.2 above.

Table 7 reports the estimation results for the two groups. Models (D4) and (D5) show the results of group (1) and group (2) respectively.

**Table 7**
PSM-DID analysis of CPTPP trade effect: two divided groups of CPTPP country pairs.

| Model: | (D4) | (D5) |
|---|---|---|
| *Variables* | | |
| $\boldsymbol{CPTPP_{ij} \times Post_t}$ | **0.143*****<br>(0.050) | **0.054**<br>(0.046) |
| *Fixed-effects* | | |
| Year | Yes | Yes |
| Exporter | Yes | Yes |
| Importer | Yes | Yes |
| Exp × Imp | Yes | Yes |
| *Fit statistics* | | |
| Num.Obs. | 3132 | 1992 |
| R2 Adj. | 0.978 | 0.977 |
| BIC | 5460.9 | 1840.3 |

Note: Clustered (Exporter-Importer) standard errors in parentheses.
Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

The following conclusions can be drawn from the table. First, the DID coefficient in model (D4) is positive and statistically significant from zero, indicating that the CPTPP resulted in a 14.3% higher average bilateral trade value for the country pairs for whom the CPTPP is their first FTA than it would have been without the agreement. Second, the same coefficient in model (D5) is positive but statistically insignificant, meaning there is no indication of the CPTPP trade effect for the CPTPP country pairs who already signed FTAs before signing the CPTPP.

### 2.2.6. Placebo test: comparison of trade effects in pre- and post-CPTPP periods

The critical assumption of the DID analysis is the parallel trend assumption. In our study, the assumption can be interpreted as that the CPTPP and the comparable non-CPTPP pairs follow similar growth trends in trade value before the CPTPP implementation.

To test the assumption, we estimate the differences in the trade changes between the two groups each year from 2015 to 2020. As Huntingon-Klein (2022) points out, an unexpected trade difference would be detected in the pre-CPTPP period if the parallel trend assumption is violated. The model (D2) is modified to estimate such dynamic trade effects to test the assumption:

$$log(M_{ij,t}) = \sum_{k=2015}^{2020} \delta_t (CPTPP_{ij} \times Post_t) I_t^k + \gamma_t + \gamma_i + \gamma_j + \gamma_{ij} + \varepsilon_{ij,t} \qquad (7)$$

where $I^k{}_t = 1$ if $k = t$ and 0 otherwise. The DID coefficients ($\delta_t$) in eq. (7) now indicate the CPTPP yearly trade effect from 2015 to 2020.

Figure. 4 shows the DID estimates for each year with their 95% confidence intervals. While trade effects are near zero in the pre-treatment periods (2015 – 2017), those in the post-treatment period become statistically positive[7]. This means that the two groups follow a similar growth path before the CPTPP implementation, implying the parallel trend assumption is held. We can also observe the positive CPTPP trade effects for the two years after the CPTPP implementation (5.3% in 2019 and 10.2% in 2020), which are consistent with the results shown in Table 6.

[7] Although the CPTPP trade effect in 2019 is statistically insignificant at the 95% confidence level, it is significant at the 90% confidence level.

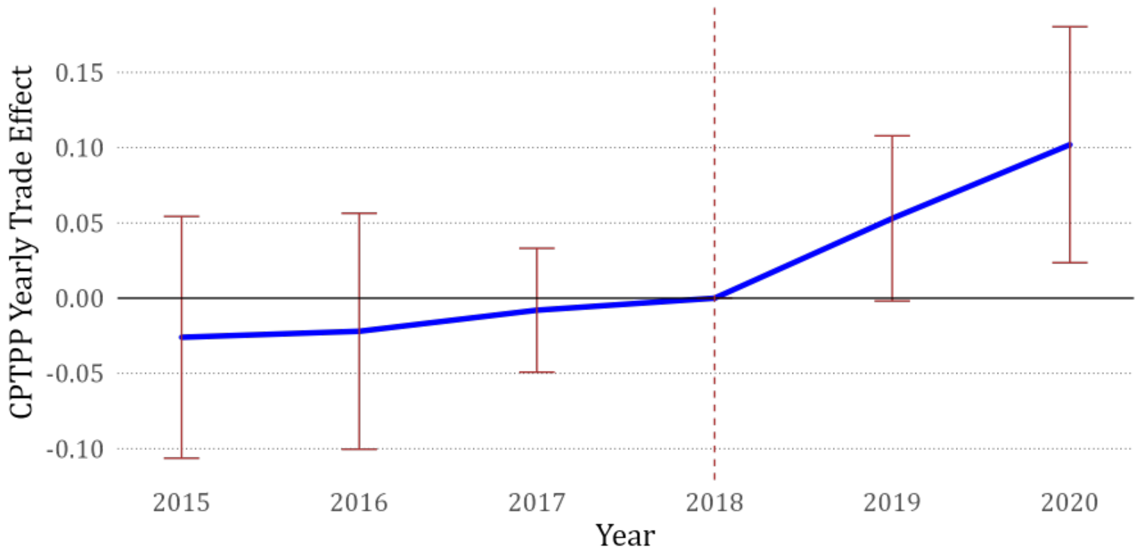



**Fig. 4**. Yearly Trade effects before and after the CPTPP implementation. **Note**: The estimates are based on the equation (D2). 95% confidence intervals for the estimates are shown as vertical solid lines. The dashed vertical line indicates the year the CPTPP was implemented.

