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Servicification in Global Value Chains toward Post-COVID-19 Era 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 missing gap, this study aims at investigating the involvement of service sectors into 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 (TiVA 2023) database of the Organization for Economic Cooperation and Development (OECD) are used for the empirical analysis during 1995-2020. 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 from the mid-2000s and are expected to expand toward the post-COVID-19 era. To enhance role of services in GVCs, Asian economies should facilitate the removal of explicit restrictions in service trade and address regulatory divergence across countries.

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

JEL Classification Codes: F14, O53

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 GVCs activities were slowed down 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 to 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 elucidate deeply 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 in this study's purpose: 1) whether manufacturing exports have induced business service inputs to enhance business performances, and 2) whether business service exports themselves have facilitated business 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 2023) 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 TiVA database is justified by this study's purpose and hypotheses. This study applies not case studies with specific sectors and countries but comprehensive and data-driven approach to clarify the mechanism of servicification in GVCs in multi 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.

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

[1] See the website: https://data-explorer.oecd.org/.

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) have 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 proved an upgrading of their services in the GVCs context.

Regarding policy issues on GVCs servicification, Findlay and Roelfsema (2023) have stated that restricting trade in services is detrimental to GVCs 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 GVCs servicification. However, the existing literature has just 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 the 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, the lower-middle incomers, show decreasing trends in their ratios; India and the Philippines show increasing trends; and China, Indonesia, Malaysia, and Thailand, the upper-middle incomers, display inverted U shaped trends.[2] Thus, servicification has progressed in the selected Asian economies, except for in the lower-middle incomers, especially since 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.

[2] The income classification is based on World Bank's classification. Please see https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

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 2020. 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 domestic origin of *mex* (*modm*) and foreign origin of *mex* (*mofm*), and value-added of "total business sector services" (hereafter, business services) as domestic origin of *mex* (*mods*) and foreign origin of *mex* (*mofs*). 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*). The data source for all value-added trade variables is the OECD TiVA 2023 database (in millions of US dollars).

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.

The estimation adds another important variable, that is, the period dummy variable for 2006–2020 (*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 2006–2020 and is attached to the following service input variables: *mods*, *mofs*, *sods*, and *sofs*.

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

[3] See the website: https://unctadstat.unctad.org/datacentre/.

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 is 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; however, the null hypothesis is rejected in the first differences for all variables (except for *pcy* in Fisher-PP test). 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.

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 comprehensive and data-driven approach to clarify the mechanism of servicification in GVCs in multi 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 1995–2020. 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; and y = (*sex*, *sodm*, *sofm*, *sods*, s*ods*d06*, *sofs*, s*ofs*d06*)' to examine the interactions between business service inputs and 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 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 Interpretations

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.

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 domestic manufacturing inputs (*modm*) to domestic business service inputs (*mods*), from foreign manufacturing inputs (*mofm*) to foreign business service inputs and their cross-terms with a period dummy for 2006–2020 (*mofs* and *mofs*d06*), and from manufacturing exports (*mex*) to the cross-terms between domestic and foreign business service inputs and a period dummy for 2006–2020 (*mods*d06* and *mofs*d06*).

These results can be interpreted as follows. First, within manufacturing sectors, 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, including domestic and foreign inputs, have been facilitated by manufacturing exports and foreign manufacturing inputs since the mid-2000s. This finding implies that business services are actively involved 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 5b and 6d as follows: from business service exports (*sex*) to domestic and foreign manufacturing inputs (*sodm* and *sofm*), and from business service exports (*sex*) to domestic and foreign business service inputs and their cross-term with a period dummy for 2006–2020 (*sods*, *sods*d06*, *sofs*, and *sofs*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, 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 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 Table 7) 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 are facilitated by foreign manufacturing inputs. Third, business service inputs are promoted by business service exports. These trends in the involvement of business services have accelerated since the mid-2000s in all aspects. These findings to support servicification in GVCs 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 on the mechanism of servicification in GVCs by quantifying the interactions between gross exports and inputs in business service and manufacturing sectors. This finding implies that "Task-composition shift: changes in final goods" as one of causes of servicification (presented by Baldwin et al. 2015, and Heuser and Mattoo 2017) has been working significantly so 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[4]. This index is based on data collected between 2008 and 2010 from 103 countries; it ranges from zero (completely open) to 100 (completely closed).

[4] See the website: https://www.worldbank.org/en/research/brief/services-trade-restrictions-database.

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 the 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 for ASEAN members. Instead, there are empirical studies to demonstrate 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.

