economies

IMPACT FACTOR 2.1

CITESCORE 4.0

Article

# The Role of Comparative Advantage in Enhancing Trade in Value-Added Using a Dynamic GMM Model

Josephine Wuri

MDPI

https://doi.org/10.3390/economies12070187 *economies*

*Article*

# The Role of Comparative Advantage in Enhancing Trade in Value-Added Using a Dynamic GMM Model

**Josephine Wuri**

Department of Economics, Faculty of Economics, Sanata Dharma University, Yogyakarta 55281, Indonesia; josephine@usd.ac.id

**Abstract:** Currently, international trade has evolved into international production fragmentation captured in GVCs. Countries must enhance intermediate exports in comparative advantage sectors to increase their trade in value-added (TVA) in global production chains. However, traditional measurements of revealed comparative advantage (RCA) based on gross exports need to be updated due to overvaluation, double counting, and implicit distortions in international trade. This study uses a new comparative advantage measure, "new revealed symmetric comparative advantage" (NRSCA). Using a dynamic General Method of Moment (GMM) approach, we investigate the role of comparative advantage in driving TVA regarding backward and forward linkages and examine the impact of the COVID-19 pandemic. We use data from the current Asian Development Bank multi-regional input–output database for 2010–2020. Our findings reveal that comparative advantage significantly impacted international TVA, along with the support of quality institutional services in each country. Implementing a new comparative advantage measure, NRSCA, provided accurate estimation results to overcome the overvaluation problem. Moreover, the COVID-19 pandemic disrupted value-added trade.

**Keywords:** comparative advantage; trade in value added; dynamic GMM model; multi-regional input output; pandemic



**Citation:** Wuri, Josephine. 2024. The Role of Comparative Advantage in Enhancing Trade in Value-Added Using a Dynamic GMM Model. *Economies* 12: 187. https://doi.org/10.3390/economies12070187

Academic Editor: Bruce Morley

Received: 9 June 2024
Revised: 14 July 2024
Accepted: 16 July 2024
Published: 18 July 2024



## 1. Introduction

In the new international trade theory, international trade has developed into trade in value-added (TVA) and is included in global value chains (GVCs). International fragmentation in the production of goods has enabled each country to specialize in producing high-value-added goods (Amendolagine et al. 2019; Fan et al. 2023; Hummels et al. 2001; Inomata 2013; Johnson and Noguera 2017). Furthermore, the opportunities for GVC participation have attracted foreign investment and allowed for profit-sharing and economic, technological, and industrial upgrading (Gereffi et al. 2005; González and Kowalski 2017; Prete et al. 2018; Zhang 2024), thus enabling developing countries to catch up with developed nations.

The participation of countries in GVCs is measured by decomposing gross exports to trace domestic value added (DVA) and foreign contributions (Z. Wang et al. 2018). Backward- and forward-linked approaches are used to determine the level of countries' participation in TVA, which traces the value added in each production phase (Asian Development Bank 2019; Koopman et al. 2014; Prete et al. 2018; Z. Wang et al. 2018; Wuri et al. 2023).

Involvement in GVC facilitates the emergence of new global competitors and has challenged the trade dominance of developed countries. Consequently, concerns over competitiveness have been researched in recent years.

Each country needs to enhance its comparative advantage to increase participation in GVCs. Understanding comparative advantages enables countries to optimize resource allocation and focus on industries with significant potential for enhancing value-added.

This promotes sustainable economic growth, reinforces economic integration, and enhances global competitiveness in international trade (Elsalih et al. 2021; Laursen 2015). Balassa (1965) introduced revealed comparative advantage (RCA), which ranked product-specific specialization in cross-country trade. A country has a comparative advantage in a specific sector if the share of that sector in its total exports exceeds its share of total world exports (Ito et al. 2017). Most countries continue to rely on traditional measures of comparative advantage, which remains a critical issue for policymakers and academics.

However, the traditional RCA (TRCA) measure based on gross exports does not accurately reflect countries' comparative advantage, as the calculation includes foreign resource components (Johnson and Noguera 2017). Furthermore, trade measurements can become overvalued and develop implicit distortions (Asian Development Bank 2019; Athukorala and Yamashita 2006; Inomata 2013; Koopman et al. 2014).

To address the gap in current research, this study developed a new comparative advantage measure, NRSCA. The symmetric calculation was based on DVA and excluded foreign value-added (FVA) and pure double-counted terms in gross exports to obtain an accurate measure of a country's comparative advantage. The NRSCA encourages TVA using high-quality institutions as control variables such as government effectiveness and control of corruption. Therefore, countries with high-quality institutions can ensure efficiency and fair contracts, reduce corruption, reduce environmental degradation, promote policy coordination and trade, and ultimately stimulate economic growth (Fan et al. 2023; Gereffi et al. 2005; Mouanda and Gong 2019; Q. Wang et al. 2024; Zergawu et al. 2020).

The pandemic disrupted trade intensity among countries due to border closures and quarantine-related restrictions (Baldwin and Mauro 2020; Vidya and Prabheesh 2020). Globally imposed restrictions continue to cause supply chain losses. We further estimated the role of the comparative advantage in driving value-added trade by considering institutional, time-invariant variables that can differ by country because of heterogeneity among them (Faheem Ur et al. 2024; Zergawu et al. 2020). Additionally, we use a new comparative advantage measure to overcome problems with traditional measures. The model was utilized to investigate the impact of the COVID-19 pandemic on TVA. We employed a dynamic GMM approach to address this issue and to overcome potential endogeneity problems. The dynamic GMM technique offers the advantage of evaluating dynamic adjustment observations, which are valuable for measuring the dynamics of adjustment between countries concerning TVA. To this end, this study used data from the current Asian Development Bank multi-regional input–output (ADB MRIO) to trace the interconnected value added among countries from 2010 to 2020, which was a challenge to obtain. This aspect enriches the growing body of research on the role of comparative advantage in international production fragmentation.

The remainder of this article is structured as follows: a literature review is introduced in Section 2. Data and Methodology is explained in detail in Section 3, while the empirical results and analysis are presented in Section 4. The final section concludes with significant findings and policy recommendations.

## 2. Literature Review

The analysis of TVA has been widely discussed since the development of the new international trade theory, which traces the distribution of value added in international trade (Athukorala and Yamashita 2006; Borin and Mancini 2019; Johnson and Noguera 2012; Koopman et al. 2014; Z. Wang et al. 2018). Currently, countries do not need to proceed with the accepted production stages. Instead, they can specialize in a specific production stage (Amendolagine et al. 2019; Inomata 2013; Prete et al. 2018). GVCs occur when the various stages of the production chain for goods and services, from the product design to the distribution of goods to final consumers, are produced and assembled through the networking of various countries, across international borders (Hummels et al. 2001; Inomata 2013; Prete et al. 2018).

The participation of countries in value-added trade is measured through the decomposition of exports. This approach identifies domestic and foreign value-added shares embedded in intermediate exports (Asian Development Bank 2019; Ceglowski 2017; Johnson and Noguera 2012; Z. Wang et al. 2018; Wuri et al. 2022). However, few studies have simultaneously performed both analyses. Our study employs both approaches to provide a more comprehensive analysis.

Furthermore, a country's international trade performance depends on its dynamic comparative advantage (Burlina and Di Maria 2020). Therefore, nations worldwide can increase their participation in value-added trade by specializing in products with a comparative advantage (Ito et al. 2017). Traditional methods of measuring comparative advantage based on gross exports are outdated due to an inability to track value added and mitigate the overvaluation problem (Athukorala and Yamashita 2006; Koopman et al. 2014; Timmer et al. 2013). A more precise method for calculating the value-added contribution and distribution of intermediate export goods is critical, as goods may cross national borders several times, thus leading to several impositions of tariffs and transportation costs (Asian Development Bank 2019; Athukorala and Yamashita 2006; Koopman et al. 2014).

The new revealed comparative advantage measure precisely reflects the comparative advantage of domestic resources by excluding foreign resources to address the overvaluation issue (Asian Development Bank 2019; Athukorala and Yamashita 2006; Koopman et al. 2014; Leromain and Orifice 2014; Marcato et al. 2019; Shuai et al. 2022; Song et al. 2021). Furthermore, given the ever-increasing trade in intermediates, this methodology supports the argument that comparative advantage measures should focus more on forward-linked value-added indicators to measure RCA. It is because the use of value-added RCA provides more information regarding the working of a real economy than the gross value of RCA (Brakman and Van Marrewijk 2017; Burlina and Di Maria 2020; Ceglowski 2017; Liu et al. 2020; Song et al. 2021; Z. Wang et al. 2018). We incorporated this measure of value-added RCA as a symmetrical measure, which will henceforth be referred to as the "new revealed symmetric comparative advantage" (NRSCA). It is essential to adjust the symmetrical measure to be compared on both sides of unity.

COVID-19 has placed an enormous strain on the global public health system and economy and weakened the trade sectors of most countries (Hayakawa and Mukunoki 2021; Qin et al. 2020). ASEAN countries experienced a 0.83% decrease in forward GVC participation due to the social restriction policies implemented to mitigate the spread of the virus. China experienced a 13.54% decrease in forward participation. As China is a global manufacturing hub, this severely disrupted supply chains across the world (Baldwin and Mauro 2020; Chen and Chen 2022). Similarly, the average GVC participation in the European Union (EU) and North American countries also decreased (Wuri et al. 2022).

Larger international trade volumes are associated with better institutions, commonly found in developed countries. According to Levchenko (2007), disparities in institutional quality could be a source of comparative advantage and a crucial determinant of trade patterns. A country with high institutional quality can promote environmental quality in trade while avoiding negative consequences such as pollution and carbon emissions (Pata et al. 2023; Q. Wang et al. 2024). Therefore, this study defines two control variables based on institutional quality government effectiveness and control of corruption. A better institution contributes to less corruption and an improved regulatory environment.

## 3. Methodology

### *3.1. Data Description*

This study estimated the importance of comparative advantage in driving TVA using ADB's annual MRIO data, covering 35 industries in 62 countries and 132 countries classified as "rest of world" (ROW) for 2010–2020 (Asian Development Bank 2019). Furthermore, institutional variables were considered control variables (Kaufmann et al. 2010). This study focused on 41 countries that were members of several groups: ASEAN, East Asia, the EU, and North America (NA) (Appendix A, Table A1). This study will investigate

ASEAN inter- and intraregional value-added trade and provide in-depth insights into the dynamics of comparative advantages and value-added trade on a global level. The data were obtained from the ADB MRIO and World Bank World Governance Indicators. Multiregional Input-Output (MRIO) data were collected by the Asian Development Bank (ADB) by integrating various national and international data sources. ADB collects data from the national input–output (I-O) tables provided by each member country. These data are usually collected by national statistical agencies or economic ministries in those countries. ADB involves international collaboration, the integration of various data sources, and technologies for managing and analyzing MRIO data. The Asian Development Bank Multi-Regional Input–Output Database (ADB MRIO) covers 2010–2020. The year 2010 was chosen as a starting point since worldwide trade circumstances had begun to recover following the financial crisis. The details are presented in Table 1.

