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Sanjeev Vasudevan
Suresh Babu Manalaya

MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India

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Sanjeev Vasudevan
Assistant Professor, Madras School of Economics,
Chennai, Tamil Nadu, India, 600025
sanjeev@mse.ac.in

and

Suresh Babu Manalaya
Professor and Director, Madras Institute of Department Studies,
Chennai, Tamil Nadu, India, 600020.

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Phone: 2230 0304/2230 0307/2235 2157
Fax: 2235 4847/2235 2155
Email : info@mse.ac.in
Website: www.mse.ac.in

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Abstract

This paper examines whether trade continuity is a determinant of global production sharing and trade in intermediate goods. We argue that the literature on global production sharing overlooks the dependent and hierarchical nature of trade relations. Huge switching costs faced by countries warrant the continuity of trade relations. With an unbalanced panel dataset of finely disaggregated bilateral exports of 29 emerging economies for 2004-17, we estimate an augmented gravity model using the Poisson Pseudo Maximum Likelihood method. We show that trade continuity has a significantly positive impact on global production sharing. We also show that the nature of trade continuity in global production sharing is process-specific and may vary between exports of parts and components and final assembly.

Keywords: *Global Production Sharing, Parts And Components, Intermediate Goods, Trade Continuity, Gravity Model, Poisson Pseudo Maximum Likelihood, Emerging Economies*

JEL Codes: *F10, F14*

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Sanjeev Vasudevan
Suresh Babu Manalaya

INTRODUCTION

One of the prominent features of this phase of globalisation is the growing trade of intermediate goods. Between 1996 and 2016, world intermediate goods trade increased from $3.23 trillion to $9.91 trillion. Global production sharing is a prominent channel driving this unprecedented growth. In recent years, the global south has emerged as a crucial participant in this process (Athukorala and Nasir, 2012). Global parts and components trade has risen from $2.93 trillion in 1996 to $5.93 trillion in 2016. Similarly, global trade in the final assembly has increased from $1.15 trillion in 1996 to $5.16 trillion in 2016. The share of emerging economies (hereafter EMEs) intermediate goods trade in global intermediate goods trade has increased from 19 per cent in 1990 to 46 per cent in 2016 (Comtrade, 2017).

Global production sharing refers to the internationalisation of a manufacturing process in which several countries participate in different stages of manufacturing a specific good (Yeats, 1999). The process significantly changes the production patterns of goods and creates new opportunities for countries to participate in global trade, even without specialising in a complete product. The global production sharing [1] literature identifies technological advancements, reduction in transportation costs and flexible tariff systems as the factors fuelling intermediate goods trade and global production sharing (Jones and Kierzkowski, 1990; Nordås, 2008).

The theoretical literature on the modern form of production sharing primarily focuses on the factor price differentials and relative labour requirements as the key determinants of global production sharing (Jones and Kierzkowski, 2001; Arndt, 1997, 1999; Deardorff, 2001) and improvements in technology and communication which eventually reduce

[1] The larger literature uses terms such as international fragmentation of production, global production sharing, vertical specialization, material offshoring etc. interchangeably.

the costs of monitoring (Jones and Kierzkowski, 1990, 2001). These theories argue that production sharing depends upon each fragment's comparative advantage and relative factor intensities. Hence, the extent of fragmentation depends on the technical divisibility of the production process, the variability of factor intensities, and reduced average coordination costs across different stages of the process.

Empirical studies on global production sharing capture the factor price and endowment differentials through the reduction in the cost of production attributed to lower manufacturing wages. They find a significant negative relationship between factor price differentials and fragmentation trade (Baldone et al., 2001; Athukorala and Yamashita, 2006; Yamashita, 2010). Studies using relative wages find a positive relationship between manufacturing wages and fragmentation trade, implying that a higher wage ratio arises from higher manufacturing wages in the home country (Athukorala and Yamashita, 2008). Contradicting these results, Zeddies (2011) found that labour cost differentials are insignificant in the case of the European Union, as lower wages could indicate lower labour productivity. On the other hand, Bandara et al. (2017) find that unit labour cost positively affects the exports of parts and components from Australia. Clark (2006) states that the differences in capital and labour endowment, captured by per capita GDP, are negative and highly significant for industries in the United States to share production. Kimura et al. (2007) find a positive impact of per capita GDP capturing the locational advantages in determining the trade in machinery parts and components for East Asia and a negative coefficient for Europe. Controlling for unit labour costs, Athukorala et al. (2017) find that relative per capita income is significant and negative in the production sharing, indicating increased export of labour-intensified goods.

A latent strand of the literature extensively analyses the relationship between the cost of service links and fragmentation trade. Studies which employ distance as a proxy for service links find an inverse relationship between fragmentation trade and service links (Kimura et al. 2007; Shimbov et al. 2013). Yamashita (2010) uses 'time for processing' to measure the quality of infrastructure and finds a negative relationship between time for processing and production sharing. Alternatively, empirical studies also employ the Logistic Performance Index (LPI), institutional quality and other trade facilitation measures to capture the service links (Athukorala et al. 2017). These studies find a significantly positive impact of the trade facilitation measures on bilateral trade. Marti et al. (2014) argue that the exporter's LPI is more significant in the EMEs' exports.

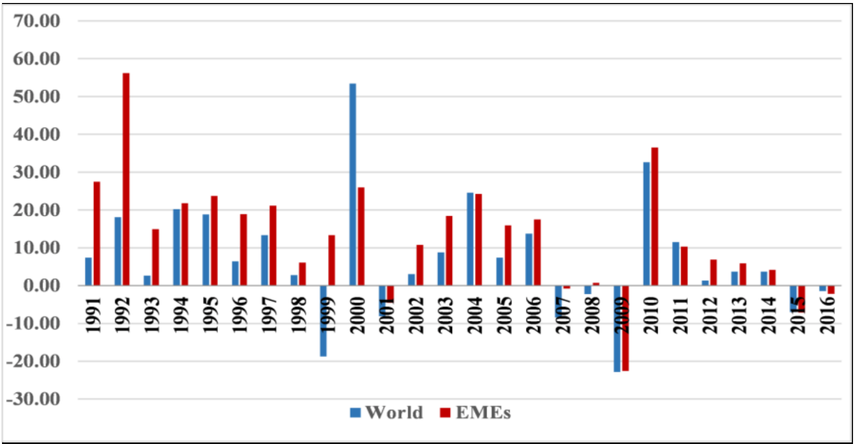
Our paper argues that the dominant literature overlooks the hierarchical nature of trade relations. As Humphrey and Schmitz (2002) and Gereffii et al. (2005) point out, value chain relations involve definite hierarchy and dependency, which demand considerable switching costs incurred by one of the partners if the trade relationship terminates. Humphrey and Schmitz (2002) argue that switching costs persist despite varying trade relations. While switching costs make the trade relations dependent on one of the suppliers, the buyers must find alternate suppliers with possible risks involved in new supplier relations (Azmeh and Nadvi, 2014). The complexity of transactions and products increases the switching costs associated with the trade. (Pietrobelli and Rabellotti, 2011) argue that firms involved in production sharing often need to build specialised capabilities and specific investments to remain in the value chains. These challenges necessitate trade relations to be continuous for a period. The continuity of trade is missing in the empirical studies of global production sharing. Even though Diaz-Mora and Triguero-Cano (2012) argue that previous outsourcing decisions are important determinants of the current outsourcing pattern in the Spanish manufacturing industries, the study does not address the cross-country nature of outsourcing. Given this background, this paper contributes to the literature in two ways. First, it introduces the concept of trade continuity and examines its impact on global production sharing. We measure trade continuity using the imports of intermediate goods from the previous period. Second, the study uses a specific measure of service link costs following Vogiatzoglu (2012) by considering the average cost of exporting and the extent of logistic performance for empirical analysis. Combining two variables provides us with a coherent measure of service link costs. The period for the empirical analysis is 2004-2017. The study considers the factors that stimulate and deter trade and examines the nature of trade continuity. Our results show that trade continuity positively impacts global production sharing. Besides, the nature of trade continuity may vary between the processes of production sharing.

