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The Heterogeneous Effects of Trade Agreements on Global Value Chain Participation: Who Specializes Matters!

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Abstract

Using difference-in-differences (DID) estimation technique on data, which covers 43 countries over the 2005-2014 period, we examine the impact of trade agreements (TA) on bilateral global value chain (GVC) participation. Empirical estimation results show that TAs between member countries with different levels of economic development are more likely to promote bilateral GVC participation. Moreover, the effects of TAs on bilateral GVC participation levels are heterogeneous across member countries. Specifically, TAs have a higher impact on forward GVC participation of developed member countries than that of developing member countries but the effect on backward GVC participation of developed member countries is smaller than that of developing member countries. Finally, the heterogeneous effect is larger in size in the case of deep TAs. This study not only enriches the literature on the relationship between trade agreements and bilateral GVC participation but also provides a new idea for economies to promote bilateral GVC participation.

Keywords

Trade Agreements (TAs), Global Value Chain (GVC) Participation, Heterogeneous Effects

1. Introduction

During the past few decades, trade agreements (TAs) have rapidly grown[1]. The number of TAs in force increased from 70 to 579 over the 1990-2022 period. Not only the number of TAs has increased but the quality or "depth" (Lee, 2019) of

[1]Following Limão (2016), TAs can be defined as the international treaties with restrictive membership and including any articles that: 1) apply only to member countries and 2) aim to secure or increase their respective market access.

such agreements has also increased. TAs in the new era involve policy cooperation far beyond the traditional tariff reductions, and also include some deeper provisions such as procurements, competition policies, investments, and intellectual property rights (Hofmann et al., 2017). TAs are commonly classified into six groups based on their depth (Frankel et al., 1997): non-reciprocal agreements (NRTA), reciprocity agreements (RTA), free trade agreements (FTA), customs union (CU), common market (CM) and economic union (EUN).

In recent years, the effect of TAs on GVC participation has attracted enormous attention (e.g., Ornelas & Turner, 2008; Antràs & Staiger, 2012; Limão, 2016; Johnson & Noguera, 2017; Boffa et al., 2019; Lee, 2019)[2]. Using panel data from 1995-2015, Lee & Kim (2021) use an augmented gravity model to examine the impact of deep TAs on GVC trade flows. They find that TAs have a positive impact on GVC trade flows. They also show that compared to shallow TAs, deep TAs lead to a large increase in GVC trade flows. In a very interesting recent study, Using data over the 2000-2014 period, Zhang et al. (2021) examine the export promotion effects of free trade areas GVC trade of member countries. They find that total trade and exports of foreign value added among member countries are positively influenced by the depth of free trade agreements (FTAs). They also find that FTAs enhance both simple and complex value chains. They also find that the level of economic development among FTA members and FTA structures can lead to heterogeneous and heterogeneous effects on foreign value-added of exports.

This paper focuses on the issue of whether the effect of TAs on bilateral GVC participation is heterogeneous across member countries, which are at different levels of economic development. Moreover, due to the heterogeneity of TAs in terms of depth, we also investigate whether the heterogeneous effect of TAs varies with the depth of TAs. The empirical analysis presented in this paper is based on the Difference-in-Differences (DID) estimation technique. We use a dataset that covers 43 countries and 56 sectors over the 2005-2014 period. Empirical results show that TAs between developed and developing countries are more like to promote bilateral GVC participation, and this effect is heterogeneous across member countries. Specifically, a TA leads to higher forward GVC participation effect on developed member countries than on developing member countries. However, the backward GVC participation effect on developed members is smaller than that on developing member countries. We also find that this heterogeneous effect is more significant in the case of deeper TAs.

The remainder of this paper is organised as follows. The theoretical foundation of our work and hypotheses tested are explained in Section 2. The empirical strategy is presented in Section 3. Data sources and summary statistics of the data are provided in Section 4. Estimation results are presented and discussed in Section 5. Some robustness checks are presented in Section 6. The main conclu-

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[2]Jangam and Rath (2021) use data from 2005 to 2015, which covers 58 countries, to examine the relationship between trade and economic growth in the context of formation of GVCs. They find that trade and trade linked to GVCs enhances economic growth.

sions and policy implications are presented in Section 7.

2. Theoretical Foundation and Hypothesis Development

Some TAs include members, which are not at the same level of economic development[3]. Owing to their power, most GVCs are organized by developed country multinationals (Feenstra & Hanson, 1996; Borga & Zeile, 2004). The production process is fragmented across international boundaries based on local comparative advantages. In the case of the production of intermediates, comparative advantages are mainly associated with technological differences between countries. Because of significant technological differences, developed and developing countries end up having comparative advantage in different intermediates. Thus, TAs between developed and developing countries are more likely to promote bilateral GVC participation.

Most developed countries tend to produce upstream high value-added goods and thus these countries are involved in forward GVC participation. On the other hand, developing countries tend to mostly produce down-stream low-value-added products and these countries are involved in backward GVC participation. Thus, TAs involving countries which are at very different levels of economic development can result in heterogeneous effects on bilateral GVC participation across member countries. Specifically, a TA can have a higher effect on forward GVC participation of developed member countries than that of developing member countries. The effect of a TA on backward GVC participation of developed member countries is likely to be smaller than that of developing member countries.

