Non-tariff Measures and the Global Value Chain Participation

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***Abstract*—Trade barriers remain high despite the large reductions in tariffs. Recent literature focuses on technical regulations such as Non-tariff measures (NTMs) to explain the additional burdens for exporters. We construct the Bilateral Regulatory Distance (BIRD) to measure the different patterns of NTMs between the exporting and importing countries to examine the impact of NTMs on the backward and forward participation in global value chains (GVCs). To control for zero-value observations and heteroskedasticity, we employ Poisson pseudo maximum likelihood (PPML) estimation. The regression results indicate that overall, the disharmony of NTMs hamper backward participation in GVCs, whereas it positively affects forward participation in GVCs, regardless of the sectors. Both exporters and importers have fewer incentives to export or import intermediate goods at the prices resulting from the higher fixed costs derived by additional NTMs. On the other hand, firms export more domestic goods as inputs of the downstream process to compensate for the additional fixed costs imposed by the foreign market. Moreover, NTMs may induce more domestic value-added goods production and exports, as they can reduce transaction costs when appropriately harmonized over the long-term. Therefore, harmonization of NTMs is suggested, rather than the mere eradication of NTMs. As NTMs serve as a tool to ensure the safety of consumers and contribute to the larger flow of forward participation in GVCs, governments need to focus on the harmonization of NTMs via international standards.**

***Index Terms*—Bilateral regulatory distance, global value chains, non-tariff measures, Poisson pseudo maximum likelihood.**

I. Introduction

Despite the large reductions in tariffs, trade barriers remain high. While past studies showed that non-technical regulations designed to protect domestic industry explicitly sabotage international trade, recent literature focuses on the impact of technical regulations, such as Non-tariff measures (NTMs). Unlike Non-tariff barriers (NTBs), NTMs often involve measures intended to protect consumers and ensure the safety of the environment; they often involve Sanitary and Phytosanitary (SPS) measures and Technical Barriers to Trade (TBT). For example, NTMs can restrict the addition of chemical substances to food, prevent infestation, and can even specify production methods. NTMs can induce more trade, as particular regulations can enhance the quality of goods traded and reduce transaction costs when appropriately harmonized. Reference [1] utilized trade data of Organization for Economic Cooperation and Development (OECD) countries and NTMs data from United Nations Conference on Trade and Development (UNCTAD) - Trade Analysis Information System (TRAINS) in 2004 to show that technical measures enhance international trade in the agriculture sector. The imposition of NTMs often stimulates import demand and hampers export supply, if import demand exceeds the export supply restriction effect. References [2] and [3] also partly confirm the positive relationship between NTMs and international trade flows. Reference [4] employed both the inventory approach and regression analysis to examine the impact of SPS and TBT on international trade flows. They used the World Trade Organization (WTO) Integrated Trade Intelligence Portal (I-TIP) database to construct the coverage ratio and frequency index of imposed NTMs. They showed that NTMs positively affect tuna fish exports from Indonesia. However, a considerable amount of the past literature focuses on the negative impact of NTMs on international trade, despite their original purposes [5]-[7]. Reference [8] is skeptical that NTMs achieve welfare improvement and even treats them as pure trade barriers.

The negative impact of NTMs on international trade is particularly critical in the current fragmented world. The current international trade trend is exemplified by the fragmentation of production, where global value chains (GVCs) play a significant role. Countries involved in international trade inevitably participate in the GVCs framework, whether they import inputs to engage in exports (the backward GVC participation) or export domestic goods as inputs of the downstream process (the forward GVC participation). Prior studies used the forward and backward vertical specialization index, or GVC participation index, to measure the position of various industries in the GVCs [9], [10]. References [11] and [12] built upon the pre-existing literature on estimating GVCs by suggesting the average position of an industry in GVC participation indices using Input-Output Tables. Reference [13] employed concepts such as *governance* and *upgrading* to highlight the importance of GVCs framework in the globalized world. However, not many pieces of research dealt with the relationship between NTMs and GVC participation.

The purpose of this research is to answer two questions. First, do NTMs hamper or enhance forward and backward participation in GVCs? On the one hand, NTMs may hamper GVC participation as they act as obstacles to international trade. Different cross-border regulations can sabotage the flow of inputs and threaten the fragmentation of the production process. On the other hand, NTMs can reduce transaction costs by compelling production of higher quality goods.

