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Resolving the trade comovement puzzle at the margin of global value chains

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Abstract

Purpose – This paper investigates the crucial role that the trade of intermediate goods plays in elucidating trade-output synchronization. We specifically highlight the significance of incorporating intermediate trade, particularly concerning the dominance of forward linkages in the global value chains (GVCs) of countries producing intermediate goods.

Design/methodology/approach – We extend Johnson (2014) international real business cycle (IRBC) model to integrate the foreign value added by intermediate exporters within a forward-linkage GVC.

Findings – Model simulations indicate that the trade of intermediate goods accounts for around 31–33% of observed trade-output synchronization. Notably, the inclusion of value-added rents in GVCs within intermediate goods trade boosts the explanatory power to 55%.

Research limitations/implications – Although adding input trade information does not replicate the empirical finding enough to resolve the trade-comovement puzzle within the IRBC-style framework, as Johnson (2014) pointed, this might highlight the limitations of the framework itself. The limitations of both our work and Johnson (2014) suggest that a more endogenous mechanism that correlates comovement with trade independently of the correlation between trade and comovement of TFPs should be introduced in the IRBC model.

Originality/value – Our paper extends Johnson (2014) IRBC model to incorporate the foreign value added to intermediate trade within forward-linkage GVCs. The model's explanatory power in resolving the trade comovement puzzle has improved.

Keywords Trade comovement puzzle, International real business cycle, Global value chain, Intermediate trade

Paper type Research paper

1. Introduction

Countries engaging in higher levels of trade generally exhibit more synchronized business cycles (Frankel and Rose, 1998; Baxter and Kouparitsas, 2005). However, conventional international real business cycle (IRBC) models have failed to generate the trade-output synchronization observed in the data. Kose and Yi's (2006) seminal paper demonstrated that productivity shocks transmitted in a standard real business cycle model do not match the empirical findings, which is a well-known trade comovement puzzle. Although the shortcomings of standard models have been thoroughly quantified, the specific mechanisms by which trade influences business cycle transmissions within this framework remain largely unexplored. It is particularly unclear which aspects are pivotal to the model's inadequacy to resolve the trade comovement puzzle.

In this paper, we propose that intermediate goods trade is crucial in explaining trade-output synchronization. We particularly emphasize the importance of considering intermediate trade

JEL Classification — E23, E32, F11, F14, F43, F44

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regarding forward-linkage dominance in the global value chains (GVC) of countries producing and exporting intermediate goods. We extend Johnson's (2014) IRBC model to analyze intermediate goods trade flows by incorporating the additional value added by intermediate exporters in a forward-linkage GVC. According to model simulations, intermediate goods trade explains approximately 31–33% of the data's observed trade-output synchronization. Importantly, when incorporating value-added rents in GVCs into intermediate goods trade, the explanatory power increases to 55%.

Our paper closely aligns with the work of Kose and Yi (2006), who pioneered the trade-comovement puzzle and analyzed the impact of trade on comovement within the standard theory. Subsequent studies have focused on a robust link between bilateral trade intensities and the comovement of business cycles across countries. Using cross-country regressions, studies such as Frankel and Rose (1998), Calderon *et al*. (2002), Baxter and Kouparitsas (2005), Kose and Yi (2006), and Inklaar *et al*. (2008) consistently find that greater trade between country pairs leads to more synchronized business cycle fluctuations.

Our paper attempts to test the phenomenon of trade synchronization through a macroeconomic theoretical approach. In this context, Wei and Santacreu (2015) proposed a theory suggesting that trade results in greater technology spillover. Similarly, de Soyres and Gaillard (2019) showed that the presence of markups caused measured total factor productivity (TFP) to comove more with increased trade. Furthermore, Drozd *et al*. (2021) emphasized that dynamic trade elasticity is vital in resolving the trade comovement puzzle. Johnson (2014) investigates the correlations between industry-level TFP and input-output linkages, demonstrating that considering TFP correlation with trade offers only a partial solution. Johnson finds that service sectors display the same trade-comovement patterns as other industries, yet measured TFP does not correlate with trade in these sectors. Moreover, input-output linkages alone are inadequate to fully explain this aspect of the data and the trade-comovement puzzle. In our paper, we extend Johnson's (2014) multi-country, multi-sector IRBC model by incorporating economic rents paid to suppliers based on their forward-linkage contribution to GVCs through intermediate goods transactions. The model's explanatory power in resolving the trade comovement puzzle has improved.

This paper proceeds as follows. Section 2 introduces the theoretical framework. Section 3 discusses the data and simulation results. Section 4 concludes.

2. Theoretical framework

This section introduces the IRBC model. We extend Johnson's (2014) multi-country, multi-sector IRBC model by incorporating economic rents paid to suppliers based on their forward-linkage contribution to GVCs through intermediate goods transactions. The model economy incorporates a production structure that reflects the cross-border trade flows of intermediate goods and a productivity shock that mutually influences trade flows between countries.