TAs differ in policy depth and provisions and thus their heterogeneous effect on bilateral GVC participation may also vary significantly across TA types. Specifically, the heterogeneous effect of a TA on GVC participation may increase as member countries move from a shallow NRTA to a deep EUN. This could be attributed to three factors. First, a deep TA can increase the existing market access to intermediates trade. Tariff is the most apparent element of policy depth of TAs (Limão, 2016). The primary feature of a deeper TA is that it sets a lower level of tariff for the member countries. Based on Frankel et al. (1997), policy depths of different TAs can be identified based on tariffs applied. For example, whether the tariff is applied to only one country (NRTA) or both (RTA); whether the tariff is zero on most commodities (FTA); and whether member countries set a common external tariff (CU). Deep TAs can better facilitate the existing vertical integration across member countries by further reducing the existing tariffs, thereby making the effect of TAs on GVC participation more heterogeneous.

Second, deep FTAs are more likely to reduce trade policy uncertainty in intermediates trade. This follows from the fact that, in the case of a deep TA, tariffs on most goods are eliminated and hence there is less risk of future renegotiation.

[3]For example, North American Free Trade Agreement (NAFTA) includes USA, which is a developed economy and Mexico, which is a developing economy.

A deep TA also includes provisions regarding cooperation with member countries, which reduces the risk of triggering future protection by member countries. Furthermore, a deep TA leads to closer economic integration among the member countries, which deters trade wars in the future. In practice, developing country economies are characterised by higher level trade policy uncertainties and hence, owing to better future market access within the member country group, deep TAs involving developing countries can lead to higher heterogeneous effects on GVC participation.

Finally, due to customised nature of intermediates, deep TAs tend to include provisions for bargaining in intermediates trade (Limão, 2016). With customised intermediates and incomplete contracts, efficiency requires regular policy intervention in intermediates market, not just free trade. Member country governments must jointly overcome the underinvestment problems that arise from hold-ups in intermediates trade. Deep TAs allow ex-post bargaining in a meaningful way, which allows member countries to avoid inefficiencies resulting from buyer-supplier conflicts (Grossman, 2016). Thus, deep TAs can better mitigate the hold-up problems, which can increase the heterogeneous GVC participation effects. Based on the discussion of the relationship between formation of TAs and GVC participation, we have three hypotheses as follows.

H1: *TAs between developed and developing countries are more likely to promote bilateral GVC participation.*

H2: *TAs between developed and developing countries can have a heterogeneous effect on bilateral GVC participation.*

H3: *The heterogeneous effect of TAs on bilateral GVC participation is more significant in the case of deep TAs.*

Hypothesis 2 follows from the fact that TAs have a higher impact on forward GVC participation of developed member countries than that of developing member countries but the effect on backward GVC participation of developed member countries is smaller than that of developing member countries.

3. Methodology

This section explains the methodology used to test the hypotheses concerning the effects of TAs on GVC participation. Existing studies measure bilateral GVC participation mainly using gross intermediates trade (Orefice & Rocha, 2014; Johnson & Noguera, 2017; Boffa et al., 2019). Some studies disaggregate GVC participation into forward and backward (Koopman et al., 2014), but these studies focus on the unilateral level GVC participation, where the forward participation reflects the share of country's domestic value-added that enters as an intermediate input in the value-added exported by other countries, while the backward GVC participation represents the sum of the share of foreign value-added used in a country's exports. As different aspects of GVC participation, forward and backward GVC participations can provide useful information on a country's specialization pattern. A country with a high value of forward GVC participation

usually specialises in high value-added stages of intermediates. In contrast, a country with a high value of backward GVC participation usually specialises in low value-added stages of intermediates.

Based on the GVC-trade decomposition developed by Wang et al. (2013), we use two measures of bilateral GVC participation as follows.

$$FGVCP_{ijt} = \sum_{k=1}^{n} INTrex_{ijkt} \tag{1}$$

$$BGVCP_{ijt} = \sum_{k=1}^{n} FDV_{ijkt} \tag{2}$$

where t represents the year, i and j denote the exporting and importing countries, respectively. $FGVCP_{ijt}$ is country i's forward GVC participation in country j, and $BGVCP_{ijt}$ is country i's backward GVC participation in country j. $INTrex_{ijkt}$ is the domestic value-added in country i's intermediate k exported to country j. FDV_{ijt} is the foreign value added in country i's intermediate k exported to country j.

One of the biggest concerns in our estimation is that the formation of TAs may be affected by the bilateral GVC participation. Specifically, a country pair with high bilateral GVC participation is more likely to sign a TA. To mitigate the potential endogeneity issue, we employ a Difference-in-Difference (DID) model to investigate the impact of TAs on bilateral GVC participation. The DID model does not require the formation of TAs to be completely exogenous. The model only assumes that the formation of TAs is independent of the trend in bilateral GVC participation. Moreover, to control observed and unobserved heterogeneity across countries and country pairs, we incorporate a rich set of dummy variables that capture the fixed effects. The DID model is as follows.

$$GVCP_{ijt} = \beta_0 + \beta_1 TA_{ij} * Time_t + \beta_2 TA_{ij} + \beta_3 Time_t + \delta_{ij} + \lambda_{it} + \vartheta_{jt} + \varepsilon_{ijt} \tag{3}$$

where $GVCP_{ijt}$ is country i's GVC participation in country j, which represents both *FGVCP* and *BGVCP*. TA_{ij} is a dummy variable indicating whether a TA is signed between country i and j. If the country pair has a TA, this dummy variable takes the value of 1, 0 otherwise. $Time_t$ is also a dummy variable that takes the value of 1 during and after the period t if the country pair signs a TA during the period t. $TA_{ij} * Time_t$ is an interaction variable involving TA_{ij} and $Time_t$, and its estimated coefficient indicates the average change in country i's GVC participation in j after a TA is signed between the country pair. δ_{ij} is the country pair fixed effects that are used to control all time-invariant heterogeneity across country pairs. λ_{it} and ϑ_{jt} are country-year fixed effects that capture time-variant heterogeneity across exporters and importers, respectively. ε_{ijt} is the usual error term.