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Second, does the impact of NTMs differ across sectors? We disaggregated the total sample using the manufacturing, machinery, and agriculture sectors to examine whether NTMs have different impacts across those sectors. We constructed Bilateral Regulatory Distance (hereafter, BIRD) by modifying the regulatory distance suggested by [14] to capture bilateral differences in regulatory patterns between two countries. Furthermore, we employ the Poisson pseudo maximum likelihood (PPML) estimation suggested by [15] to adjust for possible heteroskedasticity. The empirical results show that, overall, NTMs negatively affect the backward participation in GVCs and positively affect the forward participation in GVCs, regardless of the sectors. Both exporters and importers have fewer incentives to export or import intermediate goods at the prices resulting from the higher fixed costs derived by additional NTMs. On the other hand, when firms engage in an activity such as exporting domestic goods as inputs of a downstream process, they export more to gain profits from the higher fixed costs derived from the different patterns of NTMs. Furthermore, NTMs may induce more production and exports of domestic value-added goods, as they can reduce transaction costs when appropriately harmonized in the long-term. Therefore, we highly discourage the mere eradication of NTMs.

The rest of this research is as follows: In Section II, we describe related literature on the relationship between NTMs and GVC participation. We then present the data and methodology of our research in Sections III and IIII, respectively. We conclude our research in Sections V and VI with the regression results and policy implications.

II. Literature Review

A. Past Research

Quantification of NTMs has always been an obstacle due to the lack of systematically recorded data. Reference [16] (p. 18) illustrates that the quantification of NTMs is difficult because numerical variables hardly capture the welfare effect of NTMs. Nonetheless, past research strived to quantify NTMs. References [17] and [18] suggest a series of quantification methods. The inventory approach, such as coverage ratio and frequency index, is often used to measure the trade restrictiveness index of NTMs. It captures the percentage of goods traded that are subject to NTMs and the percentage of NTMs applied products. Reference [19] also utilized a frequency index and a coverage ratio to show that countries with higher Most Favored Nations (MFN) tariffs impose larger NTMs, albeit with a descriptive and preliminary data analysis. The results indicate that both the coverage ratio and frequency index fluctuate largely across countries, sectors, and types of NTMs. However, the research lacks information on the bilateral imposition of NTMs for each good which captures the disharmony or additional requirement of NTMs for each reporter and counterparty.

Some of the literature adopts Ad Valorem Equivalents (AVEs) as a proxy for NTMs, either by a quantity- or price-based approach [20]-[22]. Reference [20] utilizes NTMs data of 65 countries from the World Integrated Trade Solution (WITS), and estimates the price-based average AVEs for NTMs, namely SPS and TBT measures. It examined the relationship between the deep regional integration clauses from each Regional Trade Agreement (RTA) and the effect of NTMs on the unit value. The results indicate that deep regional integration clauses incur lower compliance costs and reduce the price-increasing effect of NTMs. On the other hand, [21] and [22] adopted a quantity-based approach by estimating Trade Restrictiveness Indices (TRIs) using the UNCTAD-TRAINS database. The results indicate that countries with more technical regulations face larger trade discrepancies. Moreover, poor countries had relatively more technical restrictions compared to rich countries [22]. However, past literature on the impact of NTMs overlooked the disharmony of NTMs for exporters and importers: Exporters might not need to comply with the NTMs of importing countries that the domestic markets of those countries face.

While the research on the relationship between tariffs and GVC participation has been prevalent, only a handful of the past literature evaluated the impact of NTMs on GVC participation. Reference [23] extracted data from the OECD Trade in Value Added (TiVA) database to construct GVC participation to evaluate the impact of tariffs on the backward and forward participation in GVCs. The results indicate that tariffs negatively impact both the backward and forward participation in GVCs, but had a greater impact on the backward participation. That is, tariffs distorted the imports of foreign value-added more than the exports of domestic value-added. Reference [24] theoretically and empirically shows that input tariffs negatively affect vertical integrations. Reference [25] adopts a quantity-based approach using AVEs as a proxy for NTMs. It further constructs backward linkages on trade using the World Input-Output Database (WIOD), and shows a mixed impact of NTMs on GVCs.