2.1 Production

This model economy is represented as a multi-period world economy consisting of multiple countries $i, j \in \{1, .., N\}$. Each sector s within country i produces gross output $Q_{it}(s)$ using capital $K_{it}(s)$, labor $L_{it}(s)$, and intermediate good $X_{it}(s)$. Intermediate goods are represented as an aggregate of inputs produced by various countries. The production function for each sector is expressed in the following CES form.

$$Q_{it}(s) = Z_{it}(s)\left(\theta_i(s)^{1-\sigma} V_{it}(s)^{\sigma} + (1-\theta_i(s))^{1-\sigma} X_{it}(s)^{\sigma}\right)^{1/\sigma} \quad (1)$$

$$X_{it}(s) = \left(\sum_{j=1}^{N} \sum_{s'=1}^{S} \omega_{ji}^{x}(s',s)^{1-\eta} \left[X_{jit}(s',s) + gvc_{jit}^{x}(s',s) \right]^{\eta} \right)^{1/\eta} \quad (2)$$

$$V_{it}(s) = K_{it}(s)^{\alpha} L_{it}(s)^{1-\alpha} \quad (3)$$

where $X_{jit}(s',s)$ denotes intermediate inputs traded from sector s' in country j to sector s in country i. $gvc_{jit}^{x}(s',s)$ refers to the economic rent due to GVC forward-linkage market dominance from sector s' in country j to sector s in country i. As in Johnson (2014), the baseline case sets $gvc_{jit}^{x}(s',s)$ to zero, while in the GVC case, it is measured as the forward-linkage foreign value added by the importing country in global trade. This model setup reflects the assumption that the bargaining power within a GVC varies according to the source technology capability embedded in each intermediate good and that the consuming country must compensate the producing country accordingly.

$V_{it}(s)$ represents a composite domestic factor input in gross output for the country-sector, produced based on productivity $Z_{it}(s)$, capital $K_{it}(s)$, and labor $L_{it}(s)$. It can be interpreted as the value-added excluding intermediate goods in gross output production. The parameters $\theta_i(s)$, $\omega_{ji}^{x}(s',s)$, and α respectively represent the composite domestic factor input share in gross output, the input share of intermediate goods traded, and the capital share in the production function (3). σ and η denote the elasticity of substitution between production factors in production functions (1) and (2), respectively. A perfectively competitive firm in sector s of country i produces outputs by maximizing the profit given by $p_{it}(s)$, w_{it}, r_{it}, and intermediate prices.

$$\max p_{it}(s)Q_{it}(s) - w_{it}L_{it}(s) - r_{it}K_{it}(s) - \sum_{j=1}^{N} \sum_{s'=1}^{S} p_{jt}(s')X_{jit}(s',s) \quad (4)$$

$$s.t.\, L_{it}(s) \geq 0, K_{it}(s) \geq 0, X_{jit}(s',s) \geq 0,$$

where $p_{it}(s)$, w_{it}, and r_{it} stand for the price of output, wages, and the rental rate of capital, respectively. The firm maximizes its profits using a two-stage problem. In the first stage, given the price of the composite factor $p_{it}^{v}(s) = \left(\frac{r_{it}}{\alpha}\right)^{\alpha} \left(\frac{w_{it}}{1-\alpha}\right)^{1-\alpha}$ and the intermediate price $p_{it}^{x}(s) = \left(\sum_{j=1}^{N} \sum_{s'=1}^{S} \omega_{ji}^{x}(s',s) p_{jt}(s')^{\eta/(\eta-1)} \right)^{(\eta-1)/\eta}$, the firm determines $V_{it}(s)$ and $X_{it}(s)$. In the second stage, the firm determines $K_{it}(s)$ and $L_{it}(s)$. The gross output $Q_{it}(s)$ is represented as the sum of the value of intermediate goods traded between countries and the value of the final goods. $F_{ijt}(s)$ represents the final goods shipments from country i to country j in sector s.

$$Q_{it}(s) = \sum_{j} \left(F_{ijt}(s) + \sum_{s'=1}^{S} \left[X_{ijt}(s,s') + gvc_{jit}^{x}(s',s) \right] \right) \quad (5)$$

Finally, a representative firm in the final good sectors maximizes its profits.

$$\max p_{it}^{f} F_{it} - \sum_{j=1}^{N} \sum_{s=1}^{S} p_{jt}(s) F_{jit}(s) \text{ s.t. } F_{jit}(s) \geq 0 \quad (6)$$

where $p_{it}^{f}(s) = \left(\sum_{j=1}^{N} \omega_{ji}^{f}(s) p_{jt}(s)^{\rho/(\rho-1)} \right)^{(\rho-1)/\rho}$ is the price of the composite final goods.