While estimating a DID model, we must also run a parallel trend test to check whether formation of TAs is independent of the trend in bilateral GVC participation. If the bilateral GVC participation of the two countries exhibits a high growth trend before they sign a TA, the effect of the TA on bilateral GVC par-

ticipation might be exaggerated. Based on Kudamatsu's work (2012), we test the parallel trend using the follows regression equation.

$$GVCP_{ijt} = \beta_0 + \beta_1 TA_{ij} + \sum_{n=-p}^{q} v_n * 1\{t = t_{ij} + n\} + \sum_{n=-p}^{q} \tau_n TA_{ij} * 1\{t = t_{ij} + n\}$$
$$+ \delta_{ij} + \lambda_{it} + \vartheta_{jt} + \varepsilon_{ijt} \tag{4}$$

where t_{ij} is the year in which a TA is signed between countries i and j. $1\{t = t_{ij} + n\}$ takes the value of 1 when $t = t_{ij} + n$, 0 otherwise. v_n and τ_n, respectively, are coefficients of $1\{t = t_{ij} + n\}$ and $TA_{ij} * 1\{t = t_{ij} + n\}$. δ_{ij}, λ_{it}, ϑ_{jt} and ε_{ijt} have been defined earlier.

To reduce the severity of the estimation bias arising due to many zeros in the dependent variable data, we employ the Poisson Pseudo-Maximum Likelihood (PPML) estimation technique proposed by Silva and Tenreyro (2006).

4. Data

The data used to calculate the bilateral GVC participation is sourced from the World Input-Output Database (WIOD) released in 2016, which covers 43 countries and 56 sectors over the 2000-2014 period. To decompose the bilateral manufacturing trade, we follow the approach developed by Wang et al. (2013). The classification standards for manufacturing products follow the fourth edition of International Standard Industrial Classification (ISIC), which are presented in Table 1.

The data on TAs is sourced from Global Trade Agreements database of the World Bank (GPTAD, 2021). Most existing studies on trade agreements utilise this database. The database contains information on TAs of 189 countries from 1958 to 2015. The classification of TAs based on their depth is shown in Table 2.

Since the number of countries in both NRTA and RTA is small, we combine NRTA and RTA into a single category of RNTA, and for same reason, we also combine CU, CM and EUN into a single category of CCE. By matching the TAs and GVC participation data, we have a final sample which covers 43 countries or regions over the 2005-2014 period. Descriptive statistics of the main variables are provided in Table 3, where 55.8% of the countries in the sample have trade agreements, 11.7% are involved in RNTAs, 13.4% have FTAs, and 43.5% are involved in CCEs.

5. Empirical Results and Analysis

This section, we start by presenting and discussion of Equation (1) estimation results, which allows one to determine the general effect of TAs on bilateral GVC participation. In Table 4, columns 1 and 2 present the regression results of forward and backward GVC participation, respectively. The estimated coefficient of $TA * TIME$ is positive and statistically significant in both columns 1 and 2, implying that TAs can promote forward and backward GVC participation of member countries. Specifically, TAs increase bilateral forward and backward GVC participation by 7.56% and 6.53%, respectively.

Table 1. ISIC 4th edition classification criteria for manufacturing industry.

ISIC_rev4	2016 version WIOD sector description
C10 - C12	Manufacture of food products, beverages, and tobacco products
C13 - C15	Manufacture of textiles, wearing apparel and leather products
C16	Manufacture of wood and products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers, and semi-trailers
C30	Manufacture of other transport equipment
C31 - C32	Manufacture of furniture; other manufacturing
C33	Repair and installation of machinery and equipment

Source: UNSD (2021).

Table 2. Classification of TAs.

TAs	Definition
NRTA	Non-reciprocal TAs (NRTA), providing one-way preferential tariffs, e.g. the generalised system of preferences (GSP).
RTA	Reciprocal TAs (RTA) providing two-way preferences on only part of the trade, e.g. the Latin American free trade area started in 1960.
FTA	Free trade areas (FTA), providing two-way preferences and eliminating tariffs on a substantial part of the trade, e.g. NAFTA.
CU	Customs Unions (CU), which are FTAs with common external tariffs, e.g. Mercosur, Türkiye-EU.
CM	Common markets (CM) such as the European Union, which allows freer movement of capital and labour to a CU.
EUN	Economic Unions (EU), which are CM with monetary and fiscal policy coordination such as the Economic and Monetary Union of Central Africa (1999) and Eurozone countries.

Source:
https://datacatalog.worldbank.org/dataset/wits-global-preferential-trade-agreement-database.

Table 3. Descriptive statistics.

	Mean	SD	Min	Max	Observations
FGVCP	4.208	2.255	0.002	10.07	18,060
BGVCP	3.79	2.168	0.001	10.393	18,060
RNTA	0.117	0.321	0	1	18,060
FTA	0.134	0.341	0	1	18,060
CCE	0.435	0.496	0	1	18,060

Note. The forward and backward GVC participation (i.e., FGVCP and BGVCP) variables are logarithm of the bilateral value-added trade in manufacturing. TA, FTA and CCE are dummy variables.

Table 4. The effect of TAs on bilateral GVC participation.

	FGVCP	*BGVCP*
	(1)	(2)
*TA * TIME*	0.0756***	0.0653**
	(0.0263)	(0.0260)
Constant	4.166***	3.753***
	(0.0148)	(0.0146)
Export-time FE	YES	YES
Import-time FE	YES	YES
Country-pair FE	YES	YES
Observations	18,060	18,060
R-squared	0.988	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors. There is multicollinearity between the first-order dummy variable and the fixed-effects term, so it is omitted in the regression results.

