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Servicification in Global Value Chains in Emerging and Developing Asian Economies

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Abstract: Servicification in global value chains (GVCs) in emerging and developing Asian economies has become a trend recently. However, there have been no scientific studies to elucidate the mechanism of servicification in GVCs. To fill this gap, this study aims to investigate the involvement of service sectors in GVCs in Asian economies in terms of the quantitative interactions between service inputs and manufacturing exports and inputs and between service inputs and service exports. For this purpose, a panel vector-autoregressive model and the Trade in Value Added database of the Organization for Economic Cooperation and Development (OECD) were used for the empirical analysis during 1995–2018. The estimation results find that, first, there exist reciprocal interactions between the business services and manufacturing sectors; foreign business service inputs are induced by manufacturing exports, whereas manufacturing inputs are induced by business service exports. Second, foreign manufacturing inputs facilitate foreign business service inputs. Third, business service inputs are promoted by business service exports. These trends in the involvement of business services' involvement in GVCs have accelerated since the mid-2000s. To enhance the role of services in GVCs, Asian economies should facilitate the removal of explicit restrictions in service trade and address regulatory divergence across countries.

Keywords: servicification; global value chains; emerging and developing Asian economies

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1. Introduction

Global value chains (GVCs) have been a remarkable trend in world economic activities over the past decades, becoming a great concern for policymakers and academics. GVCs were initially conceptualized by Koopman et al. (2014) in their study on tracing value-added by country in global production chains and measuring vertical specialization in international trade. Empirical studies have intensified since Koopman et al. (2014) provided an analytical framework for GVCs.

GVCs have experienced two kinds of structural changes in recent decades, namely, "slowbalization" and "servicification". Slowbalization means that GVC activities were slowed in the wake of the global financial crisis of 2008–2009, and since then, the pace of globalization, including the GVCs trend, has noticeably slowed (e.g., World Bank 2020; Alvarez et al. 2021). Servicification represents a more intensive involvement of service sectors in the GVCs processes. The modality of servicification in the GVCs is described by Nano and Stolzenburg (2021) in the following two ways: (1) service sectors are involved in GVCs to support manufacturing as the inevitable inputs of manufacturing production and exports (servicification in manufacturing) and (2) service sectors increasingly form their own GVCs because the "production" processes of certain services allow for fragmentation similar to that in manufacturing sectors (GVCs within service sectors).

Multiple studies have found that the share of services in value-added trade is both large (significantly larger than the share of services in gross trade) and increasing. The background of the increased presence of service sectors in GVCs is that the inclusion of

services, such as information and communication technology services and professional business services in GVCs, have enabled firms to perform better and invest in new business opportunities for better production technologies (Heuser and Mattoo 2017). COVID-19 may have accelerated the involvement of services in GVCs because the growth of global e-commerce trade accelerated during the COVID-19 pandemic (WTO 2021).

The GVCs' analyses have so far concentrated on the scope within the manufacturing sectors (Kimura 2006), and the empirical studies of servicification in GVCs have just started by mainly showing the increased presence of service sectors in GVCs. There have been no scientific studies to deeply elucidate the mechanism of servicification in GVCs in terms of "servicification of manufacturing" and "GVCs within service sectors" presented by Nano and Stolzenburg (2021). The motivation of this study is to fill this missing gap in the research on the mechanism of servicification in GVCs.

The purpose of this study is to clarify the involvement of service sectors in GVCs from the following two perspectives: "servicification of manufacturing" by quantifying the interactions between service inputs and manufacturing exports and inputs, and "GVCs within service sectors" by quantifying the interactions between service inputs and service exports. This study proposes the following two hypotheses in line with the two perspectives aligning with this study's purpose: (1) to determine whether manufacturing exports have induced business service inputs, including information technology (IT) and professional service inputs, to enhance business performances and (2) whether business service exports themselves have facilitated business service inputs, including IT and professional service inputs as a result of service sectors' fragmentation.

For the methodologies, this study considers a panel vector-autoregressive (PVAR) model using the Trade in Value Added (TiVA) database of the Organization for Economic Cooperation and Development (OECD).[1] This study targets emerging and developing Asian economies because the Asian region is a major player in GVCs expansion (Kimura 2006; Taguchi and Thet 2021; Alvarez et al. 2021) and shows the progress in servicification in GVCs (Baldwin et al. 2015). The application of a PVAR model with the TiVA database is justified by this study's purpose and hypotheses. This study did not use case studies regarding specific sectors and countries but a comprehensive and data-driven approach to clarify the mechanism of servicification in GVCs in multiple countries. In addition, the key variables in this study, the ones of service and manufacturing exports and inputs, are interdependent with one another. Thus, single-equation regressions would lead to biased and inconsistent estimators due to variables' endogeneities. Instead, a PVAR model allows for endogeneity among estimation variables and lets the data determine the causality between targeted variables.

The remainder of this study is organized as follows. Section 2 reviews the literature, focusing on theoretical and empirical studies on servicification in GVCs and emphasizing this study's contribution. Section 3 presents empirical methods, including data on key variables and methodologies for PVAR estimation. Section 4 shows estimation outcomes with interpretation. The final section summarizes, concludes, and highlights the implications of the study.

2. Literature Review and Contribution

This section reviews the literature related to servicification issues in GVCs and emphasizes this study's contribution. Discussions on servicification can be categorized into emerging patterns, causes, and impacts.

The emerging patterns of services in GVCs are illustrated by a large and increasing share of services in value-added trade (e.g., OECD et al. 2014; Johnson and Noguera 2017). In this context, Heuser and Mattoo (2017) have demonstrated that services, as a share of value-added trade, increased from below 30% in 1980 to more than 40% in 2009, while in terms of gross export, they have remained at approximately 20% since 1980. Asian and Central and Eastern European economies are no exception to this pattern (Baldwin et al. 2015; Kordalska and Olczyk 2021). From a sectoral perspective, some studies have verified

the increasing role of digital services in GVCs dynamics (Blázquez et al. 2023; Baek et al. 2023). Service involvement in GVCs may be complex and not necessarily follow a linear trend. Qiu (2020) has argued that service inputs help develop manufacturing in proximate districts but hinder it in faraway districts and that service inputs have an inverted U-shaped effect on GVC development.