The composite final goods of each country are used to measure consumption and investments ($F_{it} = C_{it} + I_{it}$). The aggregate capital stock $K_{it} = \sum_{s=1}^{S} K_{it}(s)$ evolves according to the law of motion, $K_{it+1} = I_{it} + (1-\delta)K_{it}$.

2.2 The household problem and financial markets

Each country is populated by a representative household, which consumes final goods C_{it} and supplies labor $L_{it} = \sum_{s=1}^{S} L_{it}(s)$. The utility function is given by

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left[log(C_{it}) - \frac{\chi \epsilon}{1+\epsilon} L_{it}^{(1+\epsilon)/\epsilon} \right] \tag{7}$$

where ϵ is the labor supply elasticity, and β is the discount factor. To introduce financial markets into the model economy, we assume the completeness of the financial market, where products exist that hedge against all possible future events. At period t, the state of the global economy is denoted by ϖ_t. This state evolves according to the transition probability density $f(\varpi_{t+1}, \varpi_t)$. $B_i(\varpi_{t+1})$ represents country i's holding bonds in state ϖ_{t+1} on a one-period state-contingent basis, providing one unit of numeraire good in state ϖ_{t+1} to the holder country. The bond prices are $b(\varpi_{t+1}, \varpi_t)$, and $\sum_i B_i(\varpi_{t+1}) = 0$ in equilibrium, meaning that total demand for bonds in all states equals total supply. The household owns the domestic capital and bonds and has the following budget constraints:

$$p_{it}^f (C_{it} + I_{it}) + \int b(\varpi_{t+1}, \varpi_t) B_i(\varpi_{t+1}) d\varpi_{t+1} = r_{it} K_{it} + w_{it} L_{it} + B_i(\varpi_t) \tag{8}$$

Given prices and initial bond holdings, the household chooses C_{it}, L_{it}, K_{it+1}, or $B_i(\varpi_{t+1})$ to maximize its utility (7) subject to (8).

2.3 Equilibrium

Given the stochastic process of productivity and initial endowments, the model equilibrium consists of quantities $\{C_{it}, F_{it}, B_i(\varpi_t)\}_i$ for each country and $\{Q_{it}(s), K_{it}(s), L_{it}(s), \{F_{jit}(s)\}_j, \{X_{jit}(s', s)\}_{j,s'}\}_{i,s}$ for each country-sector, satisfying the household's utility maximization conditions, the firms' profit maximization conditions, and the market clearing conditions for each market given prices $\{r_{it}, w_{it}, p_{it}^f, \{p_{it}(s)\}_s\}_i$ and $b(\varpi_{t+1}, \varpi_t)$.

3. Calibration and simulation

3.1 Calibration

To perform simulations of the linearized model, we calibrate several values for structural parameters, as well as steady-state value shares, based on international trade data. We set $\alpha = 0.33$, $\delta = 0.1$, $\beta = 0.96$, and $\epsilon = 4$ based on commonly used values in the literature. The parameters $\{\sigma, \eta, \rho\}$ governing elasticity vary across simulations, allowing for different degrees of complementarity and substitutability for both production and preferences. To simplify the simulation calculations, the parameters are set as follows. We assign $\rho = 0.5$, resulting in an elasticity of substitution of 2 between final goods sourced from different goods. On the production side, $\sigma = \eta = 0$ is set, indicating a Cobb-Douglas production function for real value-added and the composite intermediate, with the composite intermediate being the Cobb-Douglas function in inputs from various source countries.

The steady-state share values of the linearized model, such as the proportion of inputs in production and the allocation of foreign goods in final demand and input usage are determined based on traded data flow across countries. Data on value-added and gross output by sector $\{p_i(s), Q_i(s), p_i^v(s), V_i(s)\}$ and the bilateral shipments of final and intermediate goods

$\{p_i(s)F_{ij}(s), p_i^x(s)X_i(s,s')\}$ are adequate for calculating these shares. We sourced this data from the ADB-MRIO for the year 2019. Due to the burden of the simulation and constraints regarding the availability of time-series data on output and productivity, we incorporate data from 28 countries within the database into the model, adding four countries into Johnson's (2014) sample, encompassing approximately 80% of global GDP [1]. The remaining countries are aggregated to constitute a composite region termed "rest-of-the-world." Additionally, we aggregate the data to delineate two composite sectors: "goods" (encompassing agriculture, natural resources, and manufacturing) and "services".

We calibrate $gvc_{jit}^x(s',s)$ as the forward-linkage foreign value-added of the importing country in global trade. We calculate it as the forward GVC participation rate defined by Wang *et al.* (2022) by summing a country's value-added share that crosses the national border for production only once (Simple GVC) with the value-added share that crosses the border two or more times through third parties (Complex GVC).