**Table 1.** Description of Variables and Sources of Data.

| Variables | Description | Measurement | Expectation | Source |
|---|---|---|---|---|
| BPR | Backward GVC participation ratio | Share of foreign value added (FVA) to total world exports (ratio) | - | Multi-Regional Input–Output (MRIO), computed by authors, 2010–2020 |
| FPR | Forward GVC participation ratio | Share of domestic value added (DVA) to total world exports (ratio) | - | MRIO, computed by authors, 2010–2020 |
| TVA | Trade in value added | FPR + BPR | - | MRIO, computed by authors, 2010–2020 |
| NRSCA | New revealed symmetric comparative advantage | Share of an economic sector's forward-linked measure of DVA in exports | Positive | MRIO, computed by authors, 2010–2020 |
| COVID | Coronavirus disease 19 pandemic | Dummy COVID-19 pandemic (1 = 2019–2020, 0 = otherwise) | Negative | - |
| GOV | Government effectiveness | Index lies between −2.5 and 2.5 | Positive | World Governance Indicators (WGI), 2010–2020 |
| CC | Control of corruption | Index lies between −2.5 and 2.5 | Positive | WGI, 2010–2020 |

We extended the basic input–output framework for a single economy by using the MRIO model to trace the relationships between countries and sectors (Asian Development Bank 2019; Leontief 1936). In addition, the input–output model is useful for understanding the impact of various government policies on specific industries and the economy as a whole (Kee and Tang 2016).

### *3.2. Measuring Trade in Value Added*

Each country's participation in TVA was measured by decomposition gross exports (Johnson and Noguera 2012; Leontief 1936; Z. Wang et al. 2018). The relationship between production and final demand is as follows:

$$X = (I - A)^{-1}Y \tag{1}$$

where $X$ and $Y$ are the vectors of gross output and final demand, respectively, provided by the economy sector and $I$ is an N × N identity matrix. $A$ is the N × N matrix of the input coefficient. We disaggregated each country's gross output by rearranging the final demands of both countries into a matrix format based on sources and destinations.

This decomposition is distinguished by the forward and backward linkages. The forward-linked perspective, or forward GVC participation ratio (FPR), measures the share of domestic value added (DVA) embedded in intermediate exports compared to total world exports. Conversely, the backward-linked perspective or backward GVC participation ratio (BPR) reveals the share of FVA used to produce a country's export goods compared to total world exports (Asian Development Bank 2015; Koopman et al. 2014; Z. Wang et al. 2018; Wuri et al. 2022). Furthermore, TVA was the sum of the BPR and FPR (Amendolagine et al. 2019; Ayadi et al. 2021; Prete et al. 2018).

### *3.3. Measuring Comparative Advantage*

To enhance TVA, countries worldwide should increase their intermediate exports in sectors where they have a comparative advantage. Z. Wang et al. (2018) proposed a new approach for measuring comparative advantage (NRCA), which is based on forward-linked DVA exports. DVA refers to the domestic value-added generated by the country's sector and is ultimately embodied in exports, regardless of the place of consumption of these exports (Asian Development Bank 2019; Ceglowski 2017). This new measure was analogous to the Balassa measure, except that it was based on DVA.

The NRCA index is the share of an economic sector's forward-linked measure of DVA in its exports. The $NRCA_{sk}$ of country $s$ in sector $k$ ($i$, $s$ = 1, 2, . . ., $G$; $k$ = 1, 2, $N$) is as follows (Asian Development Bank 2019; Burlina and Di Maria 2020; Liu et al. 2020; Z. Wang et al. 2018):

$$NRCA_{sk} = \frac{VAX\_G_{sk}}{\sum_{k=1}^{N} VAX\_G_{sn}} \Bigg/ \frac{\sum_{i=1}^{G} VAX\_G_{ik}}{\sum_{k=1}^{N}\sum_{i}^{G} VAX\_G_{in}} \tag{2}$$

The subscript $i$ refers to all countries except country $s$, and subscript $n$ is all sectors except sector $k$. $VAX\_G_{sk}$ is the DVA exports of country $s$ in sector $k$:

$$VAX\_G_{sk} = \sum_{k}\sum_{r} DVA\_FIN_{sr}^{k} + DVA\_INT_{sr}^{k} + DVA\_INTrex_{sr}^{k} \tag{3}$$

The $VAX\_G$ formula is presented in Table 2 (Liu et al. 2020; Z. Wang et al. 2018). The first category was DVA in final exports (*DVA_FIN*). The second category was DVA in intermediate exports used by direct importer $r$ to produce the final local products (*DVA_INT*). Summing up the third, fourth, and fifth categories yielded the DVA of economy $s$ in its intermediate exports used by the direct importer $r$ to produce exports and ultimately absorb other economies, except for the source economy $s$ (*DVA_INTrex*).

**Table 2.** The VAX_G Decomposition Equation.

| Category | Term | Description | Formula |
|---|---|---|---|
| DVA FIN | 1 | Domestic Value Added in final use commodity exports | $(V^{s}B^{ss})^{T}\#Y^{sr}$ |
| DVA_INT | 2 | DVA in intermediate exports utilized by direct importers to manufacture final local products. | $(V^{s}L^{ss})^{T}\#(A^{sr}B^{rr}Y^{rr})$ |
| DVA_INTrex | 3 | DVA in intermediate exports used by the direct importer to produce intermediate exports and consumed in other countries except for the source country s. | $(V^{s}L^{ss})^{T}\#\left(A^{sr}\sum_{t\neq s,r}^{G}B^{rt}Y^{tt}\right)$ |
| | 4 | DVA in intermediate exports utilized by the direct importer to produce final-use exports to other countries except for the source country s. | $(V^{s}L^{ss})^{T}\#\left(A^{sr}B^{rr}\sum_{t\neq s,r}^{G}Y^{rt}\right)$ |
| | 5 | DVA in intermediate exports utilized by the direct importer to produce intermediate exports to other countries except for the source country s. | $(V^{s}L^{ss})^{T}\#\left(A^{sr}\sum_{t\neq s,r}^{G}\sum_{u\neq s,t}^{G}B^{rt}Y^{tu}\right)$ |

Source: (Asian Development Bank 2015; Z. Wang et al. 2018).

In Table 2, $V^s$ represents the DVA in country $s$. $B^{ss}$ shows the inverse Leontief N × N matrix as the total requirement matrix representing the number of gross outputs needed by country $s$ to produce a unit of final demand increase in country $s$, $Y^{sr}$ is the N × 1 matrix of the final demand of country $r$ for the final products produced in country $s$, $L^{ss}$ illustrates the local Leontief inverse, and $A^{sr}$ is the N × N input–output matrix coefficient. Additionally, $X^s$ is the N × 1 matrix of the gross output of country $s$. The symbol # means an element-wise matrix multiplication operation (Z. Wang et al. 2018). Following Laursen (2015), we modified the NRCA index into a symmetrical index as follows:

$$NRSCA_{sk} = {}^{(NRCA_{sk}-1)}\Big/_{(NRCA_{sk}+1)} \tag{4}$$

The $NRSCA_{sk}$ (hereafter, NRSCA) index ranges from −1 to 1 (−1 ≤ NRSCA ≤ 1). An NRSCA greater than 0 indicates that country $s$ has comparative advantages in sector $k$. Conversely, an NRSCA of less than 0 suggests that country $s$ has comparative disadvantages in sector $k$.

### *3.4. Dynamic GMM Model Specification*

A dynamic panel technique was used to investigate the role of comparative advantage based on the DVA in driving the TVA. The application of the SYS-GMM model begins with identifying the study objectives. It then identifies the variables and panel data that will be utilized in the model spanning from 2000 to 2020. The next stage is to assess the stationary and analyze the SYS-GMM model to estimate the relationship between variables. The Hansen and Arellano–Bond tests assess instrument validity. Finally, these methods were employed as robustness validators to determine the consistency of the relationships between the variables of interest.

Dynamic panel data estimation investigates dynamically adjusted observations, controls for unobserved individual heterogeneity, provides more information and data volatility, and reduces the possibility of multicollinearity (Baltagi 2005; Wuri et al. 2022).

Arellano and Bond (1991) and Arellano and Bover (1995) developed a generalized method of moments (GMM) panel estimator for dynamic models. Dynamic panel characteristics are represented in the model by lag-dependent variables (Rahayu et al. 2024). If the lag of the dependent variable is correlated with the error term, the ordinary least square estimator is biased and inconsistent. Thus, the GMM approach was used to produce a consistent and unbiased estimator.

Within the GMM framework, econometric analysis uses two estimation techniques: the system GMM (SYS-GMM) and first-difference GMM (FD-GMM). Because of the limitations of the FD-GMM estimator, specifically, its weak instrument, the SYS-GMM analysis was used in this study. Therefore, the SYS-GMM estimator was developed to reduce bias and overcome this limitation (Baltagi 2005; Blundell and Bond 1998; Rahayu et al. 2024). The empirical research indicates that dynamic panel data estimation based on the SYS-GMM can address unobserved individual heterogeneity, omitted variable bias, and potential endogeneity. Therefore, the GMM approach can produce consistent and unbiased estimators (Wuri et al. 2022; Xu 2016). The dynamic panel assumes that the disturbance is independent and identically distributed (IID). (2) The problem of unobserved individual heterogeneity is almost always time-invariant. (3) Comparative advantage is characterized as dynamic due to supply and demand fluctuations in domestic and international markets. (4) No perfect collinearity. Perfect multicollinearity is not allowed among independent variables in a model. (5) Assumption of endogeneity. Internal instruments are used to solve this problem. (6) Assumption of valid instruments. The instrument must be valid, meaning it must correlate with an endogenous independent variable but not with error terms—the assumption of no second-order serial correlation. (7) Error terms must not have second-order autocorrelation. It is tested using the Arellano-Bond test to ensure that the instrument used does not correlate with past error terms (Baltagi 2005).