The causes of servicification in GVCs have been explained by Baldwin et al. (2015) and Heuser and Mattoo (2017) as follows: (1) reclassification—many services traditionally sourced in-house by manufacturing firms, thus classified as manufacturing, began to be outsourced at arm's length and classified accordingly as services; (2) task-composition shift: connecting services—GVC emergence requires connections among geographically separated production sites, which involve services links including telecommunications, transportation, and mailing; (3) task-composition shift: changes in final goods—many manufactured goods have become more intensive in services such as software in cars and sophisticated design in machines; and (4) task–relative price shift—the prices of services tasks have increased relative to those of manufacturing tasks because manufacturing tasks are easier to offshore to lower cost locations.

The impact of servicification on GVCs can be described by the following two key aspects of economic performance: productivity growth and evolution of comparative advantage (Heuser and Mattoo 2017). Cheng and Xiao (2021) have demonstrated that the growth of producer services in the context of GVCs helps improve the productivity of final goods and services and reduces the cost of supplying producer services. Díaz-Mora et al. (2018) have argued that the foreign services value-added content of exports positively contributes to export performance. Through interviews and case studies of firms operating as suppliers of embedded services to wind and power projects in South Africa, Hansen et al. (2022) have displayed upgrades to their services in the GVCs context.

Regarding policy issues on GVC servicification, Findlay and Roelfsema (2023) have stated that restricting trade in services is detrimental to GVC participation, especially for ASEAN members. Accordingly, they have emphasized the need for policy actions to follow up on trade liberalization with a new round of lower restrictions on services trade.

Considering the aforementioned literature, this study focuses on the patterns of GVC servicification. However, the existing literature illustrated the increased presence of service sectors in GVCs as its patterns, and there have been no scientific studies to elucidate deeply the mechanism of servicification in GVCs. The novelty of this study is that it clarifies the servicification mechanism by visualizing the endogenous interactions between gross exports and inputs in business service and manufacturing sectors by checking their causalities using a PVAR framework.

3. Empirical Methods

This section empirically analyzes the involvement of the service sector in GVCs, focusing on selected emerging and developing Asian economies. This study targets the following eight Asian economies: Cambodia, China, India, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam. This section involves a descriptive analysis, followed by econometric methods, containing data on key variables and methodologies for PVAR estimation.

3.1. Descriptive Analysis

Figure 1 shows the trends in the ratio of business service content to gross exports for the eight sample economies. The trend is computed using the "total business sector services" as an industrial origin of value-added, divided by the "total gross exports" from the OECD TiVA database. These trends could be classified into three groups. Cambodia and Vietnam, with lower-middle incomes, show decreasing trends in their ratios; India and the Philippines show increasing trends; and China, Indonesia, Malaysia, and Thailand, with upper-middle incomes, display inverted U-shaped trends.[2] Thus, servicification has progressed in the selected Asian economies, except for in those with lower-middle incomes, especially since the mid-2000s. This observation motivates us to conduct a PVAR model

estimation to determine how the service inputs have been linked with manufacturing and service exports and whether the service inputs have domestic or foreign origins.

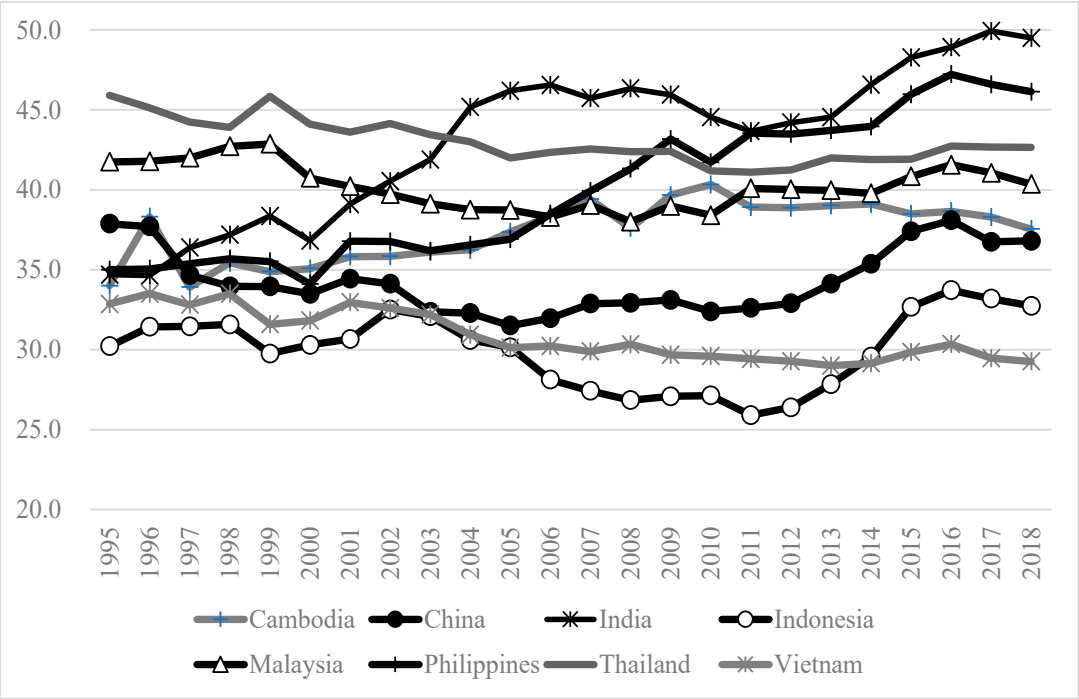

Figure 1. Ratio of service content to gross exports. Sources: author's calculation based on the OECD Stat database.

3.2. Variables and Data

This subsection identifies the variables for the PVAR model estimation. For all variables, the study samples include time-series data for the maximum data available from 1995 to 2018. Then, the study constructs a set of panel data for the eight sample countries.

Examining the interactions between service inputs and manufacturing exports and inputs requires the following variables: gross exports of manufacturing (*mex*), manufacturing value-added as the domestic origin of mex (*modm*) and foreign origin of mex (*mofm*), and value-added of "total business sector services" (hereafter, business services) as the domestic origin of mex (*mods*) and foreign origin of mex (*mofs*). The following variables are used to represent the specific vital sectors within the total business sector: the value-added of "information technology and other information services" (hereafter, IT services) as domestic origin of mex (*mods_it*) and foreign origin of mex (*mofs_it*) and value-added of "professional, scientific and technical activities" (hereafter, professional services) as domestic origin of mex (*mods_pr*) and foreign origin of mex (mofs_pr). Estimating the interactions between business service inputs and exports and manufacturing inputs requires the following variables: gross exports of business services (sex), manufacturing value-added as domestic origin of sex (*sodm*) and a foreign origin of sex (*sofm*), business service value-added as domestic origin of sex (*sods*) and foreign origin of sex (*sofs*), IT service value-added as domestic origin of sex (*sods_it*) and foreign origin of sex (sofs_it), and professional service value-added as domestic origin of sex (*sods_pr*) and foreign origin of sex (*sofs_pr*). The data source for all value-added trade variables is the OECD TiVA database (in millions of USD).