The DID estimation also involves testing for the parallel trend. Therefore, we estimate Equation (2) to investigate the dynamic effects of TAs. The 9th and earlier years ($n = -5$) before signing a TA are used as the control group (*before* 5), and two years are viewed as a time interval, so the value range of n in Equation (2) is [−5, 5]. As shown in Table 5, when $n = -2$ and −1, the coefficients of both *Before*2 and *Before*1 are statistically insignificant, implying that before signing TAs, the differences in both forward and backward GVC participation of the group with TAs and the group with no TAs are statistically insignificant. Thus, the assumption of parallel trends cannot be rejected. When $n = 1, 2$, the coefficients of both *After*1 and *After*2 are positive and statistically significant, implying that after signing TAs, the group with TAs experiences a higher growth in

Table 5. The dynamic effects of TAs on bilateral GVC participation.

	FGVCP	BGVCP
	(1)	(2)
Before4	0.0373	−0.0984
	(0.0871)	(0.0677)
Before3	−0.0523	−0.0237
	(0.0450)	(0.0452)
Before2	−0.0136	−0.0343
	(0.0367)	(0.0405)
Before1	0.0481	0.0347
	(0.0347)	(0.0375)
After1	0.0753**	0.0789***
	(0.0295)	(0.0302)
After2	0.0569**	0.0828***
	(0.0248)	(0.0262)
After3	0.00445	0.0481**
	(0.0212)	(0.0200)
After4	0.00290	0.0457***
	(0.0148)	(0.0149)
After5	0.0209	0.00576
	(0.0127)	(0.0137)
Constant	7.917***	7.723***
	(0.00529)	(0.00506)
Export-time FE	YES	YES
Import-time FE	YES	YES
Country-pair FE	YES	YES
Observations	18,060	18,060
R-squared	0.992	0.991

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors.

GVC participation than the group with no TAs. In addition, the estimated coefficients continuously decrease after After1, indicating that the effect of TAs on GVC participation diminishes over time.

The results of the parallel trend test, which exhibit the dynamic effects of TAs on bilateral GVC participation are also shown in Figure 1.
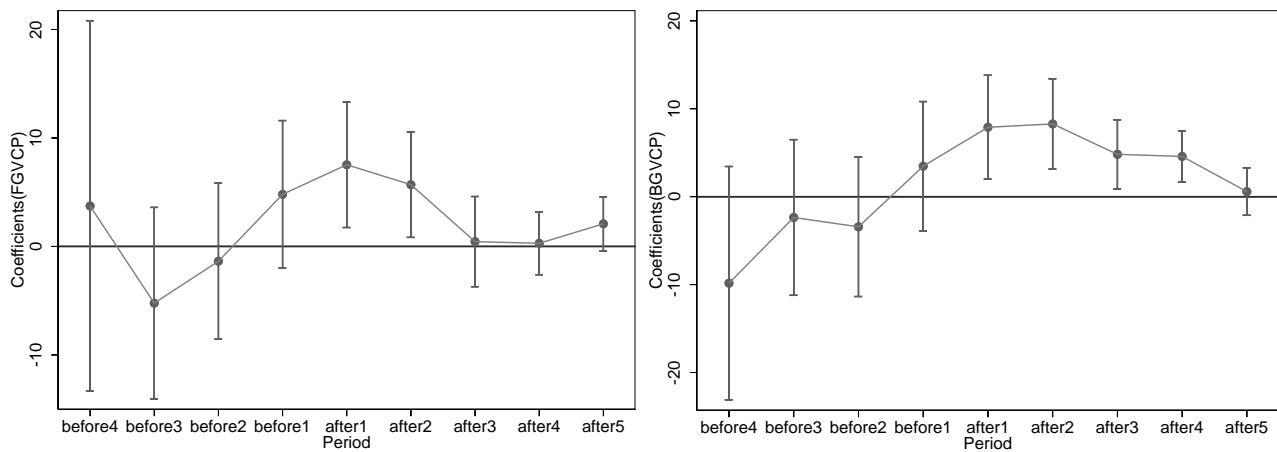
Figure 1. The dynamic effects of TAson bilateral GVC participation.

To investigate the heterogeneous effects of TAs on bilateral GVC participation of members at different levels of economic development, based on World Bank's standards, we first select 20 countries developed countries[4], and divide TAs into four groups: North-North (N-N), South-North (S-N), North-South (N-S), and South-South (S-S)[5]. We then estimate the impact of TAs on GVC participation of member countries across the four TA groups. As shown in Table 6, the estimated coefficient of the interaction term is positive and statistically significant only in the case of N-S and S-N. This implies that only the TAs signed between the developed and developing countries can significantly promote bilateral GVC participation of the member countries, which supports hypothesis H1. This follows from the fact that significant comparative advantage differences in the production of intermediates between developed and developing countries exist and thus Tas are more likely to have a positive effect on bilateral GVC participation of developed and developing countries.

As far as the forward GVC participation results are concerned, the estimated coefficient of the interaction term in the case of N-S is higher than that of S-N. However, in the case of the backward GVC participation estimation, the estimated coefficient of the interaction term for S-N is higher than that of N-S. This implies that TAs signed between developed and developing countries involve higher level forward GVC participation from developed member countries than developing member countries. However, the backward GVC participation effect for developed member countries is smaller than for developing countries, which is consistent with hypothesis H2. This result follows from the fact that developed countries are mainly involved in upstream production stages where value-added

[4]The developed countries in the sample include Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, United Kingdom, Ireland, Japan, Korea, Luxembourg, Netherlands, Norway, Portugal, Sweden, United States.