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 2023 database. This study's 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 are facilitated by foreign manufacturing. Third, business service inputs are promoted by business service exports. These trends in the involvement of business services in GVC activities have accelerated since the mid-2000s in all aspects, and are expected to expand toward the post-COVID-19 era.

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, the 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 and 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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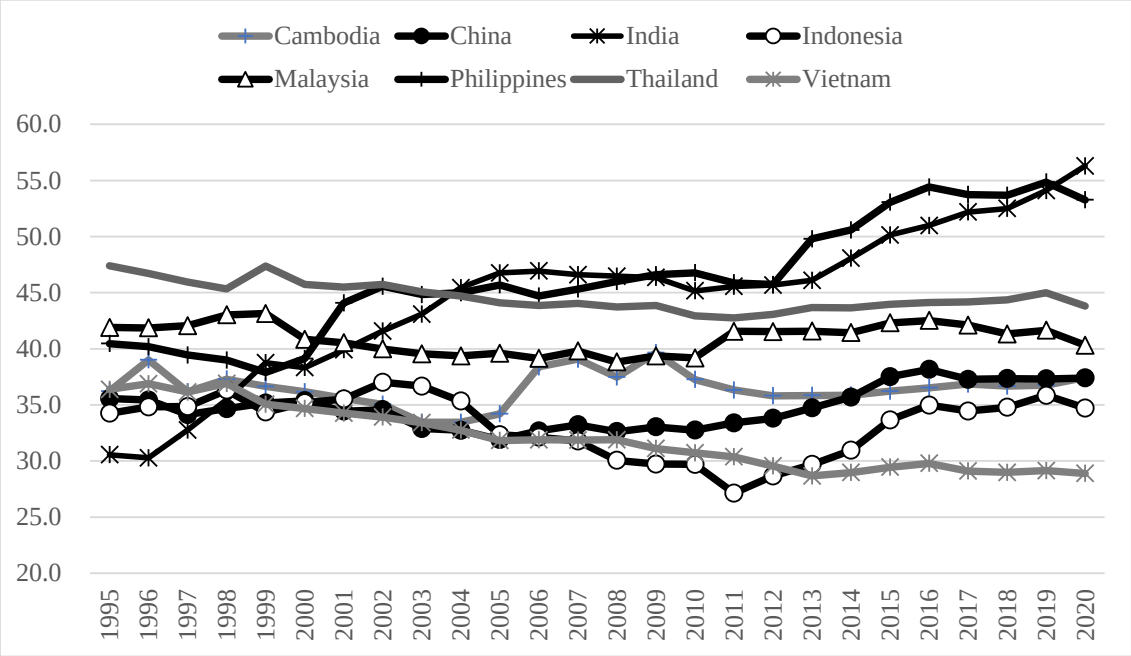
Figure 1 Ratio of Service Content to Gross Exports



Sources: Authors' calculation based on the OECD TiVA 2023 database

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*	
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*	
pcy	*GDP per capita, constant (2015) prices*	UNCTAD

Sources: Authors' description
Note: The unit of TiVA data is million US dollars, and that of GDP per capita is US dollars.

Table 2 Descriptive Statistics

Variables	Obs.	Median	Std. Dev.	Min.	Max
mex	208	56,786	388,832	447	2,022,223
modm	208	21,344	188,471	277	1,014,395
mofm	208	6,780	27,719	48	134,602
mods	208	6,519	79,633	39	435,281
mofs	208	7,058	27,907	55	133,631
sex	208	29,186	89,403	304	439,994
sodm	208	1,612	9,237	11	44,836
sofm	208	1,371	1,960	32	9,061
sods	208	18,884	68,295	196	345,943
sofs	208	2,483	3,550	38	15,818
pcy	208	2,343	2,622	383	11,115

Sources: Authors' description
Note: The unit of TiVA data is million US dollars, and that of GDP per capita is US dollars.

Table 3 Panel Unit Root Tests

Panel Unit Root Tests								
Variables	Level				First Difference			
	LLC	ADF Fisher	PP Fisher	Im et al.	LLC	ADF Fisher	PP Fisher	Im et al.
mex	0.542	7.178	6.679	1.734	-7.968***	75.609***	76.981***	-7.414***
modm	1.660	6.946	7.038	2.307	-7.308***	67.311***	67.793***	-6.600***
mofm	0.428	8.896	9.015	1.688	-8.870***	88.064***	148.860***	-8.606***
mods	-0.828	12.481	11.865	0.514	-5.588***	75.093***	80.565***	-7.345***
mofs	1.033	7.391	7.213	2.037	-6.140***	80.163***	111.282***	-7.878***
sex	2.515	2.830	2.837	4.390	-2.281**	54.946***	48.060***	-5.021***
sodm	2.554	5.914	6.279	1.814	-1.656**	50.151***	41.911***	-3.566***
sofm	0.720	9.189	7.411	1.096	-5.587***	65.944***	88.114***	-5.689***
sods	3.097	2.273	2.295	5.057	-2.092**	55.950***	50.652***	-5.219***
sofs	1.150	10.147	6.206	1.086	-2.557***	50.343***	66.033***	-4.436***
pcy	0.658	4.752	0.492	4.018	-1.383*	35.970***	19.740	-3.023***

Sources: Authors' estimation
Note: *, **, *** denote statistical significance at the 10%. 5%, and 1% levels, respectively.