The real GDP per capita (*pcy*) is inserted as a control (exogenous) variable in the PVAR model estimation because the industrial structure might be affected by the development stage of an economy, according to Petty–Clark's law (Clark 1940). The data are retrieved from United Nations Conference on Trade and Development (UNCTAD) Stat[3], particularly the "GDP per capita, constant (2015) prices". A list of variables and data sources is presented in Table 1, and their descriptive statistics are presented in Table 2.

Table 1. List of variables and data sources.

Variables	Description	Sources
mex	Gross exports: manufacturing	OECD TiVA
modm	Domestic industrial origin of mex: manufacturing	
mofm	Foreign industrial origin of mex: manufacturing	
mods	Domestic industrial origin of mex: total business sector services	
mofs	Foreign industrial origin of mex: total business sector services	
mods_it	Domestic industrial origin of mex: IT and other information services	
mofs_it	Foreign industrial origin of mex: IT and other information services	
mods_pr	Domestic industrial origin of mex: professional, scientific and technical activities	
mofs_pr	Foreign industrial origin of mex: professional, scientific and technical activities	
sex	Gross exports: total business sector services	
sodm	Domestic industrial origin of sex: manufacturing	
sofm	Foreign industrial origin of sex: manufacturing	
sods	Domestic industrial origin of sex: total business sector services	
sofs	Foreign industrial origin of sex: total business sector services	
sods_it	Domestic industrial origin of sex: IT and other information services	
sofs_it	Foreign industrial origin of sex: IT and other information services	
sods_pr	Domestic industrial origin of sex: professional, scientific and technical activities	
sofs_pr	Foreign industrial origin of sex: professional, scientific and technical activities	
pcy	GDP per capita, constant (2015) prices	UNCTAD

Sources: Authors' description. Note: the unit of TiVA data are millions of USD, and that of GDP per capita is USD.

Table 2. Descriptive statistics.

Variables	Obs.	Median	Std. Dev.	Min.	Max
mex	192	56,505	362,669	542	1,985,752
modm	192	20,890	172,045	304	950,085
mofm	192	7235	28,101	73	144,141
mods	192	7107	74,214	52	440,950
mofs	192	6794	25,860	77	129,591
mods_it	192	44	1716	0	11,340
mofs_it	192	178	792	1	4685
mods_pr	192	81	4370	1	26,168
mofs_pr	192	614	2979	6	15,292
sex	192	22,765	79,381	248	394,099
sodm	192	1209	8583	15	43,641
sofm	192	1133	1919	28	9447
sods	192	16,258	59,220	156	303,352
sofs	192	1710	3154	29	15,079
sods_it	192	211	12,542	1	71,096
sofs_it	192	71	143	1	706
sods_pr	192	701	3657	3	20,940
sofs_pr	192	173	470	3	2055
pcy	192	2256	2491	383	10,778

Sources: Authors' description. Note: the unit of TiVA data are millions of USD, and that of GDP per capita is USD.

The estimation adds another important variable, that is, the period dummy variable for 2006–2018 (*d06*), to identify the acceleration of servicification in sample economies since the mid-2000s, as shown in Section 3.1. The dummy value takes one for 2006–2018 and is attached to the following service input variables: *mods*, *mofs*, *mods_it*, *mofs_it*, *mods_pr*, *mofs_pr*, *sods*, *sofs*, *sods_it*, *sofs_it*, *sods_pr*, and *sofs_pr*.

3.3. Data Property

Before conducting the PVAR model estimation, this study investigates the stationarity of the data by employing panel unit root tests for each variable and, if required, a panel co-integration test for a set of variables. Panel unit-root tests are first conducted on the null hypothesis, suggesting that the level and/or first difference of the individual data have a unit root. If the unit-root tests reveal that each variable's data are not stationary at a given

level but stationary in the first difference, a set of variables' data corresponds to the case of $I(1)$. Then, it can be further examined using a co-integration test for "level" data. If a set of variables' data are identified to have co-integration, using "level" data is justified for model estimation.

For the panel unit-root tests, this study applies the Levin, Lin, and Chu (LLC) test (Levin et al. 2002) as a common unit-root test and the Fisher-ADF and Fisher-PP tests (Choi 2001; Maddala and Wu 1999) and Im, Pesaran, and Shin test (Im et al. 2003) as individual unit-root tests. The common unit-root test assumes that there is a common unit-root process across cross-sections, whereas the individual unit-root test allows for individual unit-root processes to vary across cross-sections. This study conducts a Johansen-Fisher panel co-integration test (Maddala and Wu 1999). All test equations contain individual intercepts and trends, with the lag length being the automatic selection.

Tables 3 and 4 list the test results. The common and individual unit root tests do not reject the null hypothesis of a unit-root in level data at conventional significance levels[4]; however, the null hypothesis is rejected in the first differences for all variables. Therefore, the variables follow the case of $I(1)$. Subsequently, the panel co-integration test is conducted on the combinations of variables, and the results (trace and max-eigenvalues) suggest that the level series for a set of variables' data are co-integrated. Thus, this study utilizes level data for subsequent estimations.

Table 3. Panel unit-root tests.

Variables	Obs.	Median	Std. Dev.	Min.	Max
mex	192	56,505	362,669	542	1,985,752
modm	192	20,890	172,045	304	950,085
mofm	192	7235	28,101	73	144,141
mods	192	7107	74,214	52	440,950
mofs	192	6794	25,860	77	129,591
mods_it	192	44	1716	0	11,340
mofs_it	192	178	792	1	4685
mods_pr	192	81	4370	1	26,168
mofs_pr	192	614	2979	6	15,292
sex	192	22,765	79,381	248	394,099
sodm	192	1209	8583	15	43,641
sofm	192	1133	1919	28	9447
sods	192	16,258	59,220	156	303,352
sofs	192	1710	3154	29	15,079
sods_it	192	211	12,542	1	71,096
sofs_it	192	71	143	1	706
sods_pr	192	701	3657	3	20,940
sofs_pr	192	173	470	3	2055
pcy	192	2256	2491	383	10,778

Sources: authors' estimation. Note: * and *** denote statistical significance at the 10% and 1% levels, respectively.