[5]North are developed countries, whereas South represents developing counters. N-N means that developed countries are both exporters and importers, S-N means that developing countries are the exporters and developed countries are importers, N-S means that developed countries are the exporters and developing countries are importers, and S-S means that both exporters and importers are developing countries.

Table 6. The heterogeneous effects of TAs on bilateral GVC participation.

	FGVCP	BGVCP
	(1)	(2)
TA * TIME * N-N	−0.0324	0.00910
	(0.0364)	(0.0337)
TA * TIME * N-S	0.206***	0.141***
	(0.0382)	(0.0367)
TA * TIME * S-N	0.163***	0.175***
	(0.0436)	(0.0443)
TA * TIME * S-S	−0.0291	−0.0604
	(0.0461)	(0.0452)
Constant	4.163***	3.752***
	(0.0149)	(0.0147)
Export-time FE	YES	YES
Import-time FE	YES	YES
Country-pair FE	YES	YES
Observations	18,060	18,060
R-squared	0.988	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors.

is higher, and thus TAs can result in a stronger positive effect on forward GVC participation of developed countries. Developing countries are mainly engaged in downstream processing trade with low value-added and hence TAs can have a stronger positive effect on the backward GVC participation of developing countries.

We now turn our attention to whether the heterogeneous effects of TAs on bilateral GVC participation of member countries vary across the depth of TAs. We classify all TAs into RNTA, FTA and CCE, and re-estimate our model for each of the three TA groups. Estimation results are presented in Table 7, where in the case of the RNTA group, the heterogeneous effect on both forward and backward GVC participation is statistically insignificant at the 10% level. However, in the case of FTA and CCE groups, the heterogeneous effects on both forward and backward GVC participation remain statistically significant. This suggests that the heterogeneous effect of TAs on bilateral GVC participation is positively associated with depth of trade agreements. Specifically, compared to a shallow TA, a deep TA is more likely to have a higher forward GVC participation effect on developed member countries than developing countries. At the

Table 7. The heterogeneous effects of TAs and the depth of TAs.

Variables	FGVCP			BGVCP		
	RNTA	FTA	CCE	RNTA	FTA	CCE
	(1)	(2)	(3)	(4)	(5)	(6)
TA * TIME * N-N		0.000893			0.0225	
		(0.0368)			(0.0344)	
TA * TIME * N-S	−0.000218	0.230***	0.229***	−0.0462	0.163***	0.192***
	(0.141)	(0.0555)	(0.0605)	(0.146)	(0.0520)	(0.0567)
TA * TIME * S-N	−0.124	0.213***	0.319***	−0.118	0.201***	0.365***
	(0.121)	(0.0601)	(0.0739)	(0.151)	(0.0692)	(0.0745)
TA * TIME * S-S	−0.0496	−0.159	0.0988*	−0.108*	−0.245***	0.137**
	(0.0517)	(0.136)	(0.0561)	(0.0591)	(0.0929)	(0.0561)
Constant	4.303***	4.186***	4.135***	3.917***	3.803***	3.712***
	(0.0174)	(0.0118)	(0.0167)	(0.0212)	(0.00936)	(0.0168)
Export-time FE	YES	YES	YES	YES	YES	YES
Import-time FE	YES	YES	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES	YES	YES
Observations	7776	10,196	18,060	7776	10,196	18,060
R-squared	0.987	0.986	0.988	0.986	0.986	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors. Due to the multicollinearity between TA * TIME * N-N and Country-Pairs in the regression of the RNTA and CCE groups, the estimation results for TA * TIME * N-N are omitted.

same time, the backward GVC participation effect for developed member countries is smaller than for developing member countries. This result supports our hypothesis H3.

6. Robustness Checks

In this section, we present the results of robustness tests. First, although high-dimensional fixed-effects are controlled in Section 5, we examine whether our results are affected by omitted variables bias. Baldwin & Venables (2013), bilateral investment agreements (BIT) have a significant effect on GVC participation of the member countries. Therefore, we re-estimate the heterogeneous impact of TAs on bilateral GVC participation by including BIT as an additional explanatory variable. The results are presented in Table 9 and Table 10. As can be seen in Table 8, the estimated coefficient of the interaction term is positive and statistically significant only in the case of N-S and S-N. Moreover, the forward

Table 8. The heterogeneous effects of TAs (Controlling for bilateral investment agreements (BITs)).

	FGVCP	BGVCP
	(1)	(2)
TA * TIME * N-N	−0.0312	0.00980
	(0.0364)	(0.0337)
TA * TIME * N-S	0.206***	0.141***
	(0.0382)	(0.0367)
TA * TIME * S-N	0.164***	0.175***
	(0.0436)	(0.0444)
TA * TIME * S-S	−0.0294	−0.0606
	(0.0461)	(0.0452)
BIT	−0.0640	−0.0390
	(0.0586)	(0.0523)
Constant	4.182***	3.763***
	(0.0228)	(0.0215)
Export-time FE	YES	YES
Import-time FE	YES	YES
Country-pair FE	YES	YES
Observations	18,060	18,060
R-squared	0.988	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors.

GVC participation effect in the case of N-S is higher than that for S-N. But the backward GVC participation effect in the case of N-S is smaller than that for S-N. In Table 9, the heterogeneous effect of TAs on bilateral GVC participation is statistically significant only for deeper TA groups, such as the FTAs and CCEs. These results are qualitatively similar to those presented in Section 5 implying the absence of omitted variable bias and thus robustness of our earlier results.