This estimator employed a lagged variable as an instrument, on the assumption that white noise errors would lose consistency if serially correlated. The following two specification tests determined the consistency of the SYS-GMM estimator: First, the Hansen test assessed the validity of an exogenous instrument by isolating over-identifying restrictions. In this test, the null hypothesis stated that the instrument was valid because there was no correlation with the error term. If the Hansen test rejected the null hypothesis, then the instrument and the error term were related, and the estimate was biased and inconsistent. Second, the AB test was a test for the presence of residual serial correlation. According to the null hypothesis, there is no second-order serial correlation or autocorrelation in idiosyncratic errors (Blundell and Bond 1998; Rahayu et al. 2024; Xu 2016). Therefore, based on the SYS-GMM model, the empirical model for analyzing the role of comparative advantage in TVA is as follows:
Model 1

$$FPR_{it} = \alpha + \sum_{j=1}^{p} \beta_j FPR_{i,t-j} + \sum_{j=1}^{p} \delta_j NRSCA_{i,t-j} + \omega COVID19_{it} + \tau_1 X_{it} + \mu_i + v_{it} \quad (5)$$

Model 2

$$BPR_{it} = \sigma + \sum_{j=1}^{p} \theta_j BPR_{i,t-j} + \sum_{j=1}^{p} \rho_j NRSCA_{i,t-j} + \epsilon COVID19_{it} + \tau_2 X_{it} + \mu_i + v_{it} \quad (6)$$

Model 3

$$TVA_{it} = \gamma + \sum_{j=1}^{p} \varphi_j TVA_{i,t-j} + \sum_{j=1}^{p} \varepsilon_j NRSCA_{i,t-j} + \vartheta COVID19_{it} + \tau_3 X_{it} + \mu_i + v_{it} \quad (7)$$

where subscripts $i$ and $t$ denote the country and time index, respectively; $\mu_i$ is an unobserved time-invariant; and $v_{it}$ represents idiosyncratic error. Variables $\mu_i$ and $v_{it}$ are assumed$\sim IID\left(0, \sigma_v^2\right)$. Moreover, $FPR_{it}$ is the forward GVC participation ratio of country $i$ during period $t$, $BPR_{it}$ is the backward GVC participation ratio, $TVA_{it}$ is the TVA, and $NRSCA_{it}$ is the new revealed symmetric comparative advantage. In the model, we considered the economic impact of the COVID-19 pandemic by including a dummy variable. $X_{it}$ is a set of control variables and $\tau$ denotes a column vector comprising the corresponding coefficients of these control variables. Our control variables were government effectiveness $(GOV_{it})$ and control of corruption $(CC_{it})$. The variables $\alpha$, $\sigma$, and $\gamma$ are constant, while $\beta, \delta, \omega, \tau, \theta, \rho, \epsilon, \varphi, \varepsilon$, and $\vartheta$ are the estimated coefficients. The study period spanned from 2010 to 2020. In addition, we examined the influence of the COVID-19 pandemic shock on the TVA model. Finally, these approaches were used as robustness validators to assess the consistency of the relationships between the variables of interest.

Before starting the empirical estimation, it was crucial to determine whether the variables of interest were stationary or not. We performed stationary analysis using the Augmented Dickey–Fuller (ADF) and Levin–Lin–Cu (LLC) tests proposed by Hao et al. (2015). This approach has been widely applied to avoid biased results for panel data with structural breaks and has attracted attention in international trade network analyses.

## 4. Empirical Results and Discussion

### *4.1. Summary Statistics*

Table 3 presents the descriptive statistical results for all variables. It reports the mean, standard deviation (SD), variance, maximum, and minimum of the variables of interest. Table 3 reveals the full sample and group countries. The full sample average for FPR was 0.420, with Malta (EU) having the lowest at 0.164 in 2013, and Brunei (ASEAN) having the highest in 2015 at 0.846. A standard deviation of 0.111 indicates minimal dispersion from the sample means. Similarly, the average sample value for BPR was 0.345 with a standard deviation of 0.128, thus indicating dispersion from the sample mean. The country with the lowest BPR of 0.077 was Brunei (ASEAN) in 2010, whereas Luxembourg (EU) showed the highest value of 0.726 in 2011. In addition, the country with the highest TVA was Bulgaria (EU) at 1.000 in 2011, whereas the lowest value of 0.431 was recorded for the

Philippines (ASEAN) in 2011. A standard deviation of 0.093 revealed that the countries were significantly dispersed from a sample average of 0.765.

**Table 3.** Descriptive statistics.

| Group | Variable | Obs | Mean | SD | Variance | Maximum | Minimum |
|---|---|---|---|---|---|---|---|
| Full Sample | FPR | 451 | 0.420 | 0.111 | 0.012 | 0.846 | 0.164 |
| | BPR | 451 | 0.345 | 0.128 | 0.016 | 0.726 | 0.077 |
| | TVA | 451 | 0.765 | 0.093 | 0.009 | 1.000 | 0.431 |
| | NRSCA | 451 | 0.114 | 0.206 | 0.042 | 0.654 | −0.824 |
| | GOV | 451 | 0.952 | 0.724 | 0.524 | 2.335 | −0.943 |
| | CC | 451 | 0.738 | 0.949 | 0.900 | 2.405 | −1.326 |
| ASEAN | FPR | 99 | 0.464 | 0.162 | 0.026 | 0.846 | 0.210 |
| | BPR | 99 | 0.286 | 0.128 | 0.016 | 0.563 | 0.077 |
| | TVA | 99 | 0.750 | 0.111 | 0.012 | 0.960 | 0.431 |
| | NRSCA | 99 | 0.132 | 0.155 | 0.024 | 0.654 | −0.095 |
| | GOV | 99 | 0.352 | 0.894 | 0.780 | 2.335 | −0.943 |
| | CC | 99 | −0.117 | 0.977 | 0.955 | 2.180 | −1.326 |
| East Asia | FPR | 33 | 0.432 | 0.047 | 0.002 | 0.522 | 0.347 |
| | BPR | 33 | 0.236 | 0.088 | 0.008 | 0.396 | 0.133 |
| | TVA | 33 | 0.669 | 0.077 | 0.006 | 0.818 | 0.532 |
| | NRSCA | 33 | −0.095 | 0.073 | 0.005 | 0.022 | −0.170 |
| | GOV | 33 | 1.041 | 0.582 | 0.339 | 1.822 | 0.004 |
| | CC | 33 | 0.592 | 0.791 | 0.626 | 1.695 | −0.562 |
| EU | FPR | 297 | 0.393 | 0.083 | 0.007 | 0.721 | 0.164 |
| | BPR | 297 | 0.388 | 0.110 | 0.012 | 0.726 | 0.162 |
| | TVA | 297 | 0.782 | 0.083 | 0.007 | 1.000 | 0.586 |
| | NRSCA | 297 | 0.135 | 0.223 | 0.050 | 0.608 | −0.824 |
| | GOV | 297 | 1.092 | 0.564 | 0.318 | 2.241 | −0.329 |
| | CC | 297 | 0.975 | 0.787 | 0.620 | 2.405 | −0.272 |
| NA | FPR | 22 | 0.562 | 0.039 | 0.002 | 0.702 | 0.508 |
| | BPR | 22 | 0.184 | 0.064 | 0.004 | 0.258 | 0.107 |
| | TVA | 22 | 0.746 | 0.055 | 0.003 | 0.861 | 0.678 |
| | NRSCA | 22 | 0.067 | 0.056 | 0.003 | 0.151 | −0.012 |
| | GOV | 22 | 1.629 | 0.147 | 0.022 | 1.854 | 1.319 |
| | CC | 22 | 1.600 | 0.313 | 0.098 | 2.070 | 1.069 |

Note: FPR, forward GVC participation ratio; BPR, backward GVC participation ratio; TVA, trade in value-added; NRSCA, new revealed symmetric comparative advantage; GOV, government effectiveness; CC, control of corruption; SD, standard deviation.

The average sample value for comparative advantage measured using NRSCA was 0.114, with the lowest value of −0.824 from Italy (EU) in 2018, whereas the highest value of 0.654 was recorded for Lao PDR (ASEAN) in 2019. Furthermore, the average NRSCA variance was 0.042. This value increased during the observation period, showing that countries competed worldwide to produce intermediate good exports by specializing in certain stages that provided high value added. The average values of government effectiveness and control of corruption are generally the highest in NA, while they are the lowest in ASEAN. Control of corruption has the lowest institutional score in ASEAN (−0.117), while NA has the highest (1.600).

### *4.2. Unit-Root-Test Result*

Table 4 presents the stationary test results obtained using ADF and LLC tests. We conducted the tests using Stata 17. The results indicate that the *p*-value for the unit root test was less than 5%, thus rejecting the null hypothesis (Ho) that all panels contained a unit root. Furthermore, the test results showed that each variable was a stationary sequence and allowed us to proceed with further analyses.

**Table 4.** Augmented Dicky–Fuller and Levin–Lin–Cu panel unit-root-test results.

| Variables | ADF Test | LLC Test |
|---|---|---|
| FPR | −7.9632 | −39.5926 |
| | (0.0000) | (0.0000) |
| BPR | −7.7441 | −39.2365 |
| | (0.0000) | (0.0000) |
| TVA | −9.6258 | −61.2305 |
| | (0.0000) | (0.0000) |
| NRSCA | −3.0311 | −2.4029 |
| | (0.0012) | (0.0081) |
| GOV | −7.3071 | −6.0623 |
| | (0.0000) | (0.0000) |
| CC | −2.4413 | −11.7025 |
| | (0.0073) | (0.0000) |

Note: ADF = augmented Dickey–Fuller; LLC = Levin–Lin–Cu; FPR = forward GVC participation ratio; BPR = backward GVC participation ratio; TVA = trade in value-added; NRSCA = new revealed symmetric comparative advantage; GOV = government effectiveness; CC = control of corruption. *p*-value in parenthesis.

### *4.3. Value-Added Trade in ASEAN and Developed Countries*

Generally, the value-added trade of worldwide countries from the forward-linked perspective dominated the backward linkage (Figure 1). Domestic value added in TVA was heavily used in these countries. Among ASEAN countries, Singapore had the highest average TVA score of 0.855. Furthermore, the average value of BPR Singapore was higher (0.514) than the FPR (0.341). This result indicated the potential for a larger downstream to be integrated into the stage of higher value-added production. Singapore had a high share of vertical specialization in exports, especially in the manufacturing sector (Ing and Kimura 2017b). However, other ASEAN countries had higher FPR values than BPR, on average. For example, Indonesia had an FPR value of 0.606, a BPR value of 0.168, and a TVA value of 0.773.

Singapore's backward GVC participation remained high until the pandemic outbreak. However, in 2020, it dropped to 0.457. Malaysia, Thailand, and Philippines had higher BPR values than Indonesian BPRs, indicating a higher utilization of foreign value added, especially in the manufacturing sector (Asian Development Bank 2019; González and Kowalski 2017). Consequently, the pandemic hampered ASEAN countries' efforts to increase forward GVC participation. As a result, ASEAN forward GVC participation decreased, on average, from 0.482 in 2019 to 0.478 in 2020 (Wuri et al. 2022).

In the East Asia region, the FPR value also dominated the BPR value, although in Korea, the BPR value was relatively high as compared to those of other East Asian countries. Korea's TVA value was also the highest in the East Asia region, which was 0.754. China and Japan mostly used domestic value added in their production process. Backward GVC participation in Korea had remained relatively high until the emergence of the pandemic in 2020, where it dropped to 0.286. In the early stages of the COVID-19 pandemic, backward GVC participation in China and Japan had decreased by 4.44% and 6.02%, respectively (Qin et al. 2020; Wuri et al. 2022). According to the forward-linked perspective, China's GVC participation was significantly reduced to 13.54%, reflecting China's exports of high domestic value-added content (Kee and Tang 2016).