Table 4. Panel co-integration test.

Johansen Fisher Panel Cointegration Test		
Group	***Trace Test***	***Max-Eigen Test***
mex, modm, mofm, mods, mofs	259.9 ***	168.1 ***
mex, modm, mofm, mods_it, mofs_it	209.8 ***	136.3 ***
mex, modm, mofm, mods_pr, mofs_pr	225.8 ***	157.4 ***
sex, sodm, sofm, sods, dofs	202.2 ***	134.6 ***
sex, sodm, sofm, sods_it, dofs_it	254.3 ***	171.9 ***
sex, sodm, sofm, sods_pr, dofs_pr	222.2 ***	132.6 ***

Sources: authors' estimation. Note: *** denotes statistical significance at the 1% level.

3.4. PVAR Model Specification

This study adopts a PVAR model to examine the quantitative interactions between service inputs and manufacturing exports and inputs and those between service inputs and

service exports. The application of a PVAR model is justified by this study's property with a comprehensive and data-driven approach to clarify the mechanism of servicification in GVCs in multiple countries. In addition, the key variables in this study, the ones of service and manufacturing exports and inputs, are interdependent with each other. Thus, single-equation regressions would lead to biased and inconsistent estimators due to variables' endogeneities. Instead, a PVAR model allows for endogeneity among estimation variables and lets the data determine the causality between targeted variables. There have been no scientific studies to elucidate the mechanism of servicification in GVCs with a PVAR model. The PVAR model can be specified for the estimation as follows:

$$y_{it} = \mu + V_1\, y_{it-1} + V_2\, z_{it} + f_i + f_t + \varepsilon_t \quad (1)$$

where the subscripts i and t denote the eight sampled Asian economies and the years 1995–2018. y is a column vector of the endogenous variables, that is, y = (*mex*, *modm*, *mofm*, *mods*, *mods*d06*, *mofs*, *mofs*d06*)′ to examine the interactions between business service inputs and manufacturing exports and inputs; y = (*mex*, *modm*, *mofm*, *mods_it*, *mods_it*d06*, *mofs_it*, *mofs_it*d06*)′ to examine the interactions between IT service inputs and manufacturing exports and inputs; y = (*mex*, *modm*, *mofm*, *mods_pr*, *mods_pr*d06*, *mofs_pr*, *mofs_pr*d06*)′ to examine the interactions between professional service inputs and manufacturing exports and inputs; y = (*sex*, *sodm*, *sofm*, *sods*, *sods*d06*, *sofs*, *sofs*d06*)′ to examine the interactions between business service inputs and exports and manufacturing inputs; y = (*sex*, *sodm*, *sofm*, *sods_it*, *sods_it*d06*, *sofs_it*, *sofs_it*d06*)′ to examine the interactions among IT service inputs, business service exports and manufacturing inputs; and y = (*sex*, *sodm*, *sofm*, *sods_pr*, *sods_pr*d06*, *sofs_pr*, *sofs_pr*d06*)′ to examine the interactions among professional service inputs, business service exports and manufacturing inputs.

The other vectors are as follows: y_{-1} is a vector of the one-year lagged endogenous variables rooted in a limited number of time-series data; z is the control variable of real GDP per capita (*pcy*); f_i and f_t represent time-invariant country-specific and country-invariant time-specific fixed effects, respectively; μ is a constant vector; V_1 and V_2 are coefficient matrices; and ε_t is a vector of the random error terms in the system. This panel estimation applies the fixed-effects model represented by f_i and f_t for the following reasons. From a statistical perspective, the Hausman specification test (Hausman 1978) is generally used to choose between fixed- and random-effects models. However, this study emphasizes the existence of exogenous factors affecting value-added trade. For instance, time-invariant factors, such as political systems, institutional quality, technology-absorbing capacity, and economic strategies, might widely differ among the sample economies, and these country-specific factors might be correlated with value-added trade. There are also country-invariant time-specific factors, namely, economic fluctuations caused by external shocks, such as the Asian financial crisis in 1997–1998 and the global financial crisis in 2008–2009. Accordingly, because these factors are correlated with the error term among the sample economies for the given sample period, simple pooled estimates that ignore this correlation may lead to an inefficient estimation. Additionally, adopting the fixed-effects model can alleviate the endogeneity problem by absorbing unobserved heterogeneity among the sample countries. Thus, a fixed-effects model is adopted for all estimations in this study.

Based on these specifications, the analysis estimates the PVAR model and examines Granger causalities among the endogenous variables using a block exogeneity test. The block exogeneity test provides a data-driven toolkit to determine whether a variable should be included or excluded from an estimation model. This test justifies the inclusion of a variable based on Granger causality in the PVAR framework. Granger causality was identified by rejecting the null hypothesis that a variable is excluded from the PVAR model.

4. Estimation Results and Discussion

Table 5 shows the PVAR model estimation results, and Table 6 presents the block exogeneity test results based on the PVAR model estimation. The estimation results are summarized in the following subsections.

Table 5. PVAR model estimation results.