The rest of the paper is organised as follows. The next section provides some stylised facts. The subsequent sections present the empirical methods, results, discussion, and concluding remarks.

SOME STYLISED FACTS

An analysis of global trade trends provides us with some insights into the nature and patterns of global production sharing among EMEs. Figure 1 shows that the annual average growth in parts and components trade in the EMEs is well above the world growth rate for the last two decades, barring a few isolated years. The average growth in parts and components trade in 1991-2016 in the EMEs is more than double the world growth rate for the same period. There have been years of deceleration of parts and components trade in EMEs and the world. Notably, in those years, the decline in trade was higher in magnitude for the world compared to the EMEs. However, in 1999 and 2008, when the world trade in parts and components witnessed negative growth, the EMEs registered favourable growth rates. Following the period of negative growth, the EMEs' growth recovered in 2010, surpassing the world growth rates for the rest of the period. The growth performance of EMEs in production sharing is impressive compared to the advanced economies, which we explain in Table 1.

Figure 1: Annual Growth in Parts and Components Trade, 1991-2016



Source: Authors' calculations based on the UN Comtrade database

Table 1 analyses the trade in manufacturing, intermediate goods and parts and components of advanced and emerging economies compared to the global growth. Manufacturing trade recorded higher growth compared to the trade in intermediate goods and parts and components. We make two inferences. First, the growth of manufacturing trade in the EMEs is not only higher than the growth in advanced economies but is more than double the world growth rate. The world manufacturing and intermediate goods trade registered a growth of 137% and 123%, respectively, while the world trade in parts and components increased by 60% from 2000 to 2016. A comparison of these figures with the performance of EMEs reveals that the latter registered higher growth compared to the global level in manufacturing. Second, EMEs trade in parts and components contributed to relatively higher global growth than advanced economies, as the former recorded a growth rate of 164% in parts and components trade and 211% growth in intermediate goods trade during the same period.

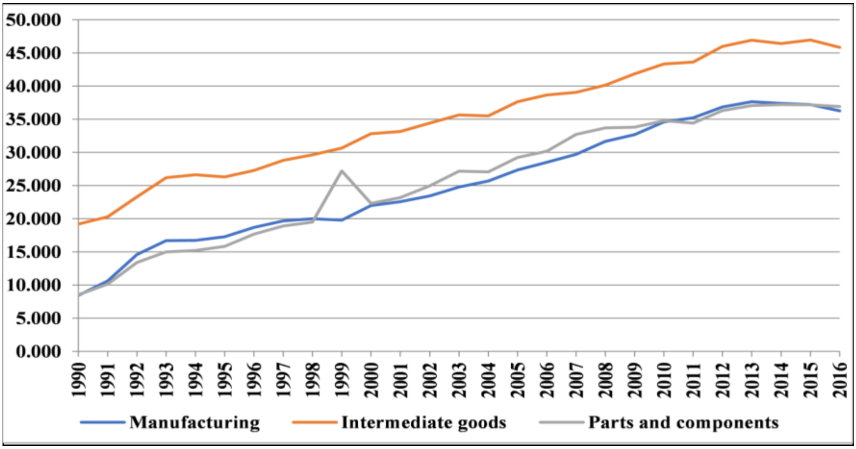
Table 1: Growth Comparison of Trade in Manufacturing, Intermediate Goods and Parts and Components (in Million US$), 2000-2016

	Manufacturing	Intermediate goods	Parts and components
World			
2000	9481340	4972521	3704514
2010	20182046	9635377	5320135
2016	22474813	11091642	5924032
	137%	*123%*	*60%*
Advanced economies			
2000	7344122	3907028	2813471
2010	13112676	6192045	3373639
2016	14226584	6958351	3634995
	94%	*78%*	*29%*
Emerging economies			
2000	2085098	1633201	827636.9
2010	6987218	4176806	1851257
2016	8157127	5084573	2186776
	291%	*211%*	*164%*

Source: Authors' calculations based on the UN Comtrade database

We also analyse the trade in EMEs as a share of the world trade in Figure 2. The share of manufacturing, intermediate goods, and parts and components trade in world trade shows a secular increase in EMEs from 1990 to 2016. Notably, EMEs' parts and components trade as a share of world trade in parts and components show the highest percentage. Another inference we draw is that the EMEs were the first destinations of the final assemblage rather than the production of parts and components, as shown by the gap between the intermediate goods and parts and components trade shares. The gap continued to shrink until the late 1990s, indicating that EMEs progressively participated in producing and trading parts and components while maintaining their status as potential final assembly destinations.

Figure 2: Performance of Emerging Economies as a Share of World Trade, 1990-2016

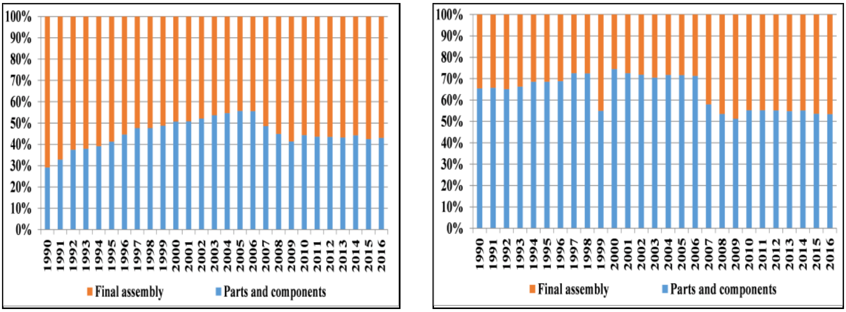


Source: Authors' calculations based on the UN Comtrade database

We extend the analysis to network trade activities within EMEs. Figure 3 displays the shares of parts and components and final assembly trade in intermediate goods trade for EMEs (in panel A) and at the global level (in panel B). There is no hard and fast rule to demarcate final assembly activities from parts and components. The conventional method is to deduct values of parts and components trade from intermediate goods trade (Athukorala et al., 2017). From Figure 3 panel A, we find that the dominance of final assembly trade characterises global production sharing in the EMEs. A similar analysis conducted for the global level, in panel B, reveals a different picture. For the EMEs, the share of parts and components trade in total intermediate goods has increased from 1990 to 2006. However, the final assembly trade dominated in terms of shares. We infer that the early years of production sharing in the EMEs witnessed a rising trend for parts and components trade due to the locational advantages, lower production and trade costs, and wage rates. However, EMEs have always been a booming hub of final assemblage, relatively underexplored in the literature. Hence, contrary to the trends at the global level, we find that trade in final assembly drives a substantial share of global production sharing in the EMEs.