The Slovak Republic had higher average BPR scores than FPR scores among European countries. The BPR in Slovakia was 0.527, the FPR was 0.296, and the TVA was 0.824. Due to its abundant wood resources and competitive prices, the Slovak Republic had the most significant comparative advantage in the industrial trade in roundwood. As a result, these industries have been increasingly incorporating foreign value added into their manufacturing processes. Other European countries with higher average FPR scores than BPR scores include Germany, Italy, Poland, and Greece, though the difference is insignificant. On average, the COVID-19 pandemic reduced the value of both forward and backward GVC participation in EU countries (Kazunobu and Hiroshi 2020; Wuri et al. 2022).

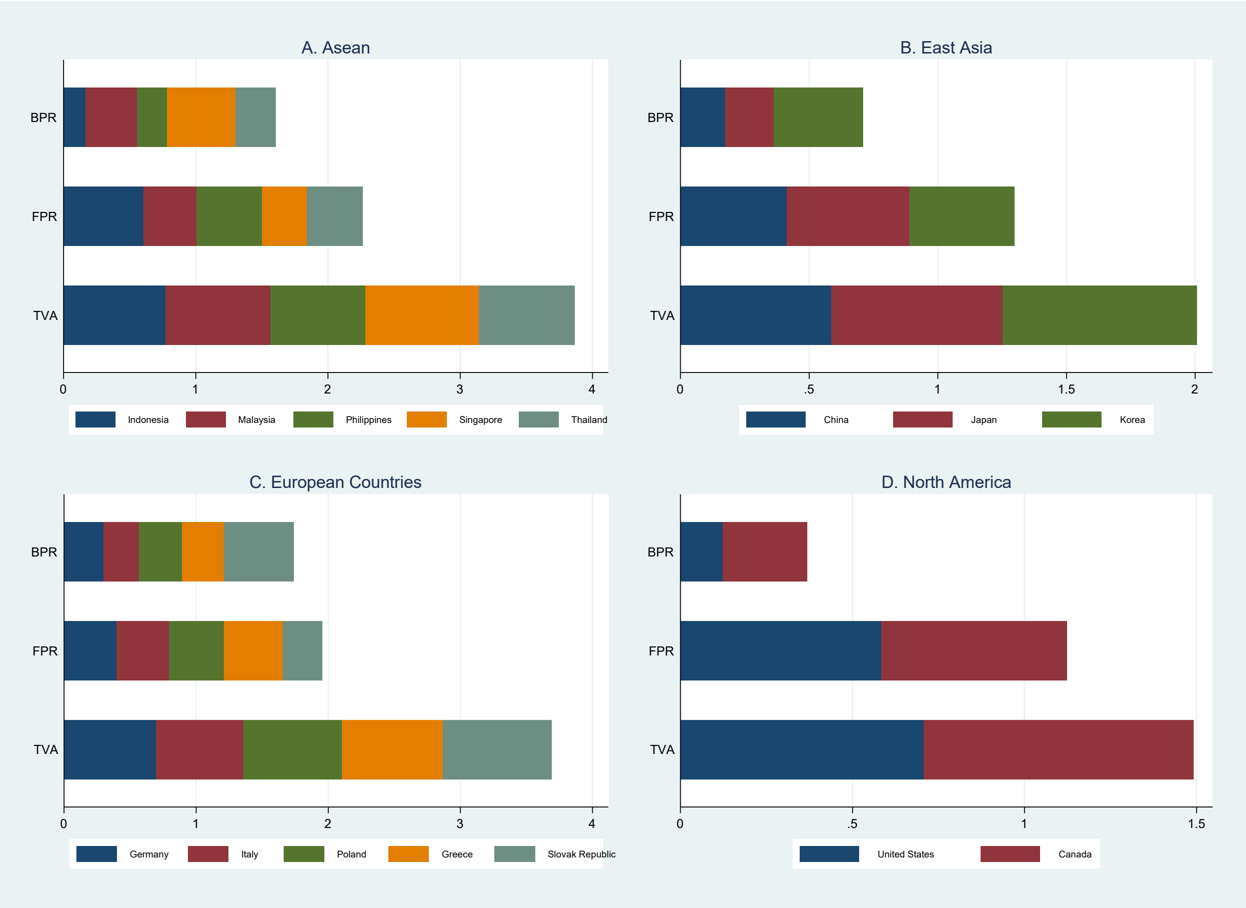


**Figure 1.** Backward and forward linkage in value-added trade, 2010–2020. Source: ADB MRIO, Authors' computations.

The dominance of FPR over BPR also occurred in North American countries. The difference in the average value of FPR and BPR was significant in the United States. DVA contributed 0.584 percent of U.S. gross exports, while FVA contributed 0.123 percent. The average TVA in the United States was 0.707. DVA's share of gross exports in Canada was 0.539, while FVA's share of gross exports in Canada was 0.245. TVA Canada's ratio was 0.784. Based on backward linkage, Canada had the highest GVC participation rate in NA, with a backward GVC participation score of 0.26 in 2019. However, as a result of the pandemic, this score declined from 3.52% to 0.247% in 2020. Regarding forward linkage, the United States and Canada consistently had high forward GVC participation rates. The projected value of GVC participation in the United States in 2020 was 0.59. However, this ratio declined throughout the COVID-19 pandemic.

### *4.4. New Revealed Symmetric Comparative Advantage in ASEAN and Developed Countries*

Figure 2 illustrates the trend in comparative advantage as measured in terms of value added in the original ASEAN member countries during the observation period. These countries' comparative advantages changed dynamically. Indonesia had a comparative advantage in the primary and low technology manufacturing sectors. Figure 2 shows that the NRSCA value in the sector was positive, though declining. The decline in comparative advantage was caused by the policy of downstreamness in the country sectors that utilized FVA in connection with the increasing involvement of countries in GVCs. However, the primary sector experienced an increase in its comparative advantage from 0.101 in 2019 to 0.430 in 2020. This was due to the restrictive policies implemented that had significantly increased the utilization of domestic resources. However, Indonesia consistently lagged behind, with a comparative disadvantage in the medium and high technology and business services sectors (Asian Development Bank 2019).

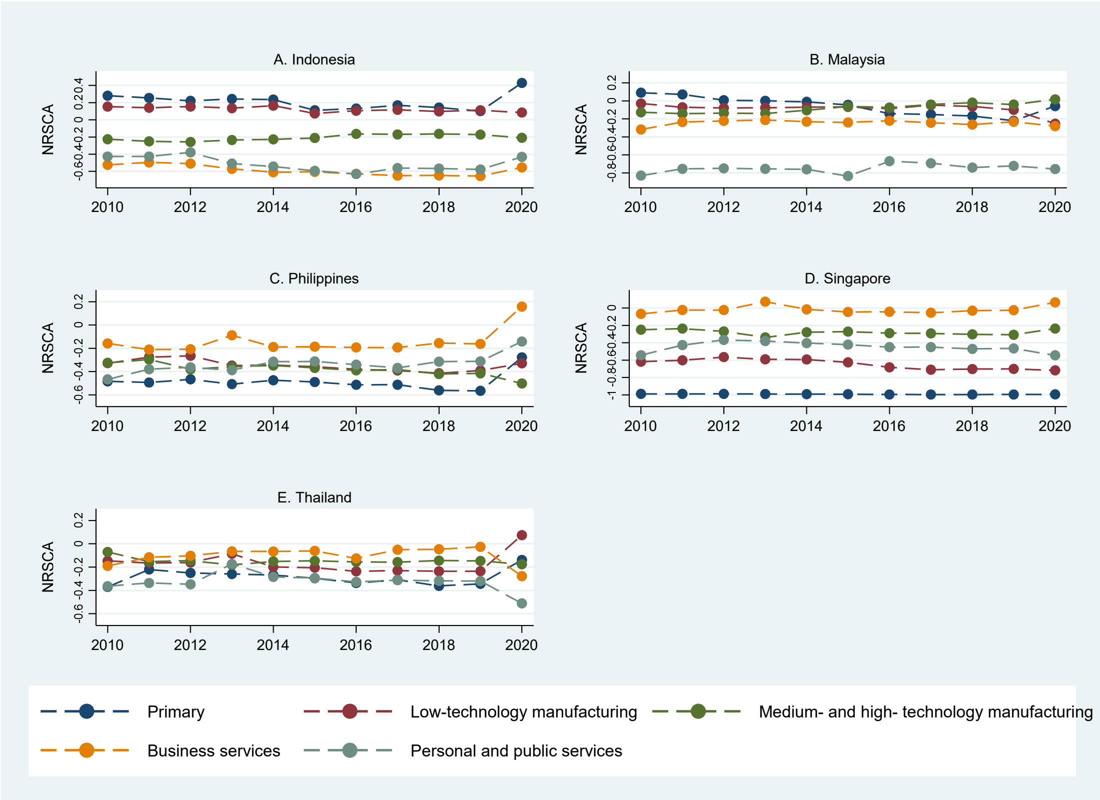


**Figure 2.** Trends in new revealed symmetric comparative advantage of broad sectors in ASEAN, 2010–2020. Source: ADB MRIO, Authors' computations.

Furthermore, Malaysia had a negative NRSCA value, on average, as it used more FVA to produce intermediate goods, particularly in the development of their semiconductor (Ing and Kimura 2017a). Malaysia's comparative advantage in the medium and high technology manufacturing sectors increased from −0.040 in 2019 to 0.017 in 2020 due to the COVID-19 pandemic. Malaysia remained very competitive in the primary sectors. In addition, Malaysia had a comparative advantage based on DVA in several sectors in low, medium, and high technology manufacturing. However, Malaysia consistently lagged behind with a comparative disadvantage based on domestic value added in the personal and public services sectors.

Philippines had a negative NRSCA average score due to its reliance on FVA in intermediate goods production, particularly in the electronics industry. The electronics industry contained the country's most important exports, accounting for roughly 60% of their total exports, on average (Ing and Kimura 2017b). Philippines' comparative advantage in the business services sector changed during the pandemic. Before the pandemic, Philippines did not have a comparative advantage in the business services sector. However, in 2020, Philippines achieved a 0.158 NRSCA index in the industry. Philippines remained highly competitive in low technology manufacturing. This sector's comparative advantage had increased. In addition, Philippines had a comparative advantage based on DVA in several of the medium and high technology manufacturing and public services sectors. However, Philippines consistently lagged behind in terms of domestic value added in their primary sectors.