Table 4 Panel Cointegration Test

Johansen Fisher Panel Cointegration Test		
Group	*trace test*	*max-eigen test*
mex, modm, mofm, mods, mofs	237.0***	130.8***
sex, sodm, sofm, sods, dofs	185.8***	128.2***

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

Table 5 PVAR Model Estimation Results

a) Interactions between business service inputs and manufacturing exports and inputs

	mex	*modm*	*mofm*	*mods*	*mods*d06*	*mofs*	*mofs*d06*
mex -1	1.401**	0.144	0.043	0.047	0.273**	0.070	0.185**
	[2.469]	[0.569]	[0.730]	[0.557]	[2.304]	[1.143]	[2.288]
modm -1	0.692	1.267***	0.012	0.226**	-0.020	0.005	-0.141
	[0.985]	[4.037]	[1.267]	[2.175]	[-1.138]	[0.060]	[-1.410]
mofm -1	7.943***	3.455***	1.650***	0.238	0.849	1.034***	1.250***
	[2.853]	[2.780]	[5.688]	[0.579]	[1.459]	[3.429]	[3.153]
mods -1	-5.405***	-2.572***	-0.341**	0.242	-0.323	-0.423***	-0.351*
	[-3.704]	[-3.948]	[-2.242]	[1.122]	[-1.058]	[-.2.674}	[-1.687]
*mods*d06 -1*	2,458	1.428**	0.164	0.140	0.444	0.171	-0.012
	[1.525]	[2.116]	[1.038]	[0.625]	[1.405]	[1.045]	[-0.056]
mofs -1	-7.093	-2.527	-0.615	-0.344	-1.858	-0.142	-1.437*
	[-1.289]	[-1.029]	[-2.073]	[-0.423]	[-1.614]	[-0.237]	[1.833]
*mofs*d06 -1*	-3.529	-1.840*	-0.337	-0.242	0.057	-0.304	0.519*
	[-1.665]	[-1.945]	[-1.526]	[-0.773]	[0.130]	[-1.323]	[1.718]
pcy	21.403**	10.113***	2.172**	2.104	2.465	2.030**	3.090**
	[2.449]	[2.592]	[2.385]	[1.628]	[1.349]	[2.144]	[2.482]
adj. R^2	0.992	0.993	0.982	0.996	0.991	0.981	0.968

b) Interactions between business service inputs and exports and manufacturing inputs

	sex	*sodm*	*sofm*	*sods*	*sods*d06*	*sofs*	*sofs*d06*
sex -1	3.200***	0.328***	0.067**	1.352***	2.289***	0.175***	0.224***
	[4.908]	[4.319]	[2.498]	[3.099]	[4.102]	[3.702]	[4.090]
sodm -1	-4.308***	0.290**	-0.141***	-2.405***	-3.479***	-0.351***	-0.430***
	[-3.892]	[2.253]	0.960***	[-3.247]	[-3.672]	[-4.377]	[-4.626]
sofm -1	3.317	0.813**	[7.458]	1.284	0.486	0.267	0.158
	[1.063]	[2.240]	[4.711]	[0.615]	[0.182]	[1.181]	[0.603]
sods -1	-2.462***	-0.375***	-0.071**	-0.523	-2.040***	-0.175***	-0.226***
	[-3.666]	[-4.793]	[-2.550]	[-1.163]	[-3.548]	[-3.590]	[-4.012]
*sods*d06 -1*	0.345*	0.060***	0.008	0.211	0.765***	0.011	0.009
	[1.766]	[2.625]	[0.949]	[1.616]	[4.573]	[0.797]	[0.568]
sofs -1	-5.567*	-0.985***	-0.169	-2.814	-3.758	0.325	-0.329
	[-1.730]	[-2.632]	[-1.276]	[-1.307]	[-1.365]	[1.394]	[-1.221]
*sofs*d06 -1*	-3.407*	-0.502**	-0.116	-2.121*	-2.603*	-0.126	0.538***
	[-1.970]	[-2.493]	[-1.624]	[-1.833]	[-1.758]	[-1.008]	[3.710]
pcy	6.234***	1.057***	0.257***	3.517**	5.337***	0.245**	0.639***
	[2.870]	[4.181]	[2.867]	[2.420]	[2.871]	[2.188]	[3.505]
adj. R^2	0.989	0.986	0.961	0.992	0.987	0.963	0.959

Sources: Authors' estimation

Note: *, **, and *** denote the rejection of the null hypothesis at the 90%, 95%, and 99% levels of significance. T-statistics are in the parentheses.