Figure 3: Composition of Intermediate Goods in EMEs, 1990-2016

(A) **(B)**



Source: Authors' calculations based on the UN Comtrade database

Even though the parts and components trade shows increasing shares overall, the shares of final assembly dominate the EMEs' global production sharing. This trend warrants a separate analysis of parts and components and the final assembly to identify their peculiar natures. The separability of global production sharing is an aspect that receives inadequate attention in the literature. In our analysis, we consider the process-specific nature of global production sharing.

DATA AND ESTIMATION METHOD

Model Specification

The primary source of trade data is the United Nations Commodity Trade Statistics (Comtrade) provided by the United Nations Statistics Division. We use the Standard Industrial Trade Classification Revision 3 (SITC Rev.3) nomenclature. Following Athukorala (2011), Athukorala et al. (2012) and Athukorala et al. (2017), we identify the products belonging to manufacturing goods, intermediate goods and parts and components. We obtain parts and components based on the 5-digit classification of

SITC Rev 3. A unique feature of global production sharing involves the trade in parts and components and final assembly products. We deduct the gross value of parts and components from the total intermediate goods trade to separate the final assembly trade. We employ an augmented gravity model to analyse the determinants of global production sharing and estimate the export equation as follows.

$$EXP_{ijt}^{k} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnDIS_{ijt} + \beta_4 lnTC\_OVERALL_{ijt} + \beta_5 lnSC_{it} + \beta_6 lnRER_{ijt} + \beta_7 lnRPG_{ijt} + \beta_8 INS_{it} + \beta_9 ADJ_{ij} + \beta_{10} LAN_{ij} + \delta_t + \epsilon_{ijt} \quad (1)$$

Where the subscripts *i* and *j* refer to the reporters and partners respectively; where *i*=0,1,….,29 and *j*=0,1,2,...28. There are 812 country pairs identified across 29 EMEs and their partners. *t* is time in years (*t*=0,1,2,.....14). We estimate the equation in the panel data framework in which δ_t is the time-fixed effect. The Breusch Pagan Lagrangian Multiplier test favours the panel data framework over the least-squares counterpart. The Hausman test favoured the application of fixed effect over random effect estimator. However, the presence of time-invariant explanatory variables, such as distance, does not allow using the fixed-effect model. Besides, Egger (2005) and Athukorala and Nasir (2012) opine that there can be endogeneity issues in the model because of the simultaneity bias between the exports and GDP values. A solution to these issues is using an instrumental variable approach, namely the Hausman and Taylor Estimator (Athukorala et al., 2017). However, two crucial econometric issues prevail as the estimation of Hausman and Taylor Estimator is based on the traditional Ordinary Least Squares (OLS) method (Silva and Tenreyro, 2006). First, the least-squares method assumes that the expected value of the error term is independent of any explanatory variables, a violation of which results in the inconsistency of the estimators[2].

In most cases, trade data exhibits a heteroscedastic nature, while the traditional econometric application ignores the same. Second, bilateral trade data often contain zero trade values for several reasons, such as unreported data, measurement error, aggregation bias or even the non-existence of bilateral trade in specific years (Silva and Tenreryro, 2006). Zero trade values prevent the complete conversion of the data into the logarithmic form; the logarithm of zero does not exist. One solution to this issue is to exclude the zero values. Doing so, however, results in a significant loss of original information, especially if the proportion of zero trade values is relatively high in the data. Instead, adding 1 to scale up the data resolves the issue of zero trade values but not the problem of heteroscedasticity owing to Jenson's inequality.

The Poisson Pseudo Maximum Likelihood (hereafter PPML) estimator offers a solution to the above challenges. It is a promising method that estimates the non-linear form of the gravity model. The PPML assumes that conditional variance depends upon the explanatory variables, naturally taking heteroscedasticity issues into account without overweighting noisier observations. Further, the dependent variable enters as absolute values accommodating zero values, while the explanatory variables remain logarithmic. The coefficients of PPML are elasticity values, making the interpretation no different to OLS. These features make the PPML estimation superior to traditional gravity equation estimation methods. Hence, we resort to the PPML estimation technique in the present analysis.

Following the global value chain literature, we argue that trading partners in production sharing face enormous switch costs, such as

[2] In econometric literature, this refers to as Jenson's inequality. Refer Silva and Tenreyro (2006) for explanation of Jensen's Inequality and its potential econometric issues.

finding an alternative supplier of inputs. It warrants a continuous trade relationship between the partners. We hypothesise that trade continuity boosts global production sharing between the partner countries. Therefore, we expect trade continuity to positively impact intermediate goods' current exports. We conduct the estimation in two stages. In the first stage, we estimate the determinants of intermediate goods exports. The variable of interest is the previous period's imports of intermediate goods, as given in equation (1).

$$EXP_{ijt}^{k} = \beta_0 + \beta_1 lnMVA\_REP_{it} + \beta_2 lnMVA\_PAR_{jt} + \beta_3 lnDIS_{ijt} + \beta_4 lnTC\_PARTS_{ijt} + \beta_5 lnTC\_ASSEMBLY_{ijt} + \beta_6 lnSC_{it} + \beta_7 lnRER_{ijt} + \beta_8 lnRPG_{ijt} + \beta_9 INS_{it} + D_1 ADJ_{ij} + D_2 LAN_{ij} + \delta_t + \epsilon_{ijt}\ , \qquad (2)$$

In the second stage, we separate intermediate goods exports as parts and components and final assembly exports. We include the imports of parts and components from the previous period and the final assembly as measures of trade continuity. Hence, in the second stage, we estimate the gravity equation specified in equation (2). We describe the variables in detail now.