(a) Interactions between IT service inputs and manufacturing exports and inputs.							
	mex	***modm***	***mofm***	***mods***	***mods*d06***	***mofs***	***mofs*d06***
mex−*1*	1.853 ***	0.457 *	0.130 *	0.073	0.19	0.162 **	0.211 **
	[3.098]	[1.755]	[1.741]	[0.858]	[1.514]	[2.394]	[2.424]
modm−*1*	−0.005	0.818 **	−0.088	0.182	0.046	−0.127	−0.200 *
	[−0.006]	[2.244]	[−0.843]	[1.516]	[0.261]	[−1.335]	[−1.646]
mofm−*1*	11.216 ***	4.989 ***	2.303 ***	1.280 **	1.438 *	1.496 ***	1.395 **
	[2.987]	[3.054]	[4.902]	[2.381]	[1.822]	[3.511]	[2.559]
mods−*1*	−5.588 ***	−2.589 ***	−0.510 ***	0.287	−0.398	−0.514 ***	−0.517 ***
	[−4.129]	[−4.397]	[−3.012]	[1.484]	[−1.400]	[−3.345]	[−2.631]
*mods*d06*−*1*	2.698 **	1.350 **	0.259	0.155	0.703 **	0.221	0.176
	[2.001]	[2.302]	[1.536]	[0.804]	[2.483]	[1.446]	[0.901]
mofs−*1*	−13.703 **	−6.031 **	−1.781 **	−1.798 *	−2.134	−1.119	−1.672 *
	[−2.124]	[−2.149]	[−2.207]	[−1.948]	[−1.574]	[−1.529]	[−1.786]
*mofs*d06*−*1*	−3.719 *	−1.739 **	−0.398 *	−0.182	−0.246	−0.325	0.301
	[−1.948]	[−2.094]	[−1.668]	[−0.668]	[−0.613]	[−1.503]	[1.087]
pcy	36.793 ***	16.550 ***	4.297 ***	3.354 **	4.761 **	3.844 ***	5.599 ***
	[3.640]	[3.763]	[3.398]	[2.318]	[2.242]	[3.352]	[3.816]
adj. R^2	0.99	0.992	0.974	0.995	0.99	0.974	0.960
(b) Interactions between IT service inputs and manufacturing exports and inputs.							
	mex	***modm***	***mofm***	***mods_it***	***mods_it*d06***	***mofs_it***	***mofs_it*d06***
mex−*1*	0.068	−0.322 **	−0.057	−0.001	−0.000	−0.001	−0.000
	[0.212]	[−2.300]	[−1.507]	[−0.444]	[−0.028]	[−0.756]	[−0.003]
modm−*1*	1.791 ***	1.607 ***	0.128 *	0.005	0.005	0.003	0.001
	[2.972]	[6.131]	[1.816]	[0.989]	[0.814]	[1.191]	[0.436]
mofm−*1*	6.472 ***	2.546 ***	1.669 ***	−0.031 ***	−0.000	0.018 ***	0.022 ***
	[4.590]	[4.151]	[10.140]	[−2.908]	[−0.034]	[3.338]	[3.579]
mods_it−*1*	13.549	6.66	0.666	1.083 ***	1.280 ***	0.065	0.247 **
	[0.592]	[0.669]	[0.249]	[6.195]	[5.383]	[0.766]	[2.453]
*mods_it*d06*−*1*	15.936	8.72	2.021	−0.161	−0.018	0.03	−0.091
	[0.882]	[1.109]	[0.958]	[−1.169]	[−0.097]	[0.443]	[−1.150]
mofs_it−*1*	−210.96 **	−85.809 **	−27.825 ***	1.325 *	−1.395	0.092	−1.103 ***
	[−2.351]	[−2.199]	[−2.658]	[1.932]	[−1.497]	[0.276]	[−2.796]
*mofs_it*d06*−*1*	−53.719	−23.444	−9.343	−0.531	0.585	−0.193	0.749 ***
	[−1.030]	[−1.034]	[−1.535]	[−1.333]	[1.079]	[−0.990	[3.267]
pcy	25.092 **	10.586 **	4.430 ***	0.149 **	0.063	0.125 ***	0.140 ***
	[2.531]	[2.455]	[3.829]	[1.962]	[0.611]	[3.377]	[3.207]
adj. R^2	0.99	0.991	0.976	0.973	0.946	0.969	0.959
(c) Interactions between professional service inputs and manufacturing exports and inputs.							
	mex	***modm***	***mofm***	***mods_pr***	***mods_pr *d06***	***mofs_pr***	***mofs_pr *d06***
mex−*1*	0.887 **	0.008	0.07	−0.013 ***	−0.013 ***	0.006	0.006
	[2.386]	[0.047]	[1.510]	[−3.427]	[−2.801]	[1.329]	[0.983]
modm−*1*	1.306 **	1.456 ***	−0.023	0.041 ***	0.044 ***	0	0.001
	[1.994]	[5.150]	[−0.282]	[6.289]	[5.427]	[0.048]	[0.124]
mofm−*1*	5.666 ***	2.055 ***	1.760 ***	0.073 ***	0.078 ***	0.087 ***	0.074 ***
	[3.324]	[2.793]	[8.313]	[4.291]	[3.698]	[3.974]	[2.580]
mods_pr−*1*	−28.931	−19.286 *	−2.084	1.119 ***	1.081 ***	−0.077	0.673
	[−1.097]	[−1.695]	[−0.636]	[4.248]	[3.322]	[−0.228]	[1.513]
*mods_pr*d06*−*1*	2.466	7.037	0.357	−0.540 **	−0.540 *	−0.140	−0.921 **
	[0.093]	[0.613]	[0.108]	[−2.032]	[−1.646]	[−0.409]	[−2.054]
mofs_pr−*1*	−84.806 **	−29.662 **	−13.567 ***	−1.176 ***	−1.473 ***	−0.532	−1.280 **
	[−2.510]	[−2.034]	[−3.232]	[−3.484]	[−3.533]	[−1.225]	[−2.247]
*mofs_pr*d06*−*1*	−2.893	−4.349	−0.453	0.397 **	0.678 ***	0.051	1.038 ***
	[−0.171]	[−0.596]	[−0.216]	[2.350]	[3.249]	[0.234]	[3.644]
pcy	45.425 ***	20.759 ***	5.925 ***	0.222 **	0.191	0.561 ***	0.590 ***
	[4.625]	[4.897]	[4.856]	[2.266]	[1.579]	[4.440]	[3.561]

Table 5. *Cont*.