Table 6 Block Exogeneity Test Results

a) Causalities between business service inputs and manufacturing exports and inputs

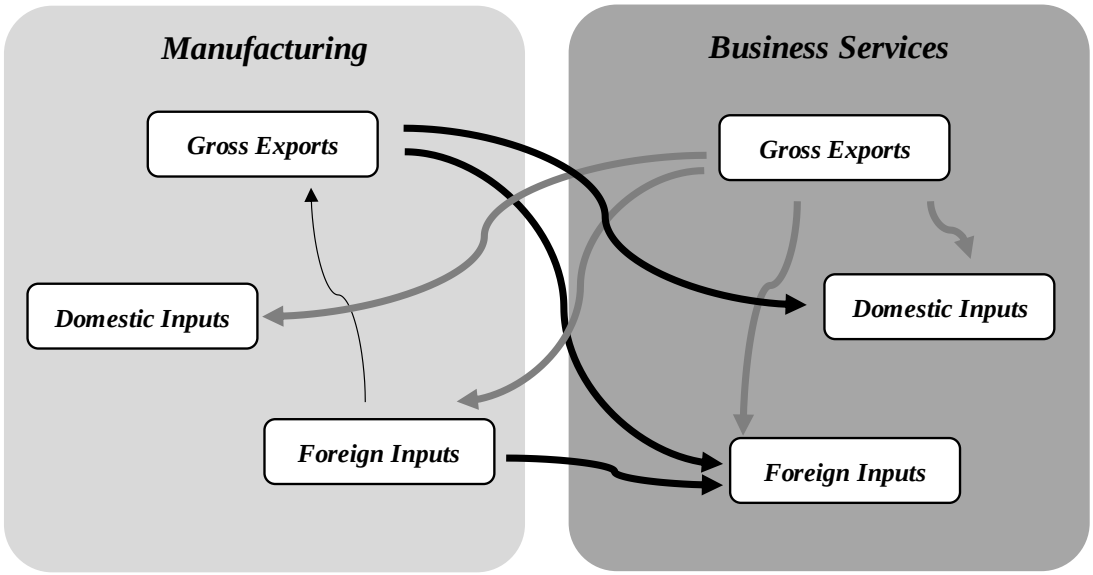
Dependent Variable	Excluded	Chi-sq	df	Probability
mex	*modm*	0.971	1	0.325
	mofm	8.141	1	0.004
	mods	13.716	1	0.000 (negative)
	mofs	1.661	1	0.198
modm	*mex*	0.323	1	0.570
	mods	15.589	1	0.000 (negative)
	mofs	1.058	1	0.304
mofm	*mex*	0.532	1	0.466
	mods	5.024	1	0.025 (negative)
	mofs	1.151	1	0.283
mods	*mex*	0.310	1	0.578
	modm	4.730	1	0.030
	mofm	0.179	1	0.672
*mods*d06*	*mex*	5.309	1	0.021
	modm	0.019	1	0.890
	mofm	2.130	1	0.144
mofs	*mex*	1.306	1	0.253
	modm	0.004	1	0.952
	mofm	11.757	1	0.001
*mofs*d06*	*mex*	5235.000	1	0.022
	modm	1.987	1	0.159
	mofm	9.939	1	0.002

b) Causalities between business service inputs and exports and manufacturing inputs

Dependent Variable	Excluded	Chi-sq	df	Probability
sex	*sodm*	15.150	1	0.001 (negative)
	sofm	1.130	1	0.288
	sods	13.439	1	0.000 (negative)
	sofs	2.993	1	0.083 (negative)
sodm	*sex*	18.651	1	0.000
	sods	22.970	1	0.000 (negative)
	sofs	6.929	1	0.009 (negative)
sofm	*sex*	6.240	1	0.013
	sods	6.504	1	0.011 (negative)
	sofs	1.627	1	0.202
sods	*sex*	9.602	1	0.002
*sods*d06*		16.829	1	0.000
sofs		13.708	1	0.000
*sofs*d06*		16.731	1	0.000

Sources: Authors' estimation

Table 7 Key Findings of Causalities between Manufacturing and Business Services



Sources: Authors' description