Data and Variables

The dependent variables for the four equations are the gross values of exports of manufacturing *(MEXP)*, intermediate goods *(INEXP)*, parts and components *(PCEXP)* and final assembly *(FAEXP),* respectively, in current US$, employed as the measures of global production sharing (Kimura et al., 2007; Shimbov, 2013). We obtained the export data from Comtrade. We include several explanatory variables to augment the gravity analysis in line with the literature (Athukorala and Yamashita, 2006; Kimura et al., 2007; Shimbov et al., 2013). Table 2 provides the data sources, expected signs and the summary statistics of all explanatory variables.

Following the gravity literature, we use the reporter's GDP *(GDP_REP)* and the partner's GDP *(GDP_PAR)* to capture the market sizes. We employ the real GDP of reporter and partner countries obtained at 2010 constant (US$) prices. In the disaggregated analysis, we use the real manufacturing output proxied by manufacturing value-added for the reporter *(MVA_REP)* and partner countries *(MVA_PAR)* (Athukorala et al., 2017). We also employ the weighted bilateral distance between the capitals *(DIS)* of the trading countries in the analysis. Bilateral distance and trade volume yield an inverse relationship (Athukorala and Yamashita, 2006; Yamashita, 2010; Zeddies, 2011).

To capture the trade continuity in production sharing, we use the previous year's intermediate goods imports as the primary interest variable in the current analysis. We hypothesise that the previous year's imports of intermediate goods from the bilateral partners are directly related to the current year's exports. In the first set of equations, we use the previous period's imports of intermediate goods as the proxy for trade continuity, labelled as *(TC_OVERALL)*. In the disaggregated analysis of intermediate goods exports, we use the previous period's imports of parts and components *(TC_PARTS)* and final assembly *(TC_ASSEMBLY)* as the measures of trade continuity. Hence, in the second stage of analysis, we have two variables of interest. Florensa et al. (2015) argue that regional integration and expansion of production networks enhance intermediate goods imports at the regional level. However, this study does not address the cross-country nature of production networks.

Lately, empirical studies have focused on the importance of the quality of trade-related infrastructural and institutional services (Shimbov et al., 2013; Athukorala et al., 2017). The existing literature employs various measures to capture the effect of service links on fragmentation trade. We incorporate trade-related costs and services in a single measure, i.e. service link costs *(SC)*[3]. Another variable that affects production sharing is the factor income differentials. Trade literature

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[3] Construction of SC is further explained in the Appendix.

[3] Construction of RER is further explained in the Appendix.

states that higher differences in income level influence global production sharing and fragmentation trade (Kimura et al., 2007). In the present study, following Athukorala et al. (2017), we use the relative per capita GDP *(RPG)* to measure inter-country differences and locational advantages. The real bilateral exchange rate *(RER)*[3] of the trading partners captures the domestic price effects along with the international transactions. *RER* also measures the international competitiveness of the two countries in the process of global production sharing. A negative sign of *RER* is indicative of depreciation and increased exports. We include the institutional quality *(INS)* variable as indexed by the first principal component of six governance indicators of the reporting country. The standard literature often uses institutional quality as a proxy for trade-related services (Shimbov et al., 2013; Athukorala et al., 2017). In the current study, we account for the trade service costs, and hence, *INS* provides the 'pure' effect of institutional quality on trade.

Common border sharing *(ADJ)* is a binary variable which assumes unity if the bilateral partners share a common land border and zero otherwise. Similarly, a common official language *(LAN)* is a binary variable that takes unity if the trading partners share a common official language. Common borders and common language simplify trading by reducing transportation and transaction costs (Zeddies, 2011; Shimbov et al., 2013). Further, we postulate that socio-cultural characteristics do not significantly vary across neighbouring countries.

The descriptive statistics show sufficient variability within the data. We scale down the dependent variables to a million US$ to ease the computational process because PPML estimation is scale-invariant. Following the standard practice, we treat all the missing and unreported values in the dependent variables as zero trade flows. However, we omit the zero values in the independent variables.

Table 2: Descriptive Statistics

Variables	Obs	Mean	SD	Exp. sign	Data sources
TC_OVERALL	11,289	20.33	21.84	+	
TC_PARTS	11,122	19.46	21.07	+	UN Comtrade
TC_ASSEMBLY	10,569	19.89	21.41	+	
GDP_REP	11,368	27.20	27.89	+	
GDP_PAR	11,368	27.20	27.89	+	
MVA_REP	11,368	25.64	26.66	+	WDI, World Bank
MVA_PAR	11,368	25.64	26.66	+	
RPG	11,368	1.84	2.51	-	
INS	11,368	0.00	1.00	+	WGI, World Bank
SC	11,368	5.96	5.64	-	World Bank
RER	11,368	6.20	7.62	-	WDI and IMF IFS
DIS	11,368	8.37	8.02	-	
ADJ	11,368	0.08	0.27	+	CEPII database
LAN	11,368	0.03	0.17	+	

Note: The institutional quality index, adjacency dummy and common language dummy are in the non-log forms, and the rest of the independent variables are in their natural logs.

DATA AND ESTIMATION METHOD

Table 3 reports the PPML estimates covering more than 10000 observations. The overall goodness of fit for the regression ranges from 0.69 to 0.77. Table 3 reports the estimates of the determinants of intermediate goods exports. We present the determinants of manufacturing exports in the same table for comparative purposes. All explanatory variables are statistically significant with a theoretically expected sign.

The standard gravity variables, such as the *GDP_REP*, *GDP_PAR* and the *DIS*, are statistically significant at the 1% level. Higher supply and absorption capacity of the trading partners leads to increased trade between them, as indicated by the coefficients of the GDPs of reporting and partner countries. The intermediate goods exports equation provides comparable results with high significance levels when we use the manufacturing output instead of GDP values. The coefficients of *MVA_REP* and *MVA_PAR* are relatively lower in magnitude than the previous results. The lower magnitude of coefficients indicates that GDP values affect the supply and absorption capacities than the sectoral output in the economy. We find qualitatively similar results even after controlling for time effects. The reporter's market size represents the supply capacity, and the partner's market size represents the capacity to absorb. Larger economies have a high capacity for supply and absorption. Further, thicker markets are positively related to fragmentation trade (Bandara et al. 2017). Countries separated by larger geographical space engage in trade because of reduced shipping or freight costs. The bilateral distance variable *(DIS)* shows a negative and highly significant impact on manufacturing and intermediate goods exports. The magnitude of coefficients (between -0.79 and -0.92) indicates that if the bilateral distance between trading partners increases by a unit, the volume of trade declines less than proportionately. Despite the drastic reduction in transportation and communication costs, empirical evidence suggests that bilateral distance is still an important determinant of trade flows.

Across all equations, the *TC_OVERALL* variable is statistically significant with a positive sign. The magnitude of *TC_OVERALL* is marginally higher for the intermediate exports' equation compared with total manufacturing. It shows that the previous period's imports of intermediate goods foster the current period's exports of intermediate goods. The relatively lower magnitude of *TC_OVERALL* in the total manufacturing exports equation indicates that, although intermediate goods are essential in manufacturing exports, the latter depends on other macroeconomic factors.