Recently, [14] developed the regulatory distance to measure the dissimilarity in NTMs imposition between importers and exporters. The regulatory distance captures disharmony of regulations that exporters and importers are facing or the additional regulations that exporters need to comply with before exporting, which is effective in examining the difference in trade policies. We further modify the model by using bilateral NTMs imposition data from UNCTAD TRAINS to construct BIRD to examine the impact of NTMs on GVC participation.

Reference [26] constructs the regulatory distance following [14] using data compiled from the International Trade Centre (ITC) to show the negative impact of NTMs on the participation in GVCs. Only a few kinds of research examine the relationship between NTMs and fragmented production processes. Reference [27] constructed an Additional Compliance Requirements Indicator (ACRI) following [28] to evaluate the effect of NTMs on the backward and forward participation in GVCs using cross-section NTMs data from UNCTAD-TRAINS via a gravity framework. The results indicate that NTMs negatively affect the backward GVC participation with statistical significance, but have no statistically significant effects on forward GVC participation.

B. Theoretical Approach

NTMs are often treated as fixed costs. As exporters need to comply with technical regulations related to consumer and

environment safety prior to participating in the foreign market, the past literature focused on the fixed costs aspects of NTMs [29]. The adoption of fixed costs in the international trade literature implies for exporters the existence of a threshold when deciding whether to participate in the foreign market. As fixed costs increase, low-productive firms will withdraw from the foreign market and serve their domestic market only, while high-productive firms will remain in the foreign market [30]. However, the impact of fixed costs on total trade varies by market; firms may export more to compensate for the increased fixed costs (the intensive margin of international trade). On the other hand, product diversification within the sector may decrease as the foreign market imposes higher fixed costs (the extensive margin of international trade) [31]. Reference [32] shows empirically the positive linkage between fixed costs and the intensive margin of international trade.

The backward and forward participation in GVCs may possess both extensive and intensive margins characteristics. Both foreign value-added and domestic value-added as inputs of downstream process can initiate or strengthen relationships with new trading partners (the extensive margin of international trade) and incumbent trading partners (the intensive margin of international trade). Reference [33] (p. 3), defines GVC participation as "as a production process that embodies value-added from at least two countries." The usage of the inventory approaches or the AVEs approach may not appropriately calculate the bilateral or multilateral aspects of international trade. Hence, we contribute to the international trade literature by following the framework of [26] and [27] with panel NTMs data from UNCTAD TRAINS and constructing BIRD with the information from [14]. We estimate the bilateral disharmony arising from different impositions of NTMs, in order to evaluate the relationship between fixed costs and GVC participation.

III. Data

We adopted the recently released NTMs data from UNCTAD-TRAINS. The database is constructed jointly among UNCTAD, regional think tanks, and universities; the raw data for the Association of Southeast Asian Nations (ASEAN) are from the Economic Research Institute for ASEAN and East Asia (ERIA). The database contains NTMs data derived from all technical regulations of 92 reporters at the reporter-partner-product-year-MAST combinations. *Product* refers to HS six-digit codes, and *MAST* refers to the Multi-Agency Support Team classification on NTMs [34]. The current data follow MAST-4 classification, which is the 2019 version. Although the explicitly reported period for the database is 2010-2018, we employ the start-date disclosed by UNCTAD-TRAINS to supplement the panel, which is highly unbalanced due to large observation loss from missing years. According to [35] (p. 11), *start-date* refers to the *Year of implementation of the NTMs.* With the inclusion of the *start-date*, we constructed panel data for the period 2005-2018. To comply with GVC participation data, we concorded NTMs data to International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 3 nomenclature, using a product concordance table from the WITS.

As [36] describes, the technical measures imply chapters A, B, and C of the MAST-4 classification: SPS, TBT, and pre-shipment inspection, respectively. We focus on chapters A, B, and C of the MAST-4 classification because we are interested in technical regulations that were initially intended to protect consumers and the safety of the environment. Hence, in this research we interchangeably use NTMs, technical regulations, and technical measures to describe NTMs.

Furthermore, chapters E and F indicate hard measures that explicitly restrict international trade [36]. They include import quotas, tariff-rate quotas, and even price-control measures for imported goods. Therefore, we construct a hard measure dummy using chapters E and F to compare the effect on the GVC participation with those of NTMs. Table I describes the classification of NTMs.