Singapore also had a negative NRSCA average due to a high share of vertical specialization in their exports, particularly in the manufacturing sector (González and Kowalski 2017). This was due to Singapore's extensive involvement in GVCs. The COVID-19 pandemic altered Singapore's comparative advantage, resulting in a new comparative advantage based on domestic value added in the business services sector, as evidenced by the positive NRSCA value in 2020 (Figure 2). Singapore remained highly competitive in several medium technology manufacturing and business services sectors. However, Singapore consistently lagged behind in terms of domestic value added in the primary and low technology manufacturing sectors.

Thailand had a negative NRSCA average score, as it used FVA to promote their automotive industry development. The Thai government developed the automotive industry to serve as an intermediary in the Southeast Asian production network, including car assembly and parts manufacturing (Natsuda et al. 2013). Thailand's comparative advantage in the low technology manufacturing sector increased from −0.235 in 2019 to 0.074 in 2020 as a result of the COVID-19 pandemic. Thailand remained highly competitive in primary industries such as agriculture, hunting, forestry, and fishing. Thailand also had a comparative advantage based on DVA in several low, medium, and high technology manufacturing and business services sectors. However, Thailand consistently lagged behind in terms of domestic value added in the personal and public services sectors.

Figure 3 illustrates the NRSCA trend in East Asian countries over the observation period. China had a comparative advantage in the low, medium, and high technology manufacturing sectors. Figure 3 shows that the industry's average NRSCA value was positive during the observation period, albeit with a fluctuating trend. The average decline in China's comparative advantage was caused by export diversification, which involved shifting from exporting resource-based products such as agricultural products to exporting manufactured goods. From 2000 to the present, China has become a major exporter of various goods from electronics to textiles. This was due to China's significant involvement in forward GVCs, making China the world's manufacturing hub (Zhang 2024). However, Japan and Korea had a relative advantage in the industrial sectors that involved medium and high technology. Japan and South Korea prioritize the manufacture of high-value-added goods, including semiconductors and other advanced technological products, alongside the automotive industry. These countries' governments play a significant role in investing in education, technology, and industrial policy. The figure shows that the average NRSCA value in the industry was positive, though with a fluctuating trend. The COVID-19 pandemic increased China's comparative advantage in the low technology manufacturing sector by 66.18%, from 0.068 in 2019 to 0.113 in 2020. Meanwhile, Korea experienced an increase in its comparative advantage in the medium and high technology manufacturing sectors by 0.49% due to the increased use of domestic resources. However, Japan experienced a decrease of 49.12% from 2019 to 2020.

Figure 4 depicts the trend in comparative advantage in several European countries based on DVA. The positive NRSCA average value indicated that Germany had a comparative advantage in the medium and high technology manufacturing sectors. Germany is a leader in high-value-added manufacturing such as automotive and industrial machinery. However, the COVID-19 pandemic reduced Germany's comparative advantage in the industry by 42.17 percent, from 0.083 in 2019 to 0.048 in 2020 (Qin et al. 2020). In addition, Germany's comparative advantage in DVA exports declined due to restriction policies, affecting production and distribution for domestic and foreign markets.

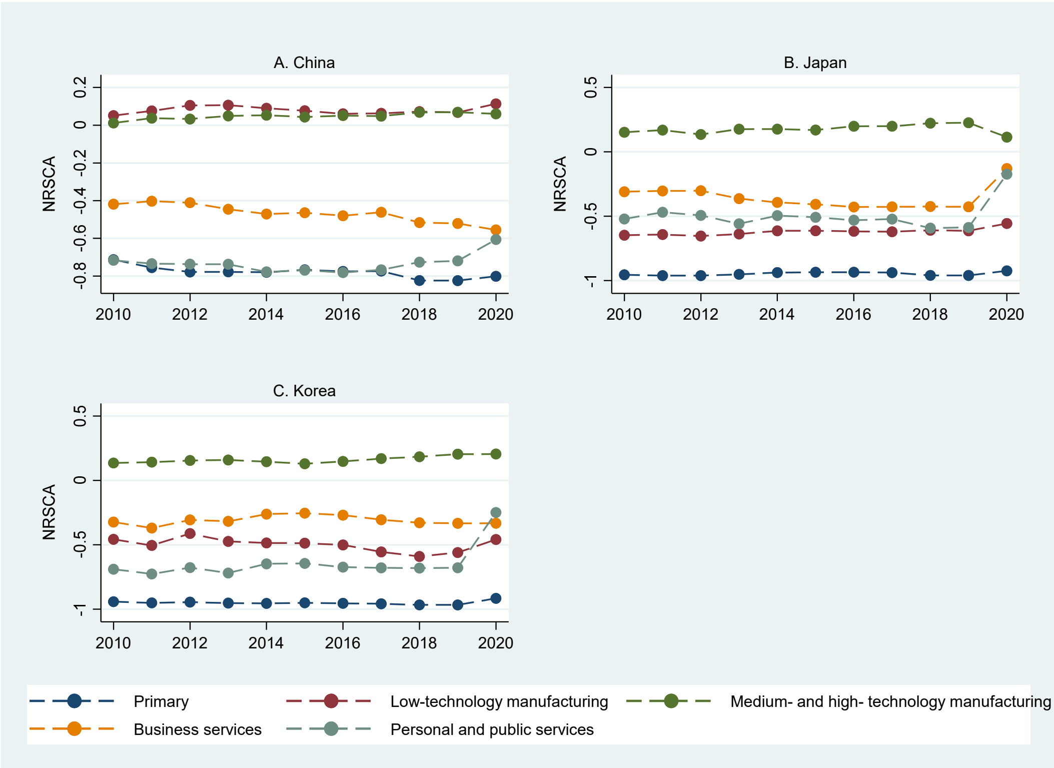


**Figure 3.** New revealed symmetric comparative advantage of broad sectors in East Asia, 2010–2020. Source: ADB MRIO, Authors' computations.

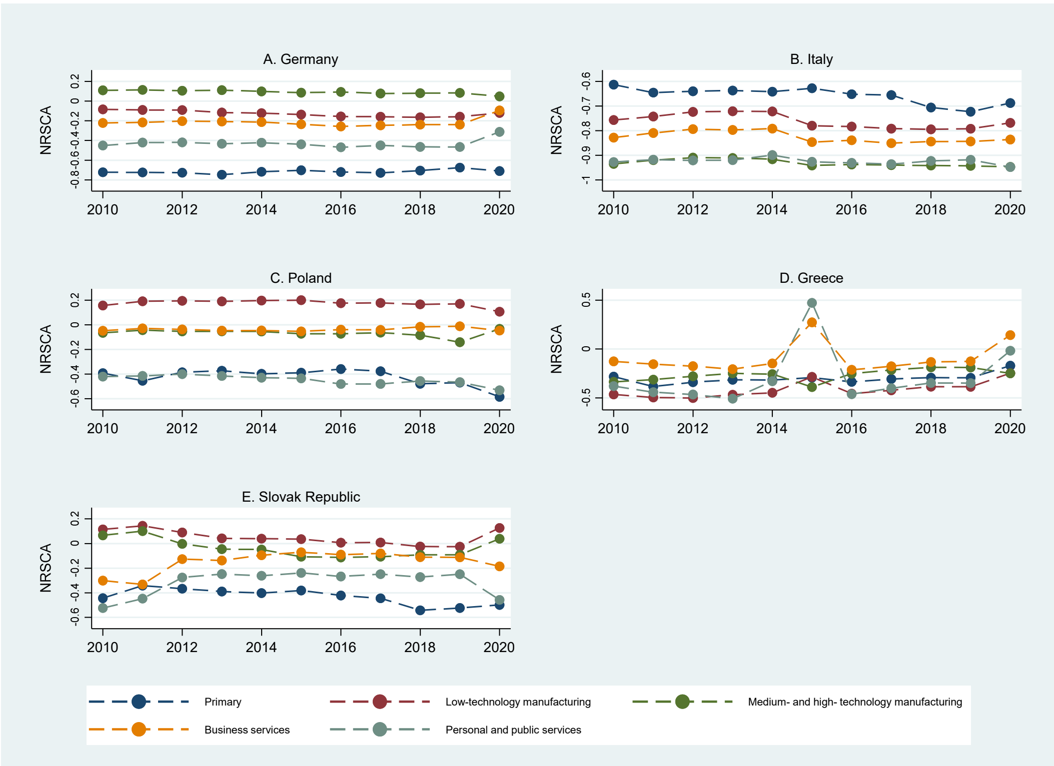


**Figure 4.** New revealed symmetric comparative advantage of broad sectors in European countries, 2010–2020. Source: ADB MRIO, Authors' computations.

Furthermore, Poland and the Slovak Republic had a comparative advantage from the perspective of forward linkage in the low technology manufacturing sector, as evidenced by the positive trend in NRSCA values. This was due to these countries' policies encouraging intermediate exports by utilizing domestic resources, such as wood and semi-finished wood and the clothing industry (Parobek et al. 2016; Smith et al. 2014). Meanwhile, Italy and Greece had negative NRSCA average values, as they used FVA to support the medium and high technology manufacturing sector (Lofrano et al. 2013; Zapata et al. 2023). Nonetheless, Italy had a comparative advantage based on forward linkage in the wood and wood products and cork sectors, as indicated by a positive NRSCA value during the observation period. In the meantime, Greece had a comparative advantage in several primary industries and low technology manufacturing. The establishment of the European Union's single market reduces trade barriers and improves production efficiency. Europe leads in technological advances and possesses an effective research and development infrastructure, enabling it to manufacture high-value-added goods.

Figure 5 shows the trend of comparative advantage based on domestic value added in North America during the observation period. The United States had a negative NRSCA average value, as more foreign resources were used to produce intermediate goods than in any other country. The United States leads the way in the high-tech and service sectors, in addition to encouraging research and development that supports high-value-added sectors. Free trade agreements integrate the North American economy, increasing the flow of goods and investment.