## 3. Discussion and conclusion

This study empirically evaluates the effect of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) on bilateral imports using two methods: the gravity equation and the difference-in-differences combined with propensity score matching (PSM-DID). These methods aim to complement and cross-validate the estimated results.

The PSM-DID reveals that the CPTPP as a whole led to a 9.1% increase in average bilateral trade value among its initial member countries in 2019 and 2020 compared to what would have been observed without the agreement. At the same time, the gravity model, incorporating three-way fixed effects and a time trend, indicates a positive but statistically insignificant effect of the CPTPP. This discrepancy may stem from heterogeneity in bilateral import values among CPTPP members, as noted by Nagengast and Yotov (2023).

We also analyze the CPTPP's effects on two groups of country pairs: (1) pairs for which the CPTPP represents their inaugural FTA, and (2) pairs that had established FTAs prior to the CPTPP. Both the PSM-DID and gravity methods yield consistent results: the CPTPP shows no significant effect for pre-existing FTA pairs but demonstrates statistically significant positive effects for new FTA pairs. This indicates that the CPTPP significantly enhances trade for country pairs for which it is the first FTA.

The positive CPTPP effects for new country pairs are further confirmed by the bilateral decomposition of the gravity model results. The decomposition shows statistically significant positive trade effects for most new CPTPP country pairs, whereas old pairs show no significant trade effects.

These findings suggest that CPTPP implementation has potentially boosted goods trade within the CPTPP region, particularly among country pairs for which the CPTPP is the inaugural FTA.

This study represents a step toward a better understanding of the CPTPP's trade effects. Given that the CPTPP covers goods, services, investments, and e-commerce, future research could extend to these non-goods areas. Sectoral analysis is another promising direction, as this study focused on overall trade values. Examining the CPTPP's impact on specific sectors and products could provide insights into which industries benefit most from the agreement. Extending the study's timeframe is also crucial, as our analysis was limited to data available up to 2020. Future research with more recent data could provide updated insights on the CPTPP's long-term effects. Additionally, investigating trade diversion effects among non-CPTPP countries could further enrich the analysis, as our study specifically focused on trade creation effects within the CPTPP.

Future research addressing these challenges could provide a clearer understanding of the CPTPP's impacts and guide policymakers in optimizing the benefits of such trade agreements.

## References

Anderson, James E., and Eric van Wincoop. 2003. "Gravity with Gravitas: A Solution to the Border Puzzle." *American Economic Review* 93 (1): 170–92.

Ando, Mitsuyo, Shujiro Urata, and Kenta Yamanouchi. 2022. "Do Japan's Free Trade Agreements Increase Its International Trade?" *Journal of Economic Integration* 37 (1): 1–29. https://doi.org/10.11130/jei.2022.37.1.1.

Austin, Peter C. 2011. "An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies." *Multivariate Behavioral Research* 46(3): 399–424. https://doi.org/10.1080/00273171.2011.568786

Baghdadi, Leila, Inmaculada Martinez-Zarzoso, and Habib Zitouna. 2013. "Are RTA Agreements with Environmental Provisions Reducing Emissions?" *Journal of International Economics* 90(2): 378–390. https://doi.org/10.1016/j.jinteco.2013.04.001

Baier, Scott L., and Jeffrey H. Bergstrand. 2007. "Do Free Trade Agreements Actually Increase Members' International Trade?" *Journal of International Economics* 71 (1): 72–95.

Borchert, Ingo, Mario Larch, Serge Shikher, and Yoto V. Yotov. 2022. "Disaggregated Gravity: Benchmark Estimates and Stylized Facts from a New Database." *Review of International Economics* 30 (1): 113–36. https://doi.org/https://doi.org/10.1111/roie.12555.

Brookhart, Maurice Alan, Sebastian Schneeweiss, Kenneth J. Rothman, Robert J. Glynn, Jerry Avorn, and Til Stürmer. 2006. "Variable Selection for Propensity Score Models." *American Journal of Epidemiology* 163(12): 1149–1156.

Cimino-Isaacs, Cathleen. 2023. "CPTPP: Overview and Issues for Congress." CRS Report, June 16, 2023.

Chi, Pei-Yu, Ting-Yu Chang, and Kuo-I Chang. 2022. "Evaluating the Impact of Preferential Trade Agreement on Fishery Imports: An Application of Difference-in-differences with Matching Method." *Agricultural Economics* 53: 90‑124. https://doi.org/10.1111/agec.12665

Claudia, Hofmann, Alberto Osnago, and Michele Ruta. 2017. "Horizontal Depth: A New Database on the Content of Preferential Trade Agreements." *Policy Research Working Paper*, no. WPS7981: 1–53.