Table 3: PPML Estimation. Aggregate Analysis

VARIABLES	*MEXP*	*IEXP*	*IEXP*	*MEXP*	*IEXP*	*IEXP*
GDP_REP	0.893***	0.941***		0.818***	0.829***	
	(0.0219)	(0.0248)		(0.0193)	(0.0208)	
GDP_PAR	0.540***	0.522***		0.520***	0.493***	
	(0.0186)	(0.0210)		(0.0172)	(0.0188)	
MVA_REP			0.936***			0.873***
			(0.0203)			(0.0200)
MVA_PAR			0.479***			0.468***
			(0.0208)			(0.0197)
DIS	-0.922***	-0.858***	-0.802***	-0.900***	-0.825***	-0.792***
	(0.0298)	(0.0340)	(0.0358)	(0.0290)	(0.0325)	(0.0354)
TC_OVERALL	**0.158*** **	**0.164*** **	**0.104*** **	**0.152*** **	**0.158*** **	**0.101*** **
	(0.0120)	**(0.0135)**	**(0.0142)**	**(0.0112)**	**(0.0124)**	**(0.0136)**
SC	-0.471***	-0.581***	-0.240***	-0.647***	-0.858***	-0.410***
	(0.0314)	(0.0356)	(0.0365)	(0.0309)	(0.0356)	(0.0400)
RPG	-0.194***	-0.328***	-0.333***	-0.183***	-0.323***	-0.324***
	(0.0422)	(0.0477)	(0.0450)	(0.0401)	(0.0446)	(0.0439)
INS	0.105***	0.242***	0.301***	0.0512*	0.168***	0.252***
	(0.0293)	(0.0331)	(0.0333)	(0.0297)	(0.0331)	(0.0337)
RER	-0.111***	-0.132***	-0.121***	-0.119***	-0.146***	-0.126***
	(0.00969)	(0.0119)	(0.0114)	(0.00950)	(0.0114)	(0.0110)
ADJ	0.332***	0.354***	0.489***	0.373***	0.417***	0.511***
	(0.0510)	(0.0590)	(0.0544)	(0.0472)	(0.0537)	(0.0518)
LAN	0.369***	0.374***	0.418***	0.355***	0.356***	0.416***
	(0.0699)	(0.0790)	(0.0757)	(0.0663)	(0.0722)	(0.0711)
Constant	-24.72***	-25.75***	-23.21***	-21.12***	-20.31***	-20.37***
	(0.834)	(0.931)	(0.754)	(0.790)	(0.856)	(0.816)
Year dummy	No	No	No	Yes	Yes	Yes
Observations	10,492	10,492	10,442	10,492	10,492	10,442
R-squared	0.720	0.696	0.754	0.755	0.747	0.774

Note: Robust standard errors are in parentheses. Coefficients on year dummies not reported. *** p<0.01, ** p<0.05, * p<0.1.

The *SC* variable is highly significant, with an expected negative sign, validating the theoretical argument that the lower the service link costs involved in conducting trade, the higher the trade volume. The coefficient of *SC* in the intermediate goods exports equation is relatively high compared to the total manufacturing exports. This finding aligns with the results of Clark (2006) and Nordås (2008). Service link costs indicate the costs incurred in monitoring dispersed production blocks, freight charges between two or more production units, and the development of trade-related infrastructure. Jones and Kierzskowski (1990) point out that the costs of coordinating production units are significantly high. However, the average cost of service links falls with increased output, depicting increasing returns to scale sufficiently to ensure overall profits by optimising production costs.

The *RPG* variable is a significant determinant in both the export equations with an expected negative sign, validating the argument that the higher the inter-country differences in income, the lesser the trade volume. The negative sign also indicates that the trade in intermediate goods is inclined more towards lower-income than high-income economies. These findings are in tandem with Athukorala et al. (2017).

The *INS* variable is significant in all equations, while its magnitude is higher in the case of intermediate exports compared to total manufacturing. The stability of the political system is essential for smooth business. Institutional quality is also closely associated with trade-related services.

The *RER* is statistically significant in all equations. We find that the exchange rate fluctuations are strongly associated with production sharing and trade in intermediate goods. Price changes significantly influence the exports of intermediate goods. This finding is in line with Shimbov et al. (2013). There is no consensus on the effect of exchange rates on fragmentation trade, specifically in the literature on global production sharing. Arndt and Huemer (2007) and Athukorala et al.

(2017) argue that exchange rate fluctuations will have minimal impact on trade in intermediate goods. However, Shimbov et al. (2013) find that exchange rate fluctuations, particularly depreciation, can negatively impact intermediate goods trade.

The *ADJ* dummy is highly significant in all equations, with a higher coefficient value in the intermediate goods exports equation. It indicates that countries which share a common border are likely to trade higher than the ones that do not share a common border. Having a common border eases the shipment of merchandise. Similarly, the *LAN* dummy is also highly significant in both export equations. Having a common official language reduces the effort of formulating a bilateral trade contract and maintains cultural homogeneity to a great extent.

Disaggregated Analysis

We proceed to analyse the nature of trade continuity at the disaggregated level. The whole of intermediate goods includes not only parts and components. Goods that are one step away from becoming finished products are also part of production sharing. The separability of intermediate goods trade into parts and components has not received much attention except in Athukorala and Nasir (2012) and Athukorala et al. (2017). We analyse the determinants of parts and components and final assembly exports. Table 4 shows the estimated coefficients for the determinants of parts and components and final assembly exports. Instead of intermediate goods, we employ the previous imports of parts and components and final assembly as measures of trade continuity in this analysis. In the disaggregated analysis, we use the real manufacturing output as a central gravity variable for economic size.

The sectoral outputs of the reporter and partner are statistically significant at a 1 per cent level. Higher real manufacturing output increases trade in parts and components between the partners. Further,