adj. R^2	0.991	0.992	0.976	0.994	0.991	0.978	0.963
(d) Interactions between business service inputs and exports and manufacturing inputs.							
	sex	***sodm***	***sofm***	***sods***	***sods *d06***	***sofs***	***sofs *d06***
sex−1	3.247 ***	0.350 ***	0.093 ***	1.396 ***	2.473 ***	0.178 ***	0.243 ***
	[4.658]	[4.525]	[3.096]	[3.024]	[4.024]	[3.948]	[4.619]
sodm−1	−3.776 ***	0.324 ***	−0.164 ***	−2.033 ***	−3.399 ***	−0.285 ***	−0.388 ***
	[−3.504]	[2.713]	[−3.521]	[−2.848]	[−3.578]	[−4.083]	[−4.771]
sofm−1	−1.741	0.327	0.775 ***	−2.027	−3.720	−0.171	−0.351
	[−0.457]	[0.773]	[4.711]	[−0.802]	[−1.107]	[−0.694]	[−1.220]
sods−1	−2.304 ***	−0.372 ***	−0.093 ***	−0.416	−2.058 ***	−0.174 ***	−0.242 ***
	[−3.203]	[−4.662]	[−3.007]	[−0.874]	[−3.246]	[−3.729]	[−4.465]
*sods*d06−1*	0.0787	0.027	0.001	0.021	0.541 ***	−0.002	−0.007
	[0.457]	[1.420]	[0.135]	[0.184]	[3.562]	[−0.208]	[−0.513]
sofs−1	−4.569	−0.971 ***	−0.170	−2.451	−2.641	0.482 **	−0.111
	[−1.546]	[−2.965]	[−1.335]	[−1.252]	[−1.014]	[2.518]	[−0.490]
*sofs*d06−1*	−2.082	−0.357 *	−0.084	−1.116	−1.831	−0.048	0.605 ***
	[−1.204]	[−1.862]	[−1.120]	[−0.974]	[−1.201]	[−0.425]	[4.643]
pcy	5.647 **	0.980 ***	0.277 ***	3.094 **	5.290 **	0.294 *	0.626 ***
	[2.373]	[3.714]	[2.699	[1.962]	[2.522]	[1.908]	[3.489]
adj. R^2	0.987	0.986	0.958	0.99	0.983	0.965	0.959
(e) Interactions among IT service inputs, business service exports, and manufacturing inputs.							
	sex	***sodm***	***sofm***	***sods_it***	***sods_it *d06***	***sofs_it***	***sofs_it *d06***
sex−1	0.834 ***	−0.016	−0.000	0.015	−0.003	0.001	−0.000
	[4.353]	[−0.711]	[−0.008]	[0.629]	[−0.096]	[0.914]	[−0.485]
sodm−1	0.704	0.966 ***	−0.031	0.045	0.192	−0.004	0
	[0.517]	[6.100]	[−0.538]	[0.259]	[0.818]	[−0.869]	[0.037]
sofm−1	1.231	0.477 **	0.950 ***	−0.923 ***	−0.798 **	−0.007	0.001
	[0.602]	[2.002]	[10.903]	[−3.560]	[−2.267]	[−0.911]	[0.078]
sods_it−1	0.73	0.012	0.001	1.232 ***	0.911 ***	0.002	0.007
	[0.974]	[0.143]	[0.025]	[12.977]	[7.062]	[0.676]	[2.174]
*sods_it*d06−1*	−0.142	0.038	0.008	−0.196 ***	0.228 **	−0.003	−0.004 **
	[−0.259]	[0.602]	[0.354]	[−2.832]	[2.421]	[−1.295]	[−2.022]
sofs_it−1	0.134	−2.905	−0.664	11.184 ***	9.276 *	0.722 ***	0.064
	[0.004]	[−0.781]	[−0.488]	[2.762]	[1.686]	[6.296]	[0.502]
*sofs_it*d06−1*	−22.679	−3.404	−1.145	−2.361	0.982	0.003	0.745 ***
	[−0.963]	[−1.242]	[−1.143]	[−0.791]	[0.242]	[0.030]	[7.898]
pcy	4.932 *	0.847 ***	0.260 **	−0.069	−0.199	0.025 ***	0.041 ***
	[1.880]	[2.772]	[2.323]	[−0.208]	[−0.440]	[2.692]	[3.880]
adj. R^2	0.986	0.984	0.956	0.991	0.9836	0.944	0.937
(f) Interactions among professional service inputs, business service exports, and manufacturing inputs.							
	sex	***sodm***	***sofm***	***sods_pr***	***sods_pr *d06***	***sofs_pr***	***sofs_pr *d06***
sex−1	1.114 ***	0.019	0.012 **	0.035 ***	0.039 ***	0.005 ***	0.004 **
	[8.378]	[1.201]	[2.114]	[4.916]	[4.869]	[3.566]	[2.401]
sodm−1	−0.643	0.777 ***	−0.065	−0.057	−0.033	−0.026 ***	−0.023 *
	[−0.631]	[6.524]	[−1.496]	[−1.051]	[−0.537]	[−2.623]	[−1.951]
sofm−1	−0.894	0.383	0.922 ***	−0.254	−0.232	0.037	0.027
	[−0.284]	[1.039]	[6.880]	[−1.517]	[−1.221]	[1.230]	[0.757]
sods_pr−1	−7.245 *	−1.220 **	−0.197	0.154	−0.396	−0.001	−0.010
	[−1.726]	[−2.485]	[−1.102]	[0.690]	[−1.564]	[−0.037]	[−0.203]
*sods_pr*d06−1*	5.475	0.988 *	0.08	0.378	0.846 ***	−0.024	−0.017
	[1.262]	[1.947]	[0.430]	[1.642]	[3.234]	[−0.579]	[−0.354]
sofs_pr−1	24.208	1.714	−0.373	−0.563	−0.861	0.388	−0.035
	[0.909]	[0.550]	[−0.328]	[−0.398]	[−0.536]	[1.517]	[−0.117]
*sofs_pr*d06−1*	−25.141	−3.272	−0.392	−0.880	−0.606	0.219	0.815 ***
	[−1.427]	[−1.588]	[−0.522]	[−0.940]	[−0.571]	[1.292]	[4.073]
pcy	3.604	0.630 **	0.204 **	0.405 ***	0.426 ***	0.019	0.046 *
	[1.593]	[2.382]	[2.115]	[3.366]	[3.120]	[0.857]	[1.796]
adj. R^2	0.986	0.984	0.956	0.981	0.977	0.963	0.954

Sources: authors' estimation. Note: *, **, and *** denote rejection of the null hypothesis at 90%, 95%, and 99% levels, respectively. The t-statistics are shown in parentheses.

Table 6. Block exogeneity test results.