Fergusson, Ian F., and Brock R. Williams. 2018. "TPP Countries Sign New CPTPP Agreement without U.S. Participation." CRS Report, March 9, 2018.

Gertler, Paul J., Sebastian Martinez, Parick Premand, Laura B. Rawlings, and Christel M. J. Vermeersch. 2016. Impact Evaluation in Practice. World Bank Publications.

Greifer, Noah. 2023. "Matching Methods." https://cran.r-project.org/web/packages/MatchIt/vignettes/matching-methods.html#optimal-pair-matching-method-optimal.

Government of Canada. 2023. “CPTPP explained.” www.international.gc.ca/trade-commerce /trade-agreements-accords-commerciaux/agr-acc/cptpp-ptpgp/cptpp_explained-ptpgp_apercu.aspx?lang=eng.

Hayakawa, Kazunobu, Juthathip Jongwanich, and Archanun Kohpaiboon. 2022 “The Trade Effect of Non-tariff Measures in a High-quality Trade Agreement.” IDE Discussion Paper, no.871: 1-25.

Head, Keith, and Thierry Mayer. 2014. “Chapter 3 - Gravity Equations: Workhorse, Toolkit, and Cookbook.” In *Handbook of International Economics*, edited by Gita Gopinath, Elhanan Helpman, and Kenneth Rogoff, 4:131–95. Handbook of International Economics. Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-444-54314-1.00003-3.

Heid, Benedikt, Mario Larch, and Yoto V. Yotov. 2021. “Estimating the Effects of Non-Discriminatory Trade Policies Within Structural Gravity Models.” *Canadian Journal of Economics* 54 (1): 376–409. https://doi.org/10.1111/caje.12493.

Huntington-Klein, N., 2021. The Effect: An Introduction to Research Design and Causality. CRC Press.

Larch, Mario, Joschka Wanner, Yoto V. Yotov, and Thomas Zylkin. 2019. “Currency Unions Trade: A PPML Re-Assessment with High-Dimensional Fixed Effects.” *Oxford Bulletin of Economics and Statistics* 81 (3): 487–510. https://doi.org/10.1111/obes.12283.

Mayer, Thierry, Vincent Vicard, and Soledad Zignago. 2019. “The Cost of Non-Europe, Revisited.” *Economic Policy* 34 (98): 145–99. https://doi.org/10.1093/epolic/eiz002.

McFadden, Daniel. 1977. “Quantitative Methods for Analyzing Travel Behaviour of Individuals: Some Recent Development.” *Cowles Foundation Discussion Papers* 707. https://elischolar.library.yale.edu/cowles-discussion-paper-series/707

Moyo, Busani, Mamello Nchake, and Blessing Chiripanhura. 2018. “An Evaluation of the US African Growth and Opportunity Act (AGOA) Trade Arrangement with Sub-Saharan African Countries.” *PSL Quarterly Review* 71(287), 389-418.

Nagengast, Arne, and Yoto V. Yotov. 2023. “Staggered Difference-in-differences in Gravity Settings: Revisiting the Effects of Trade Agreements.” *CESifo Working Paper,* no.10782.

Rosenbaum, Paul R., and Donald B. Rubin. 1983. “The Central Role of the Propensity Score in Observational Studies for Causal Effects.” *Biometrika* 70(1): 41–55. https://doi.org/10.1093/biomet/70.1.41

Santos Silva, J. M. C., and Silvana Tenreyro. 2006. “The Log of Gravity.” *Review of Economics and Statistics* 88 (4): 641–58.

———. 2022. “The Log of Gravity at 15.” *Portuguese Economic Journal* 21 (January): 423–37. https://doi.org/10.1007/s10258-021-00203-w.

Sorgho, Zakaria, and Joe Tharakan. 2019. “Assessing the Impact of Unilateral Trade Policies EBA and AGOA on African Beneficiaries’ Exports Using Matching Econometrics.” *World Economy* 42: 3086–3118. https://doi.org/10.1111/twec.12842

Suominen, Kati. 2024. “The Implementation of the CPTPP’s E-Commerce Chapter in 2023 and toward CPTPP 2.0.” CSIS Report, February 2024.

Tinbergen, Jan. 1962. *Shaping the World Economy; Suggestions for an International Economic Policy*. New York: Twentieth Century Fund. http://hdl.handle.net/1765/16826.

Wang, Xuejun, Xiaoqi Zhang, Dan Meng, and Harry M. Kaiser. 2022. “The Effects of Product Standards on Trade: Quasi-Experimental Evidence from China.” *Australian Economic Review* 55: 232–249. https://doi.org/10.1111/1467-8462.12458

Wolfram Research, Inc. 2022. *Wolfram|Alpha Knowledgebase*. Champaign, IL: Wolfram Research, Inc.

Yamanouchi, Kenta. 2019. “Heterogeneous Impacts of Free Trade Agreements: The Case of Japan.” *Asian Economic Papers* 18 (2): 1–20. https://doi.org/10.1162/ASEP_a_00686.

Yotov, Yoto V. 2022. “Gravity at Sixty: The Workhorse Model of Trade.” *CESifo Working Paper*, no. 9584 (February).