TABLE I: The Classification of NTMs

Measures on Imports	A	Sanitary and Phytosanitary Measures
	B	Technical Barriers to Trade
	C	Pre-shipment Inspection and Other Formalities
	D	Contingent Trade-Protective Measures
	E	Restrictions Other Than SPS and TBT
	F	Price-Control Measures
	G	Financial Measures
	H	Measures Affecting Competition
	I	Trade-Related Investment Measures
	J	Distribution Restrictions
	K	Restrictions on Post-Sales Services
	L	Subsidies and Other Forms of Support
	M	Government Procurement Restrictions
	N	Intellectual Property
	O	Rules of Origin
Measures on Exports	P	Export-Related Measures

Source: See [36] for more details.

When constructing BIRD following [14], we exclude A110 and A120 of the MAST-4 classification, representing prohibitions for SPS and geographical restrictions, respectively. As they explicitly prohibit and restrict international trade flows, we exclude them to examine the impact of NTMs exclusively. Furthermore, we expanded the group observation reported by UNCTAD-TRAINS; e.g., when the observation for MAST-4 classification shows *A*, we expanded the observation with all sub-groups of chapter A. Table II describes the four-digit NTMs classification employed in this research; one-digit alphabetical letter followed by three-digit numbers.

TABLE II: Four-Digit NTMs Classification

NTMs Chapters	Four-digit Classification
A	A130 A140 A150 A190 A210 A220 A310 A320 A330 A410 A420 A490 A510 A520 A530 A590 A610 A620 A630 A640 A690 A810 A820 A830 A840 A851 A852 A853 A859 A860 A890 A900
B	B140 B150 B190 B210 B220 B310 B320 B330 B410 B420 B490 B600 B700 B810 B820 B830 B840 B851 B852 B853 B859 B890 B900
C	C100 C200 C300 C400 C900

Source: For information on each three-digit classification, see [36].

For the backward and forward GVC participation data, we

extracted the foreign value-added content of gross exports and the domestic value-added content of gross exports from OECD Inter-Country Input-Output (ICIO) tables at the reporter-partner-year-sector level. The data include 65 reporters, including the European Union (EU) as a whole and the world as a whole from 2005 to 2016. *Sector* refers to the two-digit level ISIC Rev. 3 nomenclature. We aggregate the reported value of GVC participation using the total sample, manufacturing, machinery, and agriculture sectors using the following classification: manufacturing sector as 10 to 33, machinery as 28, and agriculture as 01 to 03 of the two-digit level ISIC Rev. 3. The foreign and domestic value-added content of gross exports was reported as current millions USD.

To comport with the samples of NTMs data, we dropped South Africa (ZAF), Iceland (ISL), and Norway (NOR), and arrived at 60 sample countries; we dropped EU and World as a whole as well. Moreover, as the sector-level foreign and domestic value-added content of gross exports reported no observations in 2016, we dropped observations for that year. Therefore, our total sample includes 60 sample countries for the period 2005-2015. Table III identifies the 60 sample countries of our research.

TABLE III: THE TOTAL SAMPLE COUNTRIES

ISO3	ARG AUS AUT BEL BGR BRA BRN CAN CHE CHL CHN COL CRI CYP CZE DEU DNK ESP EST FIN FRA GBR GRC HKG HRV HUN IDN IND IRL ISR ITA JPN KAZ KHM KOR LTU LUX LVA MAR MEX MLT MYS NLD NZL PER PHL POL PRT ROU RUS SAU SGP SVK SVN SWE THA TUN TUR USA VNM

Source: Author's calculation.

Note: ISO3 refers to the three-digit International Organization for Standardization (ISO). See United Nations Country Code for detailed information. https://unstats.un.org/unsd/tradekb/knowledgebase/country-code

As control variables, we included a Free Trade Agreement (FTA) dummy, gross domestic product (GDP) per capita of both importers and exporters, and distance. We extract FTA information from the WTO RTA database, current million USD GDP per capita data from World Development Indicators (WDI), and population-weighted distance information from Research and Expertise on the World Economy (CEPII) [37].

IV. METHODOLOGY

In this section, we construct variables for NTMs and GVC participation. We then present empirical equations for the regressions. First, we construct the BIRD that captures bilateral differences in the imposition of NTMs between exporters and importers. We construct bilateral dummy variable as

$$n_{ijpct} = \begin{cases} 1 \\ 0 \end{cases} \quad (1)$$

where i refers to reporters, j refers to partners, p to the four-digit ISIC Rev.3 product, c to NTMs classification, and t to time. Reporters are importers, and partners are exporters. n_{ijpct} reports one if an importer applies NTMs to a specific product in a specific year for a specific exporter. Otherwise, n_{ijpct} reports zero.