Second, geographical distance plays an important role in bilateral trade flows. In Section 5, a dummy variable was used to capture this effect. However, if the impact of geographical distance cost changes over time, it may affect the estimation results presented in Section 5 (Bergstrand et al., 2015). To control for the time-varying geographical distance cost effect, the interaction of distance (*Dist*) with years is included as additional explanatory variables. The estimated regression results are shown in Table 10 and Table 11. After controlling for the

Table 9. The heterogeneous effect of TAs and the depth of TAs (Controlling for bilateral investment agreements (BITs)).

Variables	FGVCP			BGVCP		
	RNTA	FTA	CCE	RNTA	FTA	CCE
	(1)	(2)	(3)	(4)	(5)	(6)
TA * TIME * N-N	-	0.00329	-	-	0.0242	-
		(0.0368)			(0.0344)	
TA * TIME * N-S	−0.00141	0.230***	0.230***	−0.0468	0.163***	0.193***
	(0.140)	(0.0555)	(0.0605)	(0.146)	(0.0520)	(0.0567)
TA * TIME * S-N	−0.124	0.213***	0.320***	−0.119	0.202***	0.366***
	(0.121)	(0.0602)	(0.0739)	(0.151)	(0.0692)	(0.0745)
TA * TIME * S-S	−0.0516	−0.164	0.0996*	−0.109*	−0.249***	0.138**
	(0.0517)	(0.136)	(0.0561)	(0.0591)	(0.0929)	(0.0561)
BIT	−0.112	−0.0823	−0.0676	−0.0541	−0.0592	−0.0418
	(0.0714)	(0.0610)	(0.0586)	(0.0655)	(0.0556)	(0.0524)
Constant	4.334***	4.212***	4.155***	3.932***	3.822***	3.724***
	(0.0262)	(0.0225)	(0.0242)	(0.0276)	(0.0199)	(0.0229)
Export-time FE	YES	YES	YES	YES	YES	YES
Import-time FE	YES	YES	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES	YES	YES
Observations	7776	10,196	18,060	7776	10,196	18,060
R-squared	0.987	0.986	0.988	0.986	0.986	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors. Due to multicollinearity between TA * TIME * N-N and Country-Pairs in the regression of the RNTA and CCE groups, the estimation results for TA * TIME * N-N are omitted.

Table 10. The heterogeneous effects of TAs (time-varying effects of distance).

	FGVCP	BGVCP
	(1)	(2)
TA * TIME * N-N	−0.0343	0.00786
	(0.0369)	(0.0342)
TA * TIME * N-S	0.208***	0.144***
	(0.0384)	(0.0368)
TA * TIME * S-N	0.165***	0.178***
	(0.0437)	(0.0444)

Continued

*TA * TIME * S-S*	−0.0260	−0.0569
	(0.0466)	(0.0455)
*Dist * 2006*	−3.12e−06	−7.65e−06*
	(4.03e−06)	(3.98e−06)
*Dist * 2007*	−2.58e−06	−6.70e−06*
	(3.93e−06)	(3.99e−06)
*Dist * 2008*	−9.04e−07	−6.01e−06
	(3.87e−06)	(3.97e−06)
*Dist * 2009*	1.69e−06	1.57e−06
	(3.82e−06)	(3.82e−06)
*Dist * 2010*	−5.01e−07	−1.45e−06
	(3.82e−06)	(3.79e−06)
*Dist * 2011*	−1.97e−06	−4.00e−06
	(3.88e−06)	(3.96e−06)
*Dist * 2012*	3.12e−07	−3.71e−06
	(3.72e−06)	(3.80e−06)
*Dist * 2013*	1.09e−06	−1.21e−06
	(4.24e−06)	(4.27e−06)
*Dist * 2014*	3.38e−06	1.46e−06
	(4.35e−06)	(4.40e−06)
Constant	4.164***	3.765***
	(0.0216)	(0.0213)
Export-time FE	YES	YES
Import-time FE	YES	YES
Country-pair FE	YES	YES
Observations	18,060	18,060
R-squared	0.988	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors.

time-varying geographic distance cost, the estimation results are qualitatively similar to those presented in Table 6 and Table 7, which indicates that the heterogeneous effect of TAs on GVC participation is not affected by the time-varying geographical distance cost between member countries.

Table 11. The heterogeneous effect of TAs and the depth of TAs (time-varying effects of distance).