Dependent Variable	Excluded	Chi-sq	df	Probability
(a) Causalities between business service inputs and manufacturing exports and inputs.				
mex	*modm*	0	1	0.996
	mofm	8.919	1	0.003
	mods	17.049	1	0.000 (negative)
	mofs	4.512	1	0.034 (negative)
modm	*mex*	3.081	1	0.079
	mods	19.335	1	0.000 (negative)
	mofs	4.618	1	0.032 (negative)
mofm	*mex*	3.03	1	0.082
	mods	9.073	1	0.003 (negative)
	mofs	4.873	1	0.027 (negative)
mods	*mex*	0.736	1	0.391
	modm	2.298	1	0.13
	mofm	5.669	1	0.017
*mods*d06*	*mex*	2.293	1	0.13
	modm	0.068	1	0.794
	mofm	3.321	1	0.068
mofs	*mex*	5.729	1	0.017
	modm	1.781	1	0.182
	mofm	12.329	1	0
*mofs*d06*	*mex*	5.878	1	0.015
	modm	2.711	1	0.1
	mofm	6.549	1	0.011
(b) Causalities between IT service inputs and manufacturing exports and inputs.				
Dependent Variable	**Excluded**	**Chi-sq**	**df**	**Probability**
mods_it	*mex*	0.197	1	0.657
	modm	0.978	1	0.323
	mofm	8.457	1	0.004 (negative)
*mods_it*d06*	*mex*	0.001	1	0.977
	modm	0.663	1	0.416
	mofm	0.001	1	0.973
mofs_it	*mex*	0.572	1	0.449
	modm	1.419	1	0.234
	mofm	11.144	1	0.001
*mofs_it*d06*	*mex*	0	1	0.997
	modm	0.19	1	0.663
	mofm	12.806	1	0
(c) Causalities between professional service inputs and manufacturing exports and inputs.				
Dependent Variable	**Excluded**	**Chi-sq**	**df**	**Probability**
mods_pr	*mex*	11.742	1	0.001 (negative)
	modm	39.555	1	0
	mofm	18.416	1	0
*mods_pr*d06*	*mex*	7.846	1	0.005 (negative)
	modm	29.449	1	0
	mofm	13.674	1	0
mofs_pr	*mex*	1.767	1	0.184
	modm	0.002	1	0.962
	mofm	15.79	1	0
*mofs_pr*d06*	*mex*	0.966	1	0.326
	modm	0.015	1	0.901
	mofm	6.657	1	0.01
(d) Causalities among business service, IT service, and professional service inputs, business service exports, and manufacturing inputs.				
Dependent Variable	**Excluded**	**Chi-sq**	**df**	**Probability**
sex	*sodm*	12.276	1	0.001 (negative)
	sofm	0.208	1	0.648 (negative)
	sods	10.256	1	0.001 (negative)
	sodm	2.391	1	0.122 (negative)
sodm	*sex*	20.478	1	0
	sods	21.73	1	0.000 (negative)
	sofs	8.789	1	0.003 (negative)

Table 6. *Cont.*

sofm	*sex*	9.584	1	0.002
	sods	9.039	1	0.003 (negative)
	sofs	1.782	1	0.182 (negative)
sods	*sex*	9.142	1	0.003
*sods*d06*		16.193	1	0
sofs		15.584	1	0
*sofs*d06*		21.338	1	0
sods_it	*sex*	0.396	1	0.529
*sods_it*d06*		0.009	1	0.924
sofs_it		0.836	1	0.361
*sofs_it*d06*		0.235	1	0.628
sods_pr	*sex*	24.164	1	0
*sods_pr*d06*		23.711	1	0
sofs_pr		12.718	1	0
*sofs_pr*d06*		5.766	1	0.016

Sources: authors' estimation.

4.1. Causalities between Business Service Inputs and Manufacturing Exports and Inputs

The Granger causalities with positive signs and conventionally significant levels are confirmed in Tables 5a and 6a as follows: from foreign manufacturing inputs (*mofm*) to manufacturing exports (*mex*), from manufacturing exports (*mex*) to domestic and foreign manufacturing inputs (*modm* and *mofm*), from foreign manufacturing inputs (*mofm*) to domestic business service inputs and their cross-term with a period dummy for 2006–2018 (*mods* and *mods*d06*), and from manufacturing exports and foreign manufacturing inputs (*mex* and *mofm*) to foreign business service inputs and their cross-term with a period dummy for 2006–2018 (*mofs* and *mofs*d06*).

These results can be interpreted as follows. First, within manufacturing sectors, reciprocal interactions between manufacturing exports and inputs, except domestic ones, are identified. This implies a solid linkage in manufacturing GVCs, where foreign manufacturing inputs are the driving forces behind manufacturing exports. Second, regarding the interactions between business service inputs and manufacturing exports and inputs, the estimation results suggest that business service inputs, particularly foreign inputs, have been facilitated by manufacturing exports and foreign manufacturing inputs. This trend has accelerated since the mid-2000s. This finding implies that business services are actively involved in manufacturing GVC activities.

Delving into individual service sectors, namely, IT and professional services, the Granger causalities with positive signs and conventionally significant levels are confirmed in Tables 5b and 6c as follows: from foreign manufacturing inputs (*mofm*) to foreign IT service inputs and their cross-term with a period dummy for 2006–2018 (*mofs_it* and *mofs_it*d06*), from domestic and foreign manufacturing inputs (*modm* and *mofm*) to domestic professional service inputs and their cross-term with a period dummy for 2006–2018 (*mods_pr* and *mods_pr*d06*), and from foreign manufacturing inputs (*mofm*) to foreign professional service inputs and their cross-term with a period dummy for 2006–2018 (*mofs_pr* and *mofs_pr*d06*). These results suggest that IT and professional service inputs, particularly foreign inputs, are promoted by foreign manufacturing inputs. This trend has also accelerated since the mid-2000s. This implies the active involvement of IT and professional services in manufacturing GVC activities.

4.2. Causalities between Business Service Inputs and Exports and Manufacturing Inputs

The Granger causalities with positive signs and conventionally significant levels are verified in Tables 5d–f and 6d as follows: from business service exports (*sex*) to domestic and foreign manufacturing inputs (*sodm* and *sofm*), from business service exports (*sex*) to domestic and foreign business service inputs and their cross-term with a period dummy for 2006–2018 (*sods*, *sods*d06*, *sofs*, and *sofs*d06*), and from business service exports *(sex)* to domestic and foreign professional service inputs and their cross-term with a period dummy for 2006–2018 (*sods_pr*, *sods_pr*d06*, *sofs_pr*, and *sofs_pr*d06*). These results suggest

that, first, both domestic and foreign manufacturing inputs are induced by business service exports. Second, within business service sectors, business service inputs and professional service inputs, regardless of whether they are domestic or foreign, have been facilitated by business service exports. These trends have also accelerated since the mid-2000s. This finding implies the active involvement of business services, including professional services, in business service GVC activities.