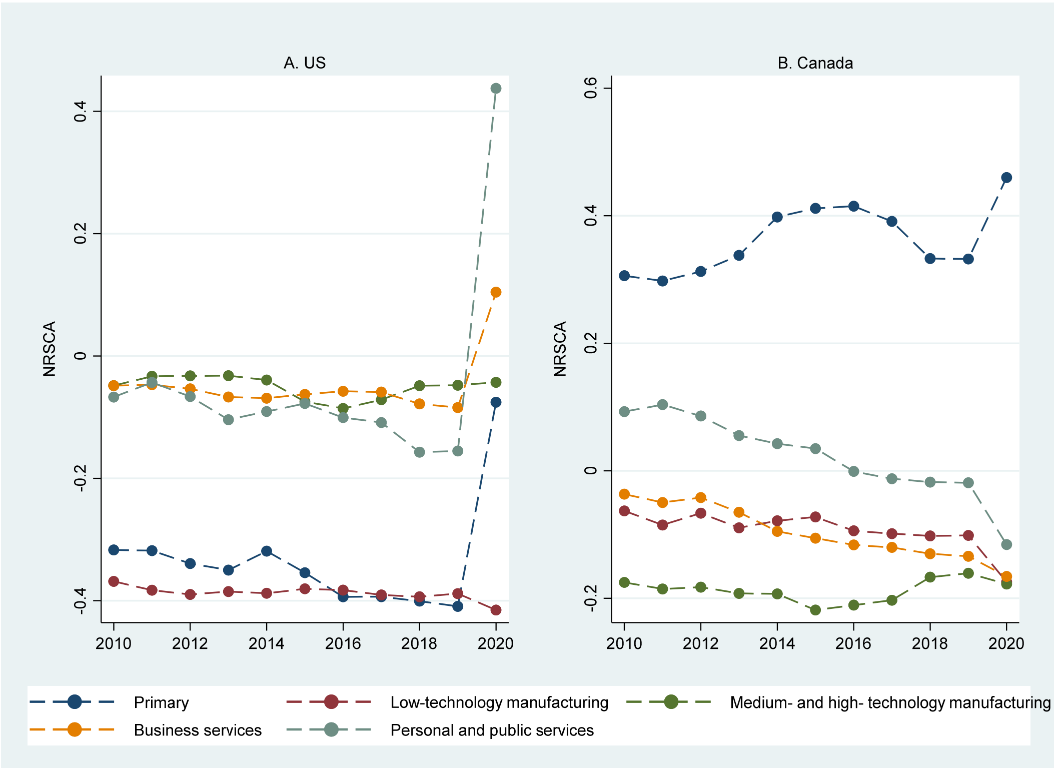


**Figure 5.** New revealed symmetric comparative advantage of broad sectors in North America, 2010–2020. Source: ADB MRIO, Authors' computations.

The COVID-19 pandemic outbreak increased the average comparative advantage from the perspective of forward linkage in the primary sector, business services, and personal and public services. The U.S. NRSCA value for the business services sector increased from −0.084 in 2019 to 0.105 in 2020. In addition, the U.S. NRSCA value for the personal and public services sector increased from −0.155 in 2019 to 0.438 in 2020. Meanwhile, Canada had a comparative advantage in the primary sector, as evidenced by the sector's positive

NRSCA value. The occurrence of the COVID-19 pandemic increased the primary sector's comparative advantage by 38.55%. As a result, the NRSCA Canada primary sector value increased from 0.332 in 2019 to 0.460 in 2020. Meanwhile, other industries appeared to be contracting. The policy of the downstreamness of a country's sectors utilizes FVA in conjunction with increasing the country's involvement in GVCs.

### *4.5. The System GMM Dynamic Panel Estimation*

A dynamic GMM approach was employed to examine the influence of the comparative advantage in encouraging TVA and avoid any potential endogeneity issues. SYS-GMM-type instruments were employed in this model with the first and higher lags of the predetermined variable and the second and higher lags of the endogenous variable (Arellano and Bond 1991; Arellano and Bover 1995; Blundell and Bond 1998). The first lagged dependent variable, FPR, BPR, or TVA, was chosen as the predetermined variable. As TVA is a process, the models are the lagged form of the variable to allow for the partial adjustment of the TVA for its long-term equilibrium value. Thus, previous TVA levels influenced the current levels. We used Stata 17 for the analysis (STATA; StataCorp, College Station, TX, USA). Arellano and Bond's (1991) residual serial correlation tests were AR (1) and AR (2). As previously stated, Hansen's disease is a test for over-identification restrictions.

Table 5 summarizes the SYS-GMM estimation results for all models. The study estimated comparative advantage to drive TVA by considering institutional variables as a control variable for a sample of 41 countries using the two-step SYS-GMM Arellano–Bond estimator. Furthermore, we investigated the impact of the COVID-19 pandemic on the TVA.

**Table 5.** The SYS-GMM results for trade in value-added (TVA), 2010–2020.

| Variables | FPR | BPR | TVA |
|---|---|---|---|
| | **(1)** | **(2)** | **(3)** |
| Lag of Dep Var | 0.115 *** | 0.831 *** | 0.034 *** |
| | (0.009) | (0.053) | (0.004) |
| NRSCA | 0.265 *** | 0.010 *** | 0.171 *** |
| | (0.022) | (0.014) | (0.019) |
| GOV | 0.012 *** | 0.029 *** | 0.045 *** |
| | (0.004) | (0.011) | (0.004) |
| CC | 0.032 *** | 0.021 ** | 0.021 *** |
| | (0.008) | (0.009) | (0.004) |
| COVID-19 | −0.010 *** | −0.010 *** | −0.009 *** |
| | (0.001) | (0.001) | (0.0008) |
| Constant | 0.424 ** | 0.002 | 0.726 *** |
| | (0.007) | (0.010) | (0.006) |
| No. of observations | 369 | 328 | 369 |
| No. of countries | 41 | 41 | 41 |
| Hansen test, *p*-value | 35.13; 0.972 | 34.21; 0.194 | 37.60; 0.488 |
| AB–AR (1); *p*-value | −1.76; 0.079 | −3.55; 0.000 | −1.70; 0.090 |
| AB–AR (2); *p*-value | −0.73; 0.464 | −0.58; 0.560 | 0.44; 0.657 |

Note: *** and ** represent statistical significance at the 1% and 5% levels, respectively. SYS-GMM = system GMM estimator; in the forward linkage, the dependent variable is FPR, and in the backward linkage, the dependent variable is BPR; in trade in value-added, the dependent variable is TVA. Standard errors are shown in parentheses. Source: Calculated by the authors using Stata 17.

The dependent lagged period includes the expected positive coefficient and is statistically significant in all models, thus indicating that the dependent variable of the previous period affects the current period. The positive sign of the coefficient suggests that the countries' TVA in previous periods contributed positively to that of the current period because of raw material imports in the previous period. Approximately 11.5% of DVA exports reflect the last period's exports (Model 1). The positive sign of the BPR coefficient indicates that approximately 83.1% of foreign value-added exports reflected the previous period's exports (Model 2), and approximately 3.4% of the total value added reflected the previous period's exports (Model 3).

All findings support NRSCA's goal of enhancing TVA by improving the institutional environment according to government effectiveness and the control of corruption. For all models, the estimation results revealed that comparative advantage (NRSCA) positively and significantly affected TVA. For the FPR, BPR, and TVA models, the NRSCA coefficients are 0.265, 0.010, and 0.171, respectively.

The implementation of a new comparative advantage measure, NRSCA, provided accurate estimation results to overcome the overvaluation problem that arises when using TRCA. Given the increased intermediary trade, RCA should be more oriented toward forward-linked value-added exports (see also Z. Wang et al. 2018). In addition, with the emergence of dynamic comparative advantage, ASEAN's pattern of comparative advantage may become similar to that of developed countries, following the flying geese (FG) paradigm (Widodo et al. 2018). In this framework, industry is transmitted from leader to follower countries. Thus, the comparative advantages of countries continue to evolve (Asian Development Bank 2019; Brakman and Van Marrewijk 2017; Ito et al. 2017). ASEAN is a key participant in GVC activities, playing a very important role in global trade and global policy. This is because ASEAN is the main production base and final assembler in production for the global economy and the dominance of ASEAN countries' export share in the global market reaches 79.2% (Zhong and Su 2021).

Furthermore, the COVID-19 pandemic reduced the average of value-added trade (Espitia et al. 2022; Kazunobu and Hiroshi 2020; Wuri et al. 2023). The coefficient of COVID-19 was negative and statistically significant for the FPR model (−0.010), BPR model (−0.010), and TVA model (−0.009). The pandemic has forced many countries to implement restrictive policies to contain the spread of this virus (Vidya and Prabheesh 2020). They restrict cross-border trade, which leads countries to use domestic resources, thereby increasing their comparative advantage based on DVA. The supply of intermediate inputs from other countries was limited, thus resulting in a reduced current aggregate demand and supply (Ayadi et al. 2021; Baldwin and Mauro 2020). Therefore, the output gap and final demand for countries' products are low (Ghuzini et al. 2020; Wuri et al. 2024). This implies that the COVID-19 pandemic has adversely affected global trade (Espitia et al. 2022; Qin et al. 2020; Vidya and Prabheesh 2020; Zapata et al. 2023).

However, the positive and significant coefficients on government effectiveness and corruption control suggested that high-quality institutions would promote TVA in international production sharing (Amendolagine et al. 2019; Faheem Ur et al. 2024; Gereffi et al. 2005; Mouanda and Gong 2019; Zergawu et al. 2020). The estimation results were consistent throughout the institutional coefficient analysis using SYS-GMM, with a positive sign and statistical significance for FPR, BPR, and TVA. The positive institutional coefficient suggests that a high-quality institution increases forward and backward linkage GVC participation (Mouanda and Gong 2019). Institutions, among others, play a role in contract enforcement, property rights, and shareholder protection. Countries could participate in TVA more when they had higher government effectiveness and better corruption control. In addition, a more effective government can provide a more conducive regulatory environment by eliminating quotas to increase the Eastern European clothing sector (Smith et al. 2014).

### *4.6. Robustness Tests*

We examined the robustness of our baseline results on the role of comparative advantage in driving countries' participation in TVA using different indicators for the COVID-19 variable (Zergawu et al. 2020). We substituted the COVID-19 dummy measure with COVID-19 shocks to represent economic fluctuations (Wuri et al. 2023). The COVID-19 shocks were calculated based on the gross export gap, which is the difference between real and potential exports (Ghuzini et al. 2020; Hubbard et al. 2014; Wuri et al. 2024). The export variable was chosen because it was directly affected by trade fluctuations. To assess the impact of the COVID-19 pandemic on global country participation in TVA, it is critical to determine whether the performance of countries is above or below their potential (González and Kowalski 2017). When the potential value is greater than the real value, a recession would occur, which would then cause an economic recession, and vice versa.

In reality, potential exports were not observed; therefore, they were often proxied by the expected value. We calculated the expected export value based on the Hodrick–Prescott filter (Hubbard et al. 2014). Therefore, the COVID-19 shocks indicate fluctuations in exports during the estimation period. This approach was used to examine the influence of other aspects of COVID-19 on TVA activity.

Table 6 displays the corresponding results. The results from the table illustrated the same conclusion in all the models. The dependent lagged period includes the expected positive coefficient and is statistically significant in all models. The positive sign of the coefficient suggests that the countries' TVA in previous periods contributed positively to that of the current period. Approximately 11.6% of DVA exports reflect the last period's exports. The positive sign of the BPR coefficient indicates that approximately 7.7% of foreign value-added exports reflected the previous period's exports, and approximately 1.2% of the total value added reflected the previous period's exports. For all models, the estimation results revealed that comparative advantage (NRSCA) positively and significantly affected TVA. For the FPR, BPR, and TVA models, the NRSCA coefficients are 0.248, 0.024, and 0.032, respectively. Thus, comparative advantage plays a crucial role in the promotion of TVA (Ito et al. 2017). Further, the impact of the COVID-19 shock was negative and significant with the institutional variable as a control variable, thus indicating that the pandemic reduced value-added trading activity (Qin et al. 2020; Vidya and Prabheesh 2020; Wuri et al. 2022).