Variables	FGVCP			BGVCP		
	RNTA	FTA	CCE	RNTA	FTA	CCE
	(1)	(2)	(3)	(4)	(5)	(6)
TA * TIME* N-N	-	−0.00726	-	-	0.0147	-
		(0.0371)			(0.0346)	
TA * TIME* N-S	0.00198	0.234***	0.231***	−0.0434	0.167***	0.194***
	(0.142)	(0.0553)	(0.0606)	(0.149)	(0.0519)	(0.0567)
TA * TIME* S-N	−0.123	0.217***	0.320***	−0.117	0.206***	0.367***
	(0.121)	(0.0600)	(0.0740)	(0.151)	(0.0689)	(0.0745)
TA * TIME* S-S	−0.0507	−0.150	0.102*	−0.110*	−0.238**	0.141**
	(0.0514)	(0.137)	(0.0563)	(0.0590)	(0.0941)	(0.0563)
BIT	−0.112	−0.0823	−0.0676	−0.0541	−0.0592	−0.0418
	(0.0714)	(0.0610)	(0.0586)	(0.0655)	(0.0556)	(0.0524)
Dist * 2006	6.53e−07	−4.80e−06	−3.15e−06	−5.63e−06	−9.61e−06**	−7.64e−06*
	(5.70e−06)	(4.90e−06)	(4.06e−06)	(5.52e−06)	(4.69e−06)	(4.00e−06)
Dist * 2007	5.89e−07	−1.07e−06	−1.85e−06	−5.53e−07	−3.05e−06	−5.50e−06
	(5.67e−06)	(4.85e−06)	(3.93e−06)	(5.70e−06)	(4.88e−06)	(4.00e−06)
Dist * 2008	8.86e−06	2.00e−06	−6.02e−07	2.86e−06	−3.54e−06	−5.18e−06
	(5.70e−06)	(4.72e−06)	(3.84e−06)	(5.60e−06)	(4.76e−06)	(3.99e−06)
Dist * 2009	7.06e−06	3.32e−06	1.96e−06	5.93e−06	1.73e−06	2.41e−06
	(5.40e−06)	(4.54e−06)	(3.84e−06)	(5.44e−06)	(4.52e−06)	(3.85e−06)
Dist * 2010	6.04e−06	3.49e−06	−1.57e−06	5.79e−06	1.73e−06	−1.71e−06
	(5.68e−06)	(4.69e−06)	(3.76e−06)	(5.57e−06)	(4.48e−06)	(3.77e−06)
Dist * 2011	5.19e−06	3.51e−06	−2.42e−06	2.44e−06	−7.82e−08	−3.45e−06
	(5.88e−06)	(4.71e−06)	(3.85e−06)	(5.91e−06)	(4.70e−06)	(3.94e−06)
Dist * 2012	8.25e−06	7.04e−06	−1.30e−07	2.60e−06	1.22e−06	−3.17e−06
	(5.73e−06)	(4.69e−06)	(3.69e−06)	(5.80e−06)	(4.66e−06)	(3.79e−06)
Dist * 2013	8.92e−06	6.08e−06	7.43e−07	8.00e−06	4.05e−06	−5.93e−07
	(6.94e−06)	(5.29e−06)	(4.24e−06)	(7.11e−06)	(5.28e−06)	(4.26e−06)
Dist * 2014	−2.55e−06	3.90e−06	3.23e−06	−5.88e−07	2.95e−06	2.15e−06
	(7.25e−06)	(5.29e−06)	(4.33e−06)	(7.58e−06)	(5.39e−06)	(4.39e−06)
Constant	4.266***	4.167***	4.137***	3.899***	3.806***	3.722***
	(0.0396)	(0.0316)	(0.0221)	(0.0410)	(0.0293)	(0.0228)
Export-time FE	YES	YES	YES	YES	YES	YES
Import-time FE	YES	YES	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES	YES	YES
Observations	7776	10,196	18,060	7776	10,196	18,060
R-squared	0.987	0.986	0.988	0.986	0.986	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors. Due to the multicollinearity between TA * TIME * N-N and Country-Pairs in the regression of the RNTA and CCE groups, the estimation results for TA * TIME * N-N are omitted.

Third, in Section 5, robust standard errors were used. To check whether Section 5 estimation results are influenced by the potential heteroscedasticity problem, we re-estimate the heterogeneous effect of TAs on bilateral GVC participation using clustered standard errors. The estimation results are presented in Table 12 and Table 13, where the use of clustered standard errors leads to a small decrease in significance level of the heterogeneous effect, but the estimated results remain qualitatively similar to those presented in Section 5 (where robust standard errors were used). Specifically, the impact of TAs on bilateral GVC participation is heterogeneous between member countries and this effect is positively associated with the depth of TAs. Thus, it can be argued that the estimated heterogeneous effect of TAs on bilateral GVC participation is not significantly influenced by heteroscedasticity problem.

Fourth, while the descriptive statistics presented in Table 3 do not shows any obvious outliers in our sample, to ensure that our results are not driven by the presence of outliers, the heterogeneous effect of TAs on bilateral GVC participation was re-estimated after excluding all dependent variable observations with residuals greater than two standard deviations (SD) from the sample. The estimation results, as shown in Table 14 and Table 15, remain highly consistent

Table 12. The heterogeneous effects of TAs (clustered standard errors).

	FGVCP	BGVCP
	(1)	(2)
TA * TIME * N-N	−0.0324	0.00910
	(0.0549)	(0.0487)
TA * TIME * N-S	0.206***	0.141**
	(0.0616)	(0.0585)
TA * TIME * S-N	0.163**	0.175**
	(0.0701)	(0.0714)
TA * TIME * S-S	−0.0291	−0.0604
	(0.0651)	(0.0627)
Constant	4.163***	3.752***
	(0.0215)	(0.0213)
Export-time FE	YES	YES
Import-time FE	YES	YES
Country-pair FE	YES	YES
Observations	18,060	18,060
R-squared	0.988	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors.

Table 13. The heterogeneous effects of TAs and the depth of TAs (clustered standard errors).

Variables	FGVCP			BGVCP		
	RNTA	FTA	CCE	RNTA	FTA	CCE
	(1)	(2)	(3)	(4)	(5)	(6)
TA * TIME * N-N		0.000893			0.0225	
		(0.0607)			(0.0530)	
TA * TIME * N-S	−0.000218	0.230**	0.229***	−0.0462	0.163**	0.192**
	(0.257)	(0.0902)	(0.0854)	(0.291)	(0.0810)	(0.0803)
TA * TIME * S-N	−0.124	0.213*	0.319***	−0.118	0.201	0.365***
	(0.159)	(0.116)	(0.103)	(0.215)	(0.137)	(0.103)
TA * TIME * S-S	−0.0496	−0.159	0.0988	−0.108	−0.245**	0.137*
	(0.0800)	(0.199)	(0.0770)	(0.0862)	(0.124)	(0.0766)
Constant	4.303***	4.186***	4.135***	3.917***	3.803***	3.712***
	(0.0231)	(0.0175)	(0.0229)	(0.0299)	(0.0141)	(0.0231)
Export-time FE	YES	YES	YES	YES	YES	YES
Import-time FE	YES	YES	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES	YES	YES
Observations	7776	10,196	18,060	7776	10,196	18,060
R-squared	0.987	0.986	0.988	0.986	0.986	0.988

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors. Due to the multicollinearity between TA * TIME * N-N and Country-Pairs in the regression of the RNTA and CCE groups, the estimation results for TA * TIME * N-N are omitted.