4.3. Summary of Findings and Policy Implications

In the block exogeneity tests in this study, all the combinations between gross exports and inputs in business service and manufacturing sectors were comprehensively examined in terms of causalities through Sections 4.1 and 4.2 based on Table 6. Thus, no significant results were left unanalyzed regarding the mechanism of servicification in GVCs. The key findings of the test results (illustrated in Figure 2) are as follows: First, reciprocal interactions between the business services and manufacturing sectors are confirmed. Thus, foreign business service inputs are induced by manufacturing exports, whereas manufacturing inputs are induced by business service exports. Second, foreign business service inputs, including IT and professional services, are facilitated by foreign manufacturing inputs. Third, business service inputs, including professional service inputs, are promoted by business service exports. These trends in the involvement of business services, including IT and professional services in GVC activities, have accelerated since the mid-2000s in all aspects. These findings to support servicification in GVCs, including IT and professional services, are consistent with the existing literature on servicification, such as OECD et al. (2014), Johnson and Noguera (2017), Heuser and Mattoo (2017), Baldwin et al. (2015), Blázquez et al. (2023), and Baek et al. (2023). However, this study is different from earlier studies in that it provided deep insights into the mechanism of servicification in GVCs by quantifying the interactions between gross exports and inputs in business service and manufacturing sectors. In addition, this study demonstrated the role of IT and professional services in servicification in GVCs. This finding implies that "Task-composition shift: changes in final goods" as one of the causes of servicification (presented by Baldwin et al. 2015, and Heuser and Mattoo 2017) has a significant effect, ensuring that servicification can contribute to productivity growth and evolution of comparative advantage.

The policy implication is that there should be room to create better environments for trade in services, especially considering that servicification in the GVC processes has accelerated in Asian economies. Heuser and Mattoo (2017) have put forth the following two types of policy issues inhibiting the enhanced role of services in GVCs: explicit restrictions on foreign services and service suppliers and regulatory divergence across countries, which reduce the intercompatibility of goods, services, and service components needed for fragmenting production across countries. The World Bank provides the Services Trade Restrictions Index that represents the restrictiveness of service trade policies across countries[5]. This index is based on data collected between 2008 and 2010 from 103 countries; it ranges from zero (completely open) to 100 (completely closed). Focusing on the sample economies in this study, the index scores of China (36.6), India (65.7), Indonesia (50.0), Malaysia (46.1), the Philippines (53.5), Thailand (48.0), and Vietnam (41.5) exceed the world sample average (28.4) (only Cambodia's index, 23.7, is below the average). This observation suggests that even the Asian economies that have reaped huge benefits from trade liberalization and investment in goods continue to restrict foreign presence in services. Findlay and Roelfsema (2023) have also pointed out the restrictions on trade in services in developing Asian countries, arguing that they are detrimental to GVCs' participation as ASEAN members. Instead, there are empirical studies demonstrating that reducing trade restrictions on service trade can provide spillover benefits for firms in manufacturing sectors as well as service sectors (Francois and Hoekman 2010; Beverelli et al. 2017; Shepherd 2019). Thus, regulatory cooperation in Asia is necessary to address regulatory divergence and facilitate the removal of explicit restrictions.

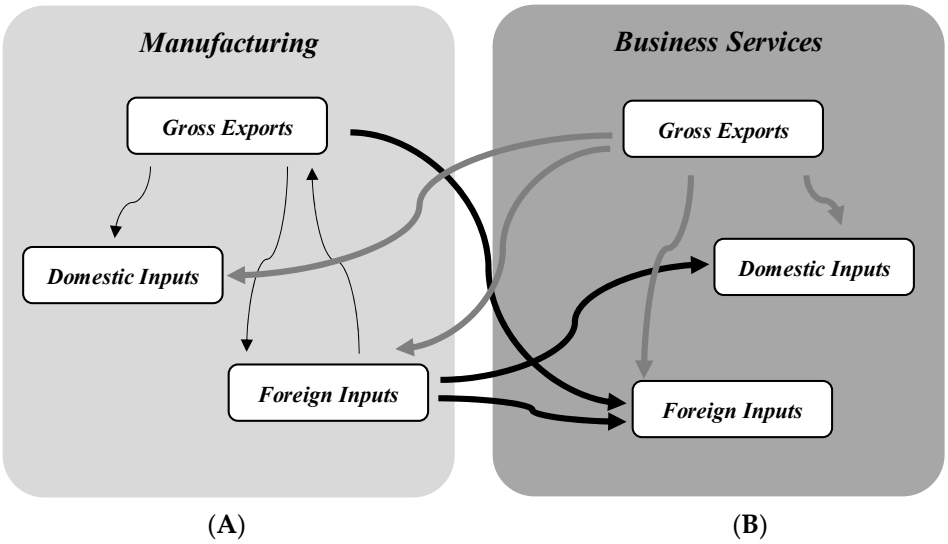

Figure 2. Key findings of causalities between manufacturing and business services. Note: A → B denoted the causality from A to B. Sources: authors' illustration.

5. Concluding Remarks

This study investigated the involvement of service sectors in GVCs in selected emerging and developing Asian economies by examining the quantitative interactions between service inputs and manufacturing exports and inputs and those between service inputs and service exports using a PVAR model based on the OECD TiVA database. This study aimed to visualize the endogenous interactions of value-added trade variables related to service sectors by checking their causalities in a PVAR framework, especially considering that previous studies have failed to do so.

The main findings of the estimation results are as follows. First, reciprocal interactions between the business services and manufacturing sectors are confirmed. Therefore, foreign business service inputs are induced by manufacturing exports, whereas manufacturing inputs are induced by business service exports. Second, foreign business service inputs, including IT and professional service inputs, are facilitated by foreign manufacturing. Third, business service inputs, including professional service inputs, are promoted by business service exports. These trends in the involvement of business services, including IT and professional services in GVC activities, have accelerated since the mid-2000s in all aspects.

A policy implication of this study is that there should be room to create better environments for trade in services following the post-COVID-19 era because servicification in GVC processes has accelerated in Asian economies. Since Asian economies, having reaped huge benefits from trade liberalization and investment in goods, have continued to maintain restrictions on foreign presence in services, regulatory cooperation in the Asian region is necessary to address regulatory divergence and facilitate the removal of explicit restrictions.

The limitation of this study is its lack of more detailed and in-depth analyses of servicification in GVCs in Asian economies. By conducting case studies on individual sectors and countries to examine the complexity of servicification in Asian GVCs, as well as studies as to how regulatory divergence has hindered their services in trade, it would be possible to validate the evidence found in this study and to develop more concrete recommendations for facilitating servicification in Asian GVCs.

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Notes

1 See the website: https://stats.oecd.org/ (accessed on 1 February 2024).

2 The income classification is based on World Bank's classification. Please see https://datahelpdesk.worldbank.org/knowledgebase/articles/906519 (accessed on 1 February 2024).

3 See the website: https://unctadstat.unctad.org/datacentre/ (accessed on 1 February 2024).

4 In the variable *pcy*, a unit-root is rejected; however, when considering only the LLC, a weak significant level is seen.

5 See the website: https://www.worldbank.org/en/research/brief/services-trade-restrictions-database (accessed on 1 February 2024).

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