**Table 6.** The SYS-GMM results for robustness tests, trade in value-added (TVA) with COVID-19 shocks, 2010–2020.

| Variables | FPR | BPR | TVA |
|---|---|---|---|
| | **(1)** | **(2)** | **(3)** |
| Lag of Dep Var | 0.116 *** | 0.077 *** | 0.012 ** |
| | (0.008) | (0.011) | (0.005) |
| NRSCA | 0.248 *** | 0.024 * | 0.032 *** |
| | (0.015) | (0.013) | (0.012) |
| GOV | 0.009 ** | 0.069 *** | 0.069 *** |
| | (0.004) | (0.007) | (0.009) |
| CC | 0.029 *** | 0.036 *** | 0.033 *** |
| | (0.009) | (0.008) | (0.008) |
| COVID shocks | −0.031 *** | −0.063 *** | −0.083 *** |
| | (0.005) | (0.007) | (0.003) |
| Constant | 0.406 *** | 0.207 *** | 0.733 *** |
| | (0.007) | (0.019) | (0.009) |
| No. of observations | 369 | 410 | 410 |
| No. of countries | 41 | 41 | 41 |
| Hansen test, *p*-value | 34.99; 0.973 | 35.51; 0.969 | 38.86; 0.652 |
| AB–AR (1); *p*-value | −1.69; 0.092 | −2.50; 0.012 | −1.33; 0.185 |
| AB–AR (2); *p*-value | −0.83; 0.408 | −1.37; 0.172 | −1.02; 0.307 |

Note: ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. SYS-GMM = system GMM estimator; in the forward linkage, the dependent variable is FPR, and in the backward linkage, the dependent variable is BPR; in trade in value-added, the dependent variable is TVA. Standard errors are shown in parentheses. Source: Calculated by the authors using Stata 17.

## 5. Conclusions

In this article, we employed the system GMM estimators for a dynamic panel model to investigate the role of the comparative advantage in driving TVA by considering institutional quality as a control variable, using the ADB MRIO for the period 2010–2020. Moreover, the COVID-19 pandemic variable was included in this study's model to examine the pandemic's impact on value-added trade. In particular, we focused on a new revealed symmetric comparative advantage measure, NRSCA. This symmetric measure was used for accurate calculations, using DVA through forward linkage, instead of gross exports. NRSCA addressed the issues of overvaluation, double counting, and implicit distortions in international trade across borders.

The results suggested an increase in value-added trade with the significant role of the comparative advantage, along with the support of quality institutional services in each country. Worldwide countries' comparative advantages changed dynamically. Indonesia had a comparative advantage in the primary and low technology manufacturing sectors. Malaysia remained very competitive in the primary sectors. In addition, Malaysia had a comparative advantage based on DVA in several sectors in low, medium, and high technology manufacturing. The Philippines remained highly competitive in low technology manufacturing. In addition, the Philippines had a comparative advantage based on DVA in several of the medium and high technology manufacturing and public services sectors. Singapore remained highly competitive in several of the medium technology manufacturing and business services sectors. Thailand remained highly competitive in primary industries such as agriculture, hunting, forestry, and fishing. Thailand also had a comparative advantage based on DVA in several low, medium, and high technology manufacturing and business services sectors. China had a comparative advantage in the East Asia Region in low, medium, and high technology manufacturing sectors. However, Japan and Korea had a comparative advantage in medium and high technology manufacturing. The positive NRSCA average value indicated that Germany had a comparative advantage in the medium and high technology manufacturing sectors. Furthermore, Poland and the Slovak Republic had a comparative advantage from the perspective of forward linkage in the low technology manufacturing sector. In the meantime, Greece had a comparative advantage in several primary industries and low technology manufacturing. In the US Area, the US had a comparative advantage from the perspective of forward linkage in the primary sector, business services, and personal and public services. Meanwhile, Canada had a comparative advantage in the primary sector. The COVID-19 pandemic slowed down TVA and potentially disrupted many sectors.

Furthermore, governments should develop value-added exports based on NRSCA to establish a competitive advantage and enhance investment in research and development. Moreover, the government is expected to build transportation and logistics infrastructure to improve supply chain efficiency and facilitate inter- and intra-regional trade. Further research is required to incorporate control variables, such as gravity control, infrastructure, GDP per capita, and trade regulation, and to calculate the position of the leading sector from final use.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** Not applicable.

**Informed Consent Statement:** Not applicable.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author.

**Acknowledgments:** The author is thankful to the ADB team for providing the required data. I would also like to thank anonymous reviewers for their valuable comments and suggestions.

**Conflicts of Interest:** The author declares no conflict of interest.

## Appendix A

**Table A1.** List of ADB multi-regional input–output countries.

| No. | Group | Countries |
|---|---|---|
| 1 | ASEAN | Malaysia, Indonesia, Thailand, Philippines, Singapore, Viet Nam, Brunei Darussalam, Lao PDR, Cambodia |
| 2 | East Asia | Japan, People's Republic of China, Republic of Korea |
| 3 | EU | Austria, Bulgaria, Belgium, Czech Republic, Cyprus, Germany, Denmark, Spain, Estonia, France, Finland, Greece, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Malta, Latvia, Netherlands, Poland, Portugal, Romania, Slovenia, Slovak Republic, Sweden |
| 4 | NA | Canada, United States |

Source: Authors' compilations.

## References

Amendolagine, Vito, Andrea F. Presbitero, Roberta Rabellotti, and Marco Sanfilippo. 2019. Local Sourcing in Developing Countries: The Role of Foreign Direct Investments and Global Value Chains. *World Development* 113: 73–88. [CrossRef]

Arellano, Manuel, and Olympia Bover. 1995. Another Look at the Instrumental Variables Estimation of Error Component Models. *Journal of Econometrics* 68: 29–51. [CrossRef]

Arellano, Manuel, and Stephen Bond. 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies* 58: 277–97. [CrossRef]

Asian Development Bank. 2015. *Global Value Chains Indicators for International Production Sharing. Key Indicators for Asia and the Pacific 2015*. Manila: Asian Development Bank. Available online: https://www.adb.org/sites/default/files/publication/175162/gvc.pdf (accessed on 9 March 2022).

Asian Development Bank. 2019. *The Evolution of Indonesia's Participation in Global Value Chains. Manila: Asian Development Bank*. Manila: Asian Development Bank. [CrossRef]

Athukorala, Prema-Chandra, and Nobuaki Yamashita. 2006. Production Fragmentation and Trade Integration: East Asia in Global Context. *North American Journal of Economics and Finance* 17: 233–56. [CrossRef]

Ayadi, Rym, Giorgia Giovannetti, Enrico Marvasi, Giulio Vannelli, and Chahir Zaki. 2021. Demand and Supply Exposure through Global Value Chains: Euro-Mediterranean Countries during COVID. *The World Economy* 45: 637–56. Available online: https://onlinelibrary.wiley.com/doi/epdf/10.1111/twec.13156 (accessed on 1 July 2023). [CrossRef] [PubMed]

Balassa, Bela. 1965. Trade Liberalisation and 'Revealed' Comparative Advantage. *The Manchester School* 33: 99–123. [CrossRef]

Baldwin, Richard E., and Beatrice W. di Mauro, eds. 2020. *Economics in the Time of COVID-19*. A VoxEU.org eBook. London: CEPR Press. Available online: https://voxeu.org/article/economics-time-covid-19-new-ebook (accessed on 2 April 2023).

Baltagi, Badi H. 2005. *Econometric Analysis of Panel Data*. Hoboken: John Wiley & Sons Ltd.

Blundell, Richard, and Stephen Bond. 1998. Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. *Journal of Econometrics* 87: 115–43. Available online: https://www.ucl.ac.uk/~uctp39a/Blundell-Bond-1998.pdf (accessed on 15 June 2022).

Borin, Alessandro, and Michele Mancini. 2019. Measuring What Matters in Global Value Chains and Value-Added Trade. WPS 8804. Available online: http://hdl.handle.net/10986/31533 (accessed on 30 November 2022).

Brakman, Steven, and Charles Van Marrewijk. 2017. A Closer Look at Revealed Comparative Advantage: Gross-versus Value-Added Trade Flows. *Papers in Regional Science* 96: 61–92. [CrossRef]

Burlina, Chiara, and Eleonora Di Maria. 2020. Manufacturing and Value-Added Dynamics in Global Value Chains: The Case of Italy. *Competitiveness Review* 30: 457–70. [CrossRef]

Ceglowski, Janet. 2017. Assessing Export Competitiveness through the Lens of Value Added. *World Economy* 40: 275–96. [CrossRef]

Chen, Ji-Ming, and Yi-Qing Chen. 2022. China Can Prepare to End Its Zero-COVID Policy. *Nature Medicine* 28: 1104–1105. [CrossRef]

Elsalih, Osama, Kamil Sertoglu, and Mustafa Besim. 2021. Determinants of Comparative Advantage of Crude Oil Production: Evidence from OPEC and Non-OPEC Countries. *International Journal of Finance and Economics* 26: 3972–83. [CrossRef]

Espitia, Alvaro, Aaditya Mattoo, Nadia Rocha, Michele Ruta, and Deborah Winkler. 2022. Pandemic Trade: COVID-19, Remote Work and Global Value Chains. *World Economy* 45: 561–89. [CrossRef]

Faheem Ur, Rehman, Islam Md. Monirul, and Kazi Sohag. 2024. Does Infrastructural Development Allure Foreign Direct Investment? The Role of Belt and Road Initiatives. *International Journal of Emerging Markets* 19: 1026–50. [CrossRef]

Fan, Zhaobin, Sajid Anwar, and Ying Zhou. 2023. Centralization of Trade Agreements Network and Global Value Chain Participation. *Quarterly Review of Economics and Finance* 94: 11–24. [CrossRef]

Gereffi, Gary, John Humphrey, and Timothy Sturgeon. 2005. The Governance of Global Value Chains. *Review of International Political Economy* 12: 78–104. [CrossRef]

Ghuzini, Diny, Josephine Wuri, and Kuntari Dasih. 2020. Structural Shocks and Macroeconomic Conditions in Indonesia. *Journal of Applied Economic Sciences* XV: 488–506. Available online: https://www.ceeol.com/search/article-detail?id=894712 (accessed on 25 June 2024).

González, Javier Lopez, and Przemyslaw Kowalski. 2017. Global Value Chain Participation in Southeast Asia: Trade and Related Policy Implications. In *Production Networks in Southeast Asia*. Edited by Lili Yan Ing and Fukunari Kimura. New York: Routledge.