We further construct a dummy variable that indicates the NTMs that exporting countries implement as

$$m_{jipct} = \begin{cases} 1 \\ 0 \end{cases} \quad (2)$$

where m_{jipct} reports one if an exporter j imposes NTMs to a product p at a time t for an importer i. Reference [14] focused on the imposition of NTMs by the total exporters or importers; n_{ipct} and m_{jpct}. We modify the existence of technical regulations as (1) and (2) to consider the bilateral impositions of technical regulations between the exporters and importers.

We then follow the methodology suggested by [14] to construct sector-level regulatory distance as

$$BIRD_{ijst} = \frac{1}{N_s}\sum_s \sum_c \left| n_{ijpct} - m_{jipct} \right| \quad (3)$$

where we take the absolute value of the subtraction between (1) and (2) to determine whether exporters and importers impose identical NTMs on their counterparts, described as $\left| n_{ijpct} - m_{jipct} \right|$. When either the exporter or the importer imposes NTMs, $\left| n_{ijpct} - m_{jipct} \right|$ will have a value of one. We then aggregate $\left| n_{ijpct} - m_{jipct} \right|$ using NTMs classification chapters c and sectors s, where s incorporates the total sample, manufacturing, machinery, and agriculture sectors. We then divide the aggregated value with the combination of four-digit NTMs classification and 4-digit ISIC Rev. 3 products; N_s refers to 25,140, 11,340, 960, 2,280 for the total sample, manufacturing sector, machinery sector, and agriculture sector, respectively. $BIRD_{ijst}$ represents the bilateral regulatory distance between the exporters and importers at time t for each sector. Compared to the absolute number of imposed NTMs reported by the importers and exporters by [14], $BIRD_{ijst}$ captures the bilateral difference of NTMs patterns between the exporters and importers, further implying the additional burden that exporters need to comply with before entering the foreign market. $BIRD_{ijst}$ lies between zero and one; it is especially close to zero as we divide the aggregated value of $\left| n_{ijpct} - m_{jipct} \right|$ by the total combination of NTMs and products of each sector.

Next, we construct the backward and forward GVC participation using the OECD ICIO table. The backward GVC participation refers to the foreign value-added share of gross exports, and the forward GVC participation indicates the domestic value-added share of gross exports.

$$Backward_{ijst} = (FVA_{ijst}/EX_{ijst}) \times 100 \quad (4)$$

$$Forward_{ijst} = (DVA_{ijst}/EX_{ijst}) \times 100 \quad (5)$$

FVA_{ijst} refers to the foreign value-added content of the total exports in the sector s by the reporting country i from the partner country j at the time t. DVA_{ijst} refers to the domestic value-added content of the total exports. EX_{ijst} refers to the total exports. $Backward_{ijst}$ and $Forward_{ijst}$ refer to the backward and forward GVC participation reported in percentages.

Equations (6) and (7) refer to the empirical model of our research. We conduct the PPML estimation to adjust for heteroskedasticity. According to [15], the PPML estimator is practical and effective in adjusting for possible

heteroskedasticity. Although our dependent variables do not possess any zero observations, where the PPML estimator is also effective in adjusting for a large number of zero observations of the dependent variable, we employ PPML estimation to adjust for heteroskedasticity; by its very nature, international trade analysis inevitably possesses heteroskedasticity.

$$Backward_{ijst} = a_0 + a_1 BIRD_{ijst} + a_2 Hard_{ijst} + a_3 FTA_{ijt} + a_4 lnDistance_{ij} + a_5 lnGDPPC_{it} + a_6 lnGDPPC_{jt} + \sigma_{ij} + \mu_{ijt} \quad (6)$$

$$Forward_{ijst} = a_0 + a_1 BIRD_{ijst} + a_2 Hard_{ijst} + a_3 FTA_{ijt} + a_4 lnDistance_{ij} + a_5 lnGDPPC_{it} + a_6 lnGDPPC_{jt} + \sigma_{ij} + \mu_{ijt} \quad (7)$$

We use the raw value of backward and forward GVC participation as the dependent variable of our regression models. $Hard_{ijst}$ refers to the hard dummy. The variable reports one when exporter-importer-sector-year observations have either of the NTMs chapters E and F; we drop observations with E300 as it is the import prohibitions for other reasons. FTA_{ijt} is the FTA dummy and $lnDistance_{ij}$ is the natural logarithm of the distance between an exporter and importer. $lnGDPPC_{it}$ and $lnGDPPC_{jt}$ refer to the natural logarithm of the per capita GDP of the exporters and importers, respectively. σ_{ij} and μ_{ijt} are time-invariant and time-variant error terms.