Table 4: PPML Estimation. Disaggregate Analysis

VARIABLES	PCEXP	FAEXP	PCEXP	FAEXP
MVA_REP	0.788***	1.003***	0.736***	0.940***
	(0.0238)	(0.0235)	(0.0237)	(0.0230)
MVA_PAR	0.458***	0.458***	0.451***	0.452***
	(0.0307)	(0.0234)	(0.0303)	(0.0218)
DIS	-0.788***	-0.786***	-0.777***	-0.781***
	(0.0470)	(0.0387)	(0.0472)	(0.0382)
TC_PARTS	**0.145*** **	-0.0178	**0.165*** **	0.000405
	(0.0188)	(0.0112)	**(0.0192)**	(0.0110)
TC_ASSEMBLY	0.0332	**0.0937*** **	0.000725	**0.0603*** **
	(0.0262)	**(0.0196)**	(0.0268)	**(0.0191)**
SC	-0.406***	-0.163***	-0.566***	-0.336***
	(0.0452)	(0.0374)	(0.0488)	(0.0432)
RPG	-0.205***	-0.397***	-0.182***	-0.365***
	(0.0575)	(0.0477)	(0.0566)	(0.0471)
INS	0.321***	0.272***	0.274***	0.213***
	(0.0367)	(0.0377)	(0.0378)	(0.0385)
RER	-0.109***	-0.138***	-0.114***	-0.142***
	(0.0114)	(0.0135)	(0.0115)	(0.0127)
ADJ	0.383***	0.560***	0.433***	0.606***
	(0.0716)	(0.0581)	(0.0685)	(0.0543)
LAN	0.307***	0.487***	0.325***	0.515***
	(0.0848)	(0.0880)	(0.0831)	(0.0818)
Constant	-20.50***	-24.79***	-17.90***	-21.82***
	(0.946)	(0.794)	(1.038)	(0.858)
Year dummy	No	No	Yes	Yes
Observations	9,637	9,637	9,637	9,637
R-squared	0.626	0.772	0.647	0.794

Note: Robust standard errors are in parentheses. Coefficients on year dummies not reported. *** p<0.01, ** p<0.05, * p<0.1

the *DIS* variable shows a negative and highly significant impact on the exports of parts and components and final assembly from EMEs. The coefficients indicate that a higher distance between bilateral partners leads to less than a proportionate decline in the volume of exports. The effect of distance is marginally higher for the final assembly exports compared to parts and components.

In the disaggregated analysis, the variables of primary interest are the previous year's imports of parts and components *(TC_PARTS)* and final assembly *(TC_ASSEMBLY)* from the partner country. The *TC_PARTS* variable is statistically significant with a positive sign in the parts and components exports equation, indicating that the trade continuity in bilateral imports of parts and components significantly improves the current year's exports of both parts and components. More explicitly, a 1 per cent increase in the imports of parts and components from the partner country leads to an average increase in the reporter's parts and components exports by 0.15-0.17 per cent. Similar to this result, the *TC_ASSEMBLY* variable is significant only in the final assembly exports. The result shows that final assembly exports are influenced by trade continuity through the imports of final assembly goods. The *TC_PARTS* variable is insignificant in the final assembly exports equation, while the *TC_ASSEMBLY* variable is insignificant in the parts and components exports. Hence, we infer that own volumes of parts and components and final assembly imports positively influence their current export volumes to the respective bilateral partners.

The *SC* variable is highly significant with an expected negative sign, supporting the theoretical postulations of Jones and Kierzkowski (1990). The magnitude is higher for parts and components exports, as cost-effective service links coordinate production blocks of parts and components. A 1 per cent increase in the exporter's costs of service links leads to a decline in the exports of parts and components by, on average, 0.40-0.57 per cent and final assembly by 0.17-0.34 per cent among EMEs.

The *RPG* variable is significant in all export equations. The variable has a relatively higher coefficient value in the final assembly exports, indicating that differences in income matter more for final assembly exports compared to parts and components. The *INS* variable is significant in all equations. We have controlled for the service link costs separately. Since we have controlled for the service link costs, the pure effect of institutional quality has become relatively higher in the parts and components equation compared to the final assembly. The *RER* is significant with a negative sign in all equations. The result shows that a depreciation of the exchange rate improves exports of parts and components and final assembly. Further, the magnitude of *RER* is relatively higher in the final assembly exports. This finding is intuitively correct that final assembly exports are associated with finished goods, compared to parts and components. Hence, the effect of price changes is more reflected in the final assembly exports.

The *ADJ* variable is highly significant in both equations, indicating that countries which share a common border are likely to trade higher than the ones that do not share a common border. Similarly, the *LAN* dummy is highly significant in both export equations, indicating that the presence of common official languages necessarily influences production sharing compared to countries that do not share a common language.

Robustness Checks

We conduct robustness checks to confirm our benchmark results. We employ the lagged dependent variable as a proxy for trade continuity. Tables 5a and 5b report the results of the empirical analysis where we use the lagged values of intermediate goods (LAG_OVERALL), parts and component exports (LAG_PARTS) and final assembly exports (LAG_ASSEMBLY) as proxies for trade continuity.

Table 5a: Lagged Dependent Variable for Trade Continuity: Aggregate Analysis

VARIABLES	***MEXP***	***IEXP***	***IEXP***	***MEXP***	***IEXP***	***IEXP***
GDP_REP	0.226***	0.0556***		0.245***	0.0646***	
	(0.0129)	(0.00876)		(0.0129)	(0.00891)	
GDP_PAR	0.210***	0.0466***		0.207***	0.0360***	
	(0.0121)	(0.00793)		(0.0121)	(0.00719)	
MVA_REP			0.0562***			0.0707***
			(0.00873)			(0.00879)
MVA_PAR			0.0439***			0.0366***
			(0.00711)			(0.00643)
DIS	-0.326***	-0.0752***	-0.0685***	-0.314***	-0.0502***	-0.0478***
	(0.0185)	(0.0110)	(0.0108)	(0.0185)	(0.00973)	(0.00918)
LAG_OVERALL	**0.694*** **	**0.921*** **	**0.914*** **	**0.712*** **	**0.951*** **	**0.942*** **
	(0.0117)	**(0.00637)**	**(0.00708)**	**(0.0123)**	**(0.00562)**	**(0.00617)**
SC	-0.0711***	-0.128***	-0.109***	0.0118	-0.0376**	-0.00703
	(0.0150)	(0.0146)	(0.0144)	(0.0169)	(0.0148)	(0.0155)
RPG	0.0683***	-0.00676	-0.0123	0.0666***	-0.00521	-0.0117
	(0.0163)	(0.0158)	(0.0158)	(0.0150)	(0.0133)	(0.0133)
INS	-0.0971***	-0.00295	-0.00183	-0.0681***	0.0249***	0.0293***
	(0.0125)	(0.0103)	(0.0102)	(0.0114)	(0.00874)	(0.00867)
RER	-0.0250***	-0.0135***	-0.0155***	-0.0152***	-0.00345	-0.00461**
	(0.00380)	(0.00289)	(0.00290)	(0.00366)	(0.00232)	(0.00235)
ADJ	0.0638***	0.0272	0.0462**	0.0437**	0.00653	0.0234
	(0.0209)	(0.0217)	(0.0219)	(0.0176)	(0.0166)	(0.0168)
LAN	0.140***	0.0322	0.0311	0.126***	0.00994	0.0123
	(0.0268)	(0.0249)	(0.0250)	(0.0266)	(0.0245)	(0.0244)
Constant	-15.90***	-13.51***	-13.30***	-17.39***	-14.88***	-15.00***
	(0.334)	(0.265)	(0.238)	(0.350)	(0.292)	(0.252)
Year dummy	No	No	No	Yes	Yes	Yes
Observations	9,461	9,461	9,411	9,461	9,461	9,411
R-squared	0.955	0.968	0.968	0.964	0.979	0.979

Note: Robust standard errors are in parentheses. Coefficients of year dummies not reported. *** p<0.01, ** p<0.05, *p<0.1.