Table 14. The heterogeneous effects of TAs (outliers removed).

	FGVCP	BGVCP
	(1)	(2)
TA * TIME * N-N	−0.0382	0.00200
	(0.0385)	(0.0360)
TA * TIME * N-S	0.202***	0.134***
	(0.0388)	(0.0377)
TA * TIME * S-N	0.154***	0.169***
	(0.0444)	(0.0448)
TA * TIME * S-S	−0.0310	−0.0638
	(0.0463)	(0.0454)

Continued

Constant	4.032***	3.599***
	(0.0155)	(0.0153)
Export-time FE	YES	YES
Import-time FE	YES	YES
Country-pair FE	YES	YES
Observations	17,573	17,486
R-squared	0.987	0.986

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors.

Table 15. The heterogeneous effects of TAs and the depth of TAs (outliers removed).

Variables	FGVCP			BGVCP		
	RNTA	FTA	CCE	RNTA	FTA	CCE
	(1)	(2)	(3)	(4)	(5)	(6)
TA * TIME * N-N	-	−0.00621	-	-	0.0233	-
		(0.0389)			(0.0361)	
TA * TIME * N-S	−0.00888	0.220***	0.230***	−0.0551	0.167***	0.194***
	(0.146)	(0.0568)	(0.0607)	(0.149)	(0.0527)	(0.0569)
TA * TIME * S-N	−0.125	0.191***	0.320***	−0.117	0.183***	0.368***
	(0.121)	(0.0616)	(0.0740)	(0.152)	(0.0702)	(0.0745)
TA * TIME * S-S	−0.0538	−0.163	0.101*	−0.0953	−0.252***	0.141**
	(0.0596)	(0.136)	(0.0562)	(0.0686)	(0.0927)	(0.0561)
Constant	4.176***	4.059***	4.000***	3.803***	3.685***	3.587***
	(0.0179)	(0.0122)	(0.0170)	(0.0219)	(0.00963)	(0.0171)
Export-time FE	YES	YES	YES	YES	YES	YES
Import-time FE	YES	YES	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES	YES	YES
Observations	7574	9932	17,573	7574	9932	17,573
R-squared	0.985	0.984	0.987	0.985	0.985	0.986

Note. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses underneath the estimated coefficients are the corresponding robust standard errors. Due to the multicollinearity between TA * TIME * N-N and Country-Pairs in the regression of the RNTA and CCE groups, the estimation results for TA * TIME * N-N are omitted.

with those presented in Section 5. Specifically, the heterogeneous effect of TAs on bilateral GVC participation is statistically significant and this effect positively related to the depth of TAs. Thus, it can be argued that our main conclusions on the heterogeneous effect of TAs are not affected by the presence of outliers in the sample[6].

7. Conclusion and Policy Implications

In line with the rapid development of trade agreements (TAs) and global value chains (GVCs), the relationship between TAs and GVC participation has captured the attention of researchers in recent years. Using data on 43 countries over the 2005-2014 period and employing difference-in-differences (DID) estimation methodology, this paper investigates the heterogeneous impacts of TAs on bilateral GVC participation of member countries.

Our analysis reveals that TAs generally promote bilateral forward and backward GVC participation of ember countries. TAs between developed and developing countries are more likely to have favourable impacts on bilateral forward and backward GVC participation. The impacts of TAs on bilateral GVC participation are heterogeneous between member countries. Specifically, the forward GVC participation effect of TAs on developed member countries is higher than the effect on developing member countries. But the backward GVC participation effect of TAs on developed member countries is smaller than the effect on developing member countries. Finally, the heterogeneous effects of TAs on bilateral GVC participation are stronger in the case of deep TAs.

Our findings have some important policy implications. First, in the current era of GVC-trade restructuring, formation of TAs can help improve bilateral GVC participation of member countries thereby increasing the efficiency of resources allocation in the production of intermediates. Second, developing and developed countries should try to establish TAs with each other as such agreements are more likely to promote bilateral GVC participation and make both developing and developed countries focus on the trade pattern that is consistent with their own comparative advantages. Finally, both developed and developing countries should focus on formation of deep TAs as such agreements have stronger effect on bilateral GVC participation.

8. Contributions

This paper makes three important contributions to the existing literature. First, by exploring the heterogeneous effect of TAs on bilateral forward and backward GVC participation of member countries, this paper contributes to existing literature that deals with heterogeneous effects of TAs on bilateral GVC participa-

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[6]Since the sample period ranges from 2005 to 2014, the estimation results may be impacted by the global financial crisis (GFC). Therefore, we excluded the 2007 and 2008 data from our sample. The estimation results, not presented here to conserve space, are qualitatively similar to the benchmark regression results, implying that our main results are not influenced by GFC.

tion. Few existing studies have paid attention to this issue. Second, this paper investigates how the heterogeneous effect of TAs on bilateral GVC participation varies across the depth of TAs. Thus, our work contributes to the literature that deals with the impact of the depth of TAs on GVC-trade. Third, unlike most existing studies where ordinary least squares (OLS) is used, to deal with the issue of self-selection associated with TAs, we use DID estimation technique. This allows us to provide more reliable estimates of the effects of TAs on bilateral GVC participation.

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Conflicts of Interest

The authors declare no conflicts of interest.

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