Tables IIII-VI show summary statistics of the total, manufacturing, machinery, and agriculture sectors. All reported variables are raw values. Backward and Forward indicate backward GVC participation and forward GVC participation. BIRD is the bilateral regulatory distance. We do not find any large correlation among the variables. We will provide the correlation matrix upon request.

TABLE IV: SUMMARY STATISTICS (TOTAL SECTOR)

VARIABLES	N	Mean	SD	Min	Max
Backward	35,456	9.780	4.352	1.009	29.51
Forward	35,456	78.22	9.456	35.48	134.6
BIRD	35,456	0.0351	0.0220	0	0.0798
Hard measure	35,456	0.885	0.319	0	1
FTA	35,456	0.374	0.484	0	1
Distance	35,456	7,517	4,913	134.6	19,645
GDPPC (*i*)	35,456	0.0244	0.0212	0.000471	0.119
GDPPC (*j*)	35,456	0.0244	0.0212	0.000471	0.119

TABLE V: SUMMARY STATISTICS (MANUFACTURING SECTOR)

VARIABLES	N	Mean	SD	Min	Max
Backward	35,456	12.74	4.823	2.593	49.70
Forward	35,456	71.83	10.21	25.14	96.11
BIRD	35,456	0.0604	0.0385	0	0.141
Hard measure	35,456	0.885	0.319	0	1
FTA	35,456	0.374	0.484	0	1
Distance	35,456	7,517	4,913	134.6	19,645
GDPPC (*i*)	35,456	0.0244	0.0212	0.000471	0.119
GDPPC (*j*)	35,456	0.0244	0.0212	0.000471	0.119

TABLE VI: SUMMARY STATISTICS (MACHINERY SECTOR)

VARIABLES	N	Mean	SD	Min	Max
Backward	33,507	13.86	6.670	3.389	67.60
Forward	33,507	71.05	11.84	11.48	94.92
BIRD	33,507	0.0267	0.0212	0	0.0667
Hard measure	33,507	0.679	0.467	0	1
FTA	33,507	0.381	0.486	0	1
Distance	33,507	7,510	4,934	134.6	19,645
GDPPC (*i*)	33,507	0.0245	0.0214	0.000471	0.119
GDPPC (*j*)	33,507	0.0246	0.0213	0.000471	0.119

TABLE VII: SUMMARY STATISTICS (AGRICULTURE SECTOR)

VARIABLES	N	Mean	SD	Min	Max
Backward	35,222	7.921	5.049	1.141	50
Forward	35,222	83.96	8.958	25	98.29
BIRD	35,222	0.0389	0.0212	0	0.0877
Hard measure	35,222	0.856	0.351	0	1
FTA	35,222	0.377	0.485	0	1
Distance	35,222	7,551	4,911	134.6	19,645
GDPPC (*i*)	35,222	0.0245	0.0212	0.000471	0.119
GDPPC (*j*)	35,222	0.0245	0.0212	0.000471	0.119

V. RESULT

Table VIII and Table IX describe the PPML results using the backward GVC participation and forward GVC participation as a dependent variable. BIRD refers to the bilateral regulatory distance, distance refers to the natural logarithm of the distance, and GDPPC refers to the natural logarithm of the GDP per capita. Log-likelihood indicates the pseudo log-likelihood ratio. All regression results control for country and year fixed effects.