Table 5b: Lagged Dependent Variables for Trade Continuity: Disaggregate Analysis

VARIABLES	***PCEXP***	***FAEXP***	***PCEXP***	***FAEXP***
MVA_REP	0.0619***	0.0701***	0.0785***	0.0820***
	(0.00902)	(0.0161)	(0.0105)	(0.0149)
MVA_PAR	0.0438***	0.0476***	0.0429***	0.0431***
	(0.00973)	(0.0101)	(0.00858)	(0.00966)
DIS	-0.0677***	-0.0668***	-0.0531***	-0.0514***
	(0.0129)	(0.0147)	(0.0118)	(0.0135)
LAG_PARTS	**0.912*** **	**0.0742*** **	**0.932*** **	**0.0722*** **
	(0.00701)	**(0.0202)**	**(0.00630)**	**(0.0206)**
LAG_ASSEMBLY	-0.00262	**0.809*** **	-0.000217	**0.835*** **
	(0.00286)	**(0.0345)**	(0.00234)	**(0.0370)**
SC	-0.0902***	-0.118***	0.00253	-0.0328*
	(0.0149)	(0.0174)	(0.0182)	(0.0179)
RPG	-0.0238	-0.0400*	-0.0336**	-0.0353*
	(0.0175)	(0.0208)	(0.0150)	(0.0192)
INS	0.0187*	-0.0287**	0.0448***	0.00144
	(0.0106)	(0.0131)	(0.0105)	(0.0121)
RER	-0.0154***	-0.0216***	-0.00751**	-0.0110***
	(0.00368)	(0.00406)	(0.00309)	(0.00411)
ADJ	0.0522**	0.0882***	0.0362*	0.0627**
	(0.0221)	(0.0277)	(0.0193)	(0.0249)
LAN	-0.00243	0.0845**	-0.0297	0.0693**
	(0.0398)	(0.0330)	(0.0361)	(0.0327)
Constant	-13.54***	-13.00***	-14.81***	-14.20***
	(0.248)	(0.296)	(0.292)	(0.292)
Year dummy	No	No	Yes	Yes
Observations	8,209	8,209	8,209	8,209
R-squared	0.959	0.963	0.969	0.976

Note: Robust standard errors are in parentheses. Coefficients of year dummies not reported. *** p<0.01, ** p<0.05, *p<0.1.

The results of Table 5a further confirm our argument that trade continuity is a determinant of global production sharing. The coefficient of the overall trade continuity *(LAG_OVERALL)* variable is highly significant in all equations in Table 5a. Further, the magnitude of the coefficients has shown a more than five-fold increase compared to the results of Table 3. The R-squared values in Table 5a are also higher compared to Table 3. These results confirm that trade continuity is essential in global production sharing and trade in intermediate goods.

Our second inference is that the nature of trade continuity may vary between processes, which is significant in the results reported in Table 5b. Contrary to the results of Table 4, the *LAG_PARTS* variable is significant in both *PCEXP* and *FAEXP* equations. However, the *LAG_ASSEMBLY* variable is significant only in the *FAEXP* equation. The plausible reason for the significance of the *LAG_PARTS* variable in the *FAEXP* equation is as follows. Exports of parts and components to a place of assemblage further boost the trade in final assembly goods. However, final assembly imports have no direct link to the exports of parts and components, and therefore, the variable of *LAG_ASSEMBLY* is insignificant in the *PCEXP* equation. Notably, the coefficients of *LAG_ASSEMBLY* are very low in magnitude, implying no practical significance to the result. The comparison of coefficients shows that processes in global production sharing are influenced more by their lag values, as evident from the relatively higher magnitude of *LAG_ASSEMBLY* compared to *LAG_PARTS* in the *FAEXP* equation.

Next, we examine the benchmark results in the absence of China. Tables 6a and 6b report the impact of trade continuity on global production sharing for a sub-sample, excluding China as both reporter and partner. We observe qualitatively similar results in the aggregate analysis. *TC_OVERALL* significantly positively impacts global production sharing, with a relatively higher magnitude of the coefficient for intermediate goods exports than manufacturing exports. TC_ASSEMBLY is insignificant in the parts and components exports equation in the disaggregated analysis. However, *TC_PARTS* is significant in both equations, indicating that parts and components exports are vital to final assembly exports.

Our findings on the magnitudes of service link costs are similar to the benchmark results. Consistent with the earlier findings, service link costs are negative and significant in the context of global production sharing. However, their magnitudes are impaired, showing an insignificant impact when controlled for time effects.

CONCLUSION

This paper introduces the concept of trade continuity in global production sharing. We analyse the role of trade continuity in determining the nature and pattern of global production sharing among emerging economies. The importance of trade continuity is mostly missing in the empirical literature on global production sharing. From the brief literature survey, the paper hypothesises that trade continuity positively influences the current year's exports between bilateral partners. We employ the imports of intermediate goods (parts and components and final assembly) from the previous period to measure trade continuity. Besides, we also use a specific variable to capture the effects of service link costs, often proxied by geographical distance and institutional stability in the standard literature. Hence, we model the flow of exports as a function of trade continuity and service link costs. We estimate an augmented gravity model of bilateral exports of 29 emerging economies for 2004-17. We use the PPML estimator to mitigate some of the econometric issues. The study results are in tandem with the existing literature on fragmentation, providing empirical support for theoretical arguments. The empirical analysis shows that the EME's bilateral trade patterns conform to the standard gravity analysis, as evident from the significance of market size and bilateral distance variables.