Hao, Yu, Hua Liao, and Yi-Ming Wei. 2015. Is China's Carbon Reduction Target Allocation Reasonable? An Analysis Based on Carbon Intensity Convergence. *Applied Energy* 142: 229–39. [CrossRef]

Hayakawa, Kazunobu, and Hiroshi Mukunoki. 2021. Impacts of COVID-19 on Global Value Chains. *Developing Economies* 59: 154–77. [CrossRef]

Hubbard, R. Glenn, Anthony P. O'Brien, Matthew Rafferty, and Robert J. Gordon. 2014. *Macroeconomics*. London: Pearson Education Limited.

Hummels, David, Jun Ishii, and Kei-Mu Yi. 2001. The Nature and Growth of Vertical Specialization in World Trade. *Journal of International Economics* 54: 75–96. [CrossRef]

Ing, Lili Yan, and Fukunari Kimura, eds. 2017a. *Production Networks in Southeast Asia*. Economic Research Institute for ASEAN and East Asia. New York: Routledge, Taylor and Francis Group. Available online: https://www.eria.org/publications/production-networks-in-southeast-asia/ (accessed on 24 September 2022).

Ing, Lili Yan, and Fukunari Kimura, eds. 2017b. Global Value Chain Participation in Southeast Asia: Trade and Related Policy Implications. In *Production Networks in Southeast Asia*. New York: Routledge.

Inomata, Sitoshi. 2013. *Trade in Value Added: An East Asian Perspective*. ADBI Working Paper Series; Tokyo: Asian Development Bank Institute. [CrossRef]

Ito, Tadashi, Lorenzo Rotunno, and Pierre Louis Vézina. 2017. Heckscher–Ohlin: Evidence from Virtual Trade in Value Added. *Review of International Economics* 25: 427–46. [CrossRef]

Johnson, Robert C., and Guillermo Noguera. 2012. Accounting for Intermediates: Production Sharing and Trade in Value Added. *Journal of International Economics* 86: 224–36. [CrossRef]

Johnson, Robert C., and Guillermo Noguera. 2017. A Portrait of Trade in Value-Added over Four Decades. *Review of Economics and Statistics* 99: 896–911. [CrossRef]

Kaufmann, Daniel, Aart Kraay, and Massimo Mastruzzi. 2010. The Worldwide Governance Indicators: Methodology and Analytical Issues. *Hague Journal on the Rule of Law* 3: 220–46. [CrossRef]

Kazunobu, Hayakawa, and Mukunoki Hiroshi. 2020. Impacts of COVID-19 on Global Value Chains. Institute of Developing Economies (IDE) Discussion Papers 791. Available online: https://ir.ide.go.jp/?action=pages_view_main&active_action=repository_view_main_item_detail&item_id=51871&item_no=1&page_id=39&block_id=158 (accessed on 15 January 2023).

Kee, Hiau Looi, and Heiwai Tang. 2016. Domestic Value Added in Exports: Theory and Firm Evidence from China. *American Economic Review* 106: 1402–36. [CrossRef]

Koopman, Robert, Zhi Wang, and Shang-Jin Wei. 2014. Tracing Value-Added and Double Counting in Gross Exports. *Amrican Economic Review* 104: 459–94. [CrossRef]

Laursen, Keld. 2015. Revealed Comparative Advantage and the Alternatives as Measures of International Specialization. *Eurasian Business Review* 5: 99–115. [CrossRef]

Leontief, Wassily W. 1936. Quantitative Input and Output Relations in the Economic System of the United States. *Review of Economics and Statistics* 18: 105–25. Available online: https://orion.math.iastate.edu/driessel/15Models/1936_Input_Output.pdf (accessed on 15 August 2022). [CrossRef]

Leromain, Elsa, and Gianluca Orifice. 2014. New Revealed Comparative Advantage Index: Dataset and Empirical Distribution. *International Economics* 139: 48–70. [CrossRef]

Levchenko, Andrei A. 2007. Institutional Quality and International Trade. *Review of Economic Studies* 74: 791–819. [CrossRef]

Liu, Xuepeng, Aaditya Mattoo, Zhi Wang, and Shang-Jin Wei. 2020. Services Development and Comparative Advantage in Manufacturing. *Journal of Development Economics* 144: 102438. [CrossRef]

Lofrano, Giusy, Sureyya Meriç, Gülsüm Emel Zengin, and Derin Orhon. 2013. Chemical and Biological Treatment Technologies for Leather Tannery Chemicals and Wastewaters: A Review. *Science of the Total Environment* 461–62: 265–81. [CrossRef]

Marcato, Marilia, Carolina Baltar, and Fernando Sarti. 2019. International Competitiveness in a Vertically Fragmented Production Structure: Empirical Challenges and Evidence. *Economics Bulletin* 39: 876–93. Available online: https://ideas.repec.org/a/ebl/ecbull/eb-18-00788.html (accessed on 5 September 2023).

Mouanda, Gilhaimé M., and Jiong Gong. 2019. Determinants of Global Value Chains Participation for Landlocked Countries. *International Journal of Social Science and Economic Research* 4: 3265–94. Available online: https://ijsser.org/files_2019/ijsser_04__246.pdf (accessed on 25 June 2023).

Natsuda, Kaoru, Noriyuki Segawa, and John Thoburn. 2013. Liberalization, Industrial Nationalism, and the Malaysian Automotive Industry. *Global Economic Review* 42: 113–34. Available online: https://www.tandfonline.com/doi/abs/10.1080/1226508X.2013.791475 (accessed on 8 September 2023). [CrossRef]

Parobek, Jan, Hubert Paluš, Martina Kalamarova, Erika Loučanova, Anna Križanova, and Katarina Repkova Štofkova. 2016. Comparative Analysis of Wood and Semi-Finished Wood Product Trade of Slovakia and Its Central European Trading Partners. *Drewno* 59: 183–94. [CrossRef]

Pata, Ugur Korkut, Mehmet Metin Dam, and Funda Kaya. 2023. How Effective Are Renewable Energy, Tourism, Trade Openness, and Foreign Direct Investment on $CO_2$ Emissions? An EKC Analysis for ASEAN Countries. *Environmental Science and Pollution Research* 30: 14821–37. [CrossRef]

Prete, Davide Del, Giorgia Giovannetti, and Enrico Marvasi. 2018. Global Value Chains: New Evidence for North Africa. *International Economics* 153: 42–54. [CrossRef]

Qin, Meng, Xiuyan Liu, and Xiaoxue Zhou. 2020. COVID-19 Shock and Global Value Chains: Is There a Substitute for China? *Emerging Markets Finance and Trade* 56: 3588–98. [CrossRef]

Rahayu, Caecilia Wahyu Estining, Christina Heti Tri Rahmawati, Josephine Wuri, Yuliana Rini Hardanti, and Laurentius Bambang Harnoto. 2024. Role of Indonesia's G20 Presidency and Exchange Rate on LQ45 Stock Price: Dynamic Panel Model Approach. *Migration Letters* 21: 926–39. [CrossRef]

Shuai, Jing, Xinjie Peng, Yujia Zhao, Yilan Wang, Wei Zu, Jinhua Cheng, Yang Lu, and Jingjin Wang. 2022. A Dynamic Evaluation on the International Competitiveness of China's Rare Earth Products: An Industrial Chain and Tech-Innovation Perspective. *Resources Policy* 75: 102444. [CrossRef]

Smith, Adrian, John Pickles, Milan Buček, Rudolf Pástor, and Bob Begg. 2014. The Political Economy of Global Production Networks: Regional Industrial Change and Differential Upgrading in the East European Clothing Industry. *Journal of Economic Geography* 14: 1023–51. [CrossRef]

Song, Yiru, Chunjiao Yu, Lulu Hao, and Xi Chen. 2021. Path for China's High-Tech Industry to Participate in the Reconstruction of Global Value Chains. *Technology in Society* 65: 101486. [CrossRef]

Timmer, Marcel P., Bart Los, Robert Stehrer, and Gaaitzen J. de Vries. 2013. Fragmentation, Incomes, and Jobs: An Analysis of European Competitiveness. *Economic Policy* 28: 613–61. [CrossRef]

Vidya, C. T., and K.P. Prabheesh. 2020. Implications of COVID-19 Pandemic on the Global Trade Networks. *Emerging Markets Finance and Trade* 56: 2408–21. [CrossRef]

Wang, Qiang, Jiayi Sun, Rongrong Li, and Ugur Korkut Pata. 2024. Linking Trade Openness to Load Capacity Factor: The Threshold Effects of Natural Resource Rent and Corruption Control. *Gondwana Research* 129: 371–80. [CrossRef]

Wang, Zhi, Shang-jin Wei, and Kunfu Zhu. 2018. *Quantifying International Production Sharing at the Bilateral and Sector Levels*. NBER Working Paper 19677. Cambridge: National Bureau of Economic Research, Revised February 2018. Available online: https://www.nber.org/papers/w19677 (accessed on 5 March 2021).

Widodo, Tri, Rini Setyastuti, and Sri Adiningsih. 2018. 'Flying Geese' Paradigm: Review, Analytical Tool, and Application. *Munich Personal RePEc Archive*. Available online: https://mpra.ub.uni-muenchen.de/87171/ (accessed on 10 February 2024).

Wuri, Josephine, Tri Widodo, and Amirullah Setya Hardi. 2022. Global Value Chains Participation during the COVID-19 Pandemic: A Dynamic Panel Approach. *Economies* 10: 121. [CrossRef]

Wuri, Josephine, Tri Widodo, and Amirullah Setya Hardi. 2023. Speed of Convergence in Global Value Chains: Forward or Backward Linkage. *Heliyon* 9: e18070. [CrossRef] [PubMed]

Wuri, Josephine, Yuliana Rini Hardanti, Laurentius Bambang Harnoto, Caecilia Wahyu Estining Rahayu, and Christina Heti Tri Rahmawati. 2024. The Impact of Interest Rate Spillover on Output Gap: A Dynamic Spatial Durbin Model. *Economies* 12: 22. [CrossRef]

Xu, Haifeng. 2016. Financial Intermediation and Economic Growth in China: New Evidence from Panel Data. *Emerging Markets Finance and Trade* 52: 724–32. [CrossRef]

Zapata, Amadeo Navarro, María Arrazola, and José de Hevia. 2023. Determinants of High-Tech Exports: New Evidence from OECD Countries. *Journal of the Knowledge Economy* 15: 1103–17. [CrossRef]

Zergawu, Y. Zewdu, Yabibal M. Walle, and José M. G. Gómez. 2020. The Joint Impact of Infrastructure and Institutions on Economic Growth. *Journal of Institutional Economics* 16: 481–502. [CrossRef]

Zhang, Qian. 2024. The Impact of Digitalization on the Upgrading of China's Manufacturing Sector's Global Value Chains. *Journal of the Knowledge Economy, 1–24*. [CrossRef]

Zhong, Sheng, and Bin Su. 2021. Investigating Asean's Participation in Global Value Chains: Production Fragmentation and Regional Integration. *Asian Development Review* 38: 159–88. [CrossRef]