TABLE VIII: PPML RESULTS ON THE BACKWARD GVC PARTICIPATION

	(1)	(2)	(3)	(4)
	Backward GVC Participation			
VARIABLES	Total	Manufacturing	Machinery	Agriculture
BIRD	-4.881***	-2.838***	-4.972***	-6.486***
	(0.131)	(0.064)	(0.147)	(0.192)
Hard Measure	-0.102***	0.017**	-0.073***	0.157***
	(0.009)	(0.007)	(0.006)	(0.011)
FTA	0.133***	0.111***	-0.051***	-0.074***
	(0.007)	(0.006)	(0.008)	(0.011)
Distance	0.133***	0.111***	-0.051***	-0.074***
	(0.007)	(0.006)	(0.008)	(0.011)
GDPPC (*i*)	-0.034***	-0.012***	-0.013***	-0.033***
	(0.004)	(0.003)	(0.004)	(0.005)
GDPPC (*j*)	-0.048***	-0.046***	-0.153***	0.160***
	(0.002)	(0.002)	(0.002)	(0.004)
Constant	-0.018	-0.046***	-0.068***	-0.014
	(0.018)	(0.015)	(0.018)	(0.026)
Country	YES	YES	YES	YES
Year	YES	YES	YES	YES

Observations	35,456	35,456	33,507	35,222
R-squared	0.182	0.218	0.276	0.172
log-likelihood	-99560	-101625	-106156	-103108

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

TABLE IX: PPML RESULTS ON THE FORWARD GVC PARTICIPATION

	(1)	(2)	(3)	(4)
	Forward GVC Participation			
VARIABLES	Total	Manufacturing	Machinery	Agriculture
BIRD	0.800***	0.482***	0.741***	0.676***
	(0.038)	(0.026)	(0.056)	(0.033)
Hard Measure	0.033***	0.006**	0.016***	-0.013***
	(0.002)	(0.003)	(0.002)	(0.002)
FTA	-0.039***	-0.053***	0.008***	0.002
	(0.002)	(0.003)	(0.003)	(0.002)
Distance	0.008***	0.004***	0.007***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
GDPPC (*i*)	0.016***	0.021***	0.043***	-0.026***
	(0.001)	(0.001)	(0.001)	(0.001)
GDPPC (*j*)	-0.006	0.002	-0.011	-0.004
	(0.005)	(0.006)	(0.007)	(0.004)
Constant	4.280***	4.331***	4.332***	4.223***
	(0.037)	(0.044)	(0.057)	(0.033)
Country	YES	YES	YES	YES
Year	YES	YES	YES	YES
Observations	35,456	35,456	33,507	35,222
R-squared	0.100	0.094	0.104	0.134
log-likelihood	-128709	-132310	-134673	-126134

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

As shown in Table VIII, the disharmony of NTMs hampers backward participation in GVCs. BIRD, which captures the bilateral differences of NTMs imposition by each country, negatively affects all backward GVC participation sectors with statistical significance. As shown in Table III, the mean value of the total BIRD is 0.035, which indicates the average number of NTMs imposed on the total products traded is 880; 0.035 * 25,140, where 25,140 refers to the combinations of the total number of NTMs and four-digit ISIC Rev. 3, described in Section IV. If we assume the total BIRD to increase by the mean value over the year, approximately 0.17% of the backward GVC participation decreases for the total sample; (880/25,140) * (-4.881). Likewise, the average growth of BIRD decreases the backward GVC participation in the manufacturing, machinery, and agriculture sectors by 0.17%, 0.13%, and 0.25%, respectively. On the other hand, as shown in Table IX, the average growth of BIRD increases the forward GVC participation in the total, manufacturing, machinery, and agriculture sectors by 0.03%, 0.03%, 0.02%, and 0.03%, respectively. As GVC participation indicates the share of value-added content of gross exports, the seemingly small percentages shown above cannot be ignored.

The negative coefficients of BIRD on the backward participation in GVCs may indicate the following: First, the regulatory distance negatively affects the foreign value-added share of gross exports, regardless of the sector. In line with [27], additional regulations raise the fixed costs of exporting firms seeking to enter the foreign market. Hence, exporting firms will have fewer incentives to establish further vertical multinational integration in the importing market. Second, as the fixed costs for the exporting firms increase, at the same time, the price of imported intermediate goods will increase. Domestic firms will have fewer incentives to import costly intermediate goods, which hamper innovation upgrading and impose a trade-distorting effect; the data for this research captures the bilateral relationship between exporters and importers. Therefore, countries imposing different patterns of NTMs may experience less participation in the backward GVCs.