Table 6a: Excluding China: Aggregate Analysis

VARIABLES	*MEXP*	*IEXP*	*IEXP*	*MEXP*	*IEXP*	*IEXP*
GDP_REP	0.575***	0.560***		0.575***	0.554***	
	(0.0184)	(0.0215)		(0.0182)	(0.0214)	
GDP_PAR	0.523***	0.484***		0.525***	0.483***	
	(0.0188)	(0.0220)		(0.0184)	(0.0217)	
DIS	-0.791***	-0.699***	-0.700***	-0.804***	-0.710***	-0.715***
	(0.0231)	(0.0283)	(0.0307)	(0.0227)	(0.0280)	(0.0301)
TC_OVERALL	**0.281*** **	**0.315*** **	**0.255*** **	**0.271*** **	**0.302*** **	**0.244*** **
	(0.0114)	**(0.0138)**	**(0.0154)**	**(0.0111)**	**(0.0134)**	**(0.0150)**
SC	-0.403***	-0.585***	-0.346***	-0.427***	-0.638***	-0.369***
	(0.0365)	(0.0439)	(0.0454)	(0.0384)	(0.0457)	(0.0472)
RPG	-0.0710**	-0.197***	-0.201***	-0.0604**	-0.184***	-0.189***
	(0.0312)	(0.0378)	(0.0394)	(0.0303)	(0.0374)	(0.0388)
INS	0.0703***	0.189***	0.208***	0.0598***	0.170***	0.198***
	(0.0231)	(0.0265)	(0.0274)	(0.0230)	(0.0264)	(0.0273)
RER	-0.0332***	-0.0409***	-0.0547***	-0.0307***	-0.0416***	-0.0518***
	(0.00708)	(0.00824)	(0.00883)	(0.00701)	(0.00826)	(0.00866)
ADJ	0.612***	0.650***	0.698***	0.613***	0.660***	0.700***
	(0.0435)	(0.0519)	(0.0561)	(0.0419)	(0.0507)	(0.0546)
LAN	0.0416	-0.00174	0.179	0.0254	-0.0145	0.163
	(0.103)	(0.117)	(0.112)	(0.104)	(0.119)	(0.113)
Constant	-19.94***	-19.13***	-19.35***	-19.66***	-18.31***	-19.20***
	(0.597)	(0.741)	(0.731)	(0.613)	(0.761)	(0.772)
Year dummy	No	No	No	Yes	Yes	Yes
Observations	9,737	9,737	9,689	9,737	9,737	9,689
R-squared	0.653	0.604	0.589	0.667	0.614	0.600

Note: Robust standard errors are in parentheses. Coefficients of year dummies not reported. *** p<0.01, ** p<0.05, *p<0.1

Table 6b: Excluding China: Disaggregate Analysis

VARIABLES	PCEXP	FAEXP	PCEXP	FAEXP
MVA_REP	0.499***	0.740***	0.502***	0.744***
	(0.0258)	(0.0289)	(0.0263)	(0.0289)
MVA_PAR	0.483***	0.476***	0.491***	0.488***
	(0.0289)	(0.0277)	(0.0287)	(0.0276)
DIS	-0.641***	-0.747***	-0.657***	-0.772***
	(0.0371)	(0.0364)	(0.0367)	(0.0354)
TC_PARTS	**0.340*** **	**0.0642*** **	**0.342*** **	**0.0676*** **
	(0.0217)	**(0.0185)**	**(0.0218)**	**(0.0185)**
TC_ASSEMBLY	-0.00327	**0.121*** **	-0.0173	**0.101*** **
	(0.0271)	**(0.0247)**	(0.0269)	**(0.0243)**
SC	-0.494***	-0.187***	-0.512***	-0.205***
	(0.0536)	(0.0496)	(0.0549)	(0.0521)
RPG	-0.191***	-0.177***	-0.180***	-0.160***
	(0.0461)	(0.0447)	(0.0456)	(0.0439)
INS	0.256***	0.172***	0.246***	0.157***
	(0.0300)	(0.0308)	(0.0299)	(0.0310)
RER	-0.0494***	-0.0616***	-0.0472***	-0.0578***
	(0.00900)	(0.0103)	(0.00908)	(0.00984)
ADJ	0.590***	0.771***	0.593***	0.775***
	(0.0598)	(0.0658)	(0.0588)	(0.0639)
LAN	-0.0499	0.383***	-0.0554	0.367***
	(0.114)	(0.117)	(0.115)	(0.118)
Constant	-17.67***	-21.25***	-17.58***	-21.20***
	(0.855)	(0.855)	(0.900)	(0.920)
Year dummy	No	No	Yes	Yes
Observations	8,905	8,905	8,905	8,905
R-squared	0.631	0.483	0.640	0.496

Note: Robust standard errors are in parentheses. Coefficients of year dummies not reported. *** p<0.01, ** p<0.05, *p<0.1.

The findings of our study provide strong evidence supporting our hypothesis that continuous trade relations are highly significant in determining the nature of global production sharing among emerging economies. We find a positive relationship between trade continuity and global production sharing. Further, we also find that the nature of trade continuity is process-specific in global production sharing, as the trade continuity in final assembly is significant only in the current exports of final assembly and is insignificant in the current exports of parts and components. We find that the trade continuity capture by TC_PARTS positively impacts the current period's exports of parts and components, while TC_ASSEMBLY positively impacts final assembly exports. Hence, we infer that countries involved in global production sharing should maintain trade relations to avoid the costs of finding an alternative partner.

Further, the study finds that average service link costs, measured by the average cost to exports adjusted to the respective reporter's logistic performance index, strongly impact global production sharing. Better trade-related logistics improve trade by reducing the average cost of exporting. Countries that have improved trade logistics, despite having higher export costs, tend to engage in fragmentation trade because of the increasing returns to scale.

Based on our findings, we conclude that trade in intermediate goods between bilateral partners should continue as emerging economies evolve as key participants in production sharing. Reduced service links and coordination costs prosper global production sharing and fragmentation trade, and therefore, trade-related logistics should be improved.

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APPENDIX

List of Countries

Argentina, Brazil, Bulgaria, Chile, China, Colombia, Croatia, Czech Republic, Estonia, Hungary, India, Indonesia, Kazakhstan, Latvia, Lithuania, Malaysia, Mexico, Morocco, Pakistan, Philippines, Poland, Romania, Russian Federation, Saudi Arabia, Slovakia, TFYR of Macedonia, Thailand, Turkey, Ukraine

Average Services Link Costs Construction

Following Vogiatzoglu (2012), we construct the average service link costs using two measures: the average cost of exporting per container (in $US) and the LPI of the exporter. We obtain the average cost of exporting from the WDI Doing Business database of the World Bank and the LPI World Bank LPI database. Both of these variables are available at discrete levels. We fill out the missing years using the *carryforward* command in STATA, as both the series are highly persistent. Hence, we use the non-missing values to fill the series.

$$\text{Average service link costs (SC)} = \frac{\text{Average cost of exports per container (US\$)}}{\text{Reporter's LPI}}$$

By construction, the average service link costs have a negative effect on exports.

Real Bilateral Exchange Rate Construction

We construct the real bilateral exchange rate by adjusting the reporter's local currency in US dollars to the price indices of the respective countries. We obtain the reporter's nominal exchange rate values in local currency per $US, period average, from the IMF International Finance Statistics (IFS) database. We use both countries' Consumer Price Index (CPI) to adjust for price fluctuations, which we source from the IMF IFS database. Wherever CPI data are not available, we use the Producer Price Index.

$$\text{Real bilateral exchange rate (RER)} = \text{Reporter's nominal exchange rate*} \frac{\text{Reporter's CPI}}{\text{Partner's CPI}}$$

By construction, a decline in this variable indicates depreciation in the exchange rate and improvement in the exports. Hence, we expect a negative relationship between RER and the flow of goods. Following Florensa et al. (2015), we expect an increase in this variable indicates depreciation in the exchange rate and improvement in the exports.

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