On the other hand, the disharmony of NTMs positively affects all sectors of the forward GVC participation, with statistical significance. When exporting domestically produced goods as part of their partners' downstream production stages, reporting firms need to follow technical regulations imposed by the partners. As [30] and [38] discussed, less productive firms will exit the foreign market as fixed costs increase; the additional burden of NTMs and distance can both acts as fixed costs. Although less productive firms exit from the market, more productive firms will continue to export domestically produced inputs to the foreign market and absorb the market shares of those that left the foreign market. With less competition, productive firms may export more goods to their partners. As described in [31], firms increase the amount of goods traded when fixed costs increase (the intensive margin of international trade). To gain profits from increased fixed costs, exporting firms need to sell more to the foreign market. Likewise, the additional burden of NTMs and distance increase fixed costs, and the remaining productive firms increase their share of domestically produced inputs, which eventually increases the forward participation in GVCs.

Furthermore, hard measure dummy and FTA showed mixed results. Hard measure dummy negatively affects the total sample of backward GVC participation, whereas it positively affects the total sample of forward participation in GVCs. Whether or not its explicit purpose is to restrict international trade, the hard measure seems to coincide with NTMs and fixed costs. However, the hard measure dummy showed opposite results in the agriculture sector. When firms need to sell a finished goods to the foreign market, explicit restrictions on international trade increase agricultural exports. The phenomenon reflects the high protection imposed on the agriculture sector. For example, Japan is famous for its high protection in the agriculture sector, including export subsidies. Explicit trade barriers may be a determinant when choosing destinations; as indicated by the negative coefficient of hard measure dummy on the forward participation in GVCs. However, the hard measure may be ignored once firms choose their destinations, as high explicit trade barriers may also mean higher export subsidies.

We also show that the FTA dummy no longer strictly shows a positive relationship with international trade variables, as it shows opposite results between Tables VII and VIII. As tariffs decrease, firms engage more in the participation in backward GVCs, and less in the forward

GVCs in the manufacturing sector (excluding machinery goods), similar to the impact of BIRD. However, in the machinery sector, the FTA relationship decreases the backward participation in GVCs and increases the forward participation in GVCs. With FTA or RTA initiation, firms export domestically produced goods as inputs of the downstream process in other countries (the forward GVC participation). However, as the FTA relationship increases, the destination to sell final goods may increase, incurring a trade-distorting effect (the backward GVC participation); machinery goods that can be conveniently diversified may show such results. Furthermore, in the agriculture sector, the FTA dummy only shows a statistically significant result in Table IX. As some countries impose high protection for agricultural goods even with FTAs and RTAs ratification, FTA dummy shows no significant result for choosing a destination for the exports of domestically produced goods (the forward GVC participation). Although the rate of tariff liberalization for agriculture sector may be relatively lower than the of machinery sector, firms nevertheless check for the markets with the lowest tariff rates when selling the final goods. As more FTAs and RTAs ratify, the agriculture sector experience trade-diversion effect; the spaghetti bowl effect.

VI. Conclusion

In this research, we examined the impact of NTMs on backward and forward participation in GVCs. By modifying the regulatory distance suggested by [14], we constructed the BIRD that captures the bilateral difference of NTMs patterns between two countries. The disharmony of NTMs patterns between exporters and importers negatively affects the backward GVC participation and positively affects the forward GVC participation.

Our research has some shortcomings that future research needs to consider. First is the lack of data for explaining the NTMs data. Although the recent publication of the NTMs database by UNCTAD-TRAINS includes panel data, the magnitude of the NTMs is still ambiguous. For example, NTMs classification A140 may be harder to comply with for exporters, compared to A150. With the current NTMs database, capturing such qualitative information may be difficult. Second, future research needs to consider the extensive and intensive margins of international trade incorporating with the participation in GVCs. As shown in Section V, the relationship between fixed costs and international trade varies by the number of products traded (the extensive margin of international trade) and the trade value of incumbent goods (the intensive margin of international trade). By incorporating the two margins of international trade, the literature can examine the impact fixed costs portion of NTMs.

Nonetheless, this research contributes to the international trade literature by examining the impact of NTMs on the current fragmented production process. Unlike most research on NTMs, the results of this research present both the negative and positive impacts of NTMs on international trade and GVC participation. NTMs may hamper international trade by imposing additional burdens on exporters but, at the same time, contribute to international trade by upgrading quality and lowering transaction costs once measures are harmonized. Therefore, each government needs to harmonize NTMs using international standards. Mere eradication of NTMs may deteriorate the quality of imported goods and simultaneously increase the transaction costs by imposing different compliance costs.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Kunhyui Kim conducted all the research and analysis on the data.

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