In the model, $Z_{it}(s)$ represents the Total Factor Productivity (TFP) of producing gross output. We updated Johnson's (2014) value-added TFP constructed from the EU-KLEMS up to 2019. Given the unavailability of data on TFP for gross output across many countries and years, we use data on value-added labor productivity (LP_{it}) instead of value-added TFP data [2] and estimate the productivity process as follows.

$$\log LP_{it}(s) = \lambda_i(s)\log LP_{it-1}(s) + \varepsilon_{it}(s) \tag{9}$$

We utilize $\varepsilon_{it}(s)$ to construct the covariance matrix of shocks for the log of $Z_{it}(s)$, denoted as Σ. Furthermore, we utilize data on annual sectoral labor productivity growth spanning from 2007 to 2020, sourced from the World Bank Development Indicator, to isolate the cyclical component of productivity, corresponding to log $LP_{it}(s)$. To obtain a detrended series, we employ the Hodrick-Prescott (HP) filter with a smoothing parameter of 6.25.

In the simulations, we implement the covariance matrix Σ in two ways. One set of simulations incorporates correlated shocks across countries, with the correlations dictated by the estimated covariance matrix. For the other set of simulations, we nullify the "off-diagonal" elements of the covariance matrix, $cov(Z_{it}(s), Z_{jt}(s')) = 0$, for all i ≠ j. This permits shocks to be correlated across sectors within countries but uncorrelated for cross-country sector pairs. While this eliminates cross-country correlations in shocks, we tried to verify how correlated shocks magnify the genuinely idiosyncratic shocks experienced by countries. Table A1 in the appendix presents descriptive statistics of key variables

3.2 Stylized facts on data

First, we discuss how bilateral trade intensity positively correlates with bilateral comovement in real value-added and gross output between country-sector pairs. For each country-sector pair, bilateral trade intensity is defined as log $(EX_{ij} + EX_{ji})/(VAD_i + VAD_j)$, where EX_{ij} represents exports from country-sector i to j [3]. VAD_i shows the year-on-year growth of the real value-added of country-sector i. To examine trade comovement over business cycles, we run a regression as follows.

$$\text{Corr}\left(\Delta Y_i, \Delta Y_j\right) = \beta_o + \beta_1 \log(\textit{Bilateral Trade}) + \varepsilon_{ij} \tag{10}$$

The dependent variable is a correlation coefficient between ΔY_i and ΔY_j, where ΔY is the year-on-year gross output (or value-added) growth. ε_{ij} is an error term. The trade comovement hypothesis indicates that $\beta_1 > 0$. Table 1 presents the phenomenon of trade comovement with real value-added growth across country-sector pairs over business cycles. The finding at the aggregate level in Column 1 indicates that a 1% increase in bilateral trade intensity significantly increases the comovement of value-added growth between country-sector pairs by 0.047. Columns 2, 3, and 4 present the trade comovement phenomenon for the good-good,

Table 1. Trade comovement data

	Real value-added				Gross output			
Dependent	Aggregate (1)	Goods (2)	Services (3)	Cross (4)	Aggregate (1)	Goods (2)	Services (3)	Cross (4)
Log bilateral trade	0.047***	0.056***	0.069***	0.048***	0.048***	0.056***	0.076***	0.044***
	(0.011)	(0.014)	(0.015)	(0.010)	(0.010)	(0.012)	(0.015)	(0.008)
Constant	0.526***	0.603***	0.729***	0.531***	0.654***	0.771***	0.785***	0.601***
	(0.060)	(0.076)	(0.080)	(0.053)	(0.055)	(0.067)	(0.081)	(0.042)
Observation	351	351	351	702	351	351	351	702
R Squared	0.06	0.06	0.06	0.04	0.07	0.08	0.08	0.04

Note(s): Robust standard errors are in parentheses. *** are significant at the 1% level
Source(s): Table by author

service-service, and good-service sectors, respectively. While the comovement for the good-good and service-service sectors is greater than for the aggregate level, the results presented in Column 4 indicate that the trade comovement for good-service sectors is relatively weak. Columns 5 to 8 present the corresponding results for the phenomenon of trade comovement with real gross output growth across country-sector pairs. These results are similar to Columns 1 to 4.

3.3 Simulation results

In this section, we compare model moments with the data moments presented in Table 1. We compute the pairwise correlation of year-on-year output growth in the model with correlated shocks ($cov(Z_{it}(s), Z_{jt}(s')) \neq 0$) averaging over 500 replications of each period corresponding to the data. Table 2 presents the simulated results of trade comovement with output growth across country-sector pairs over business cycles. Generally, in the baseline case ($gvc^{x}_{jit}(s', s) = 0$), the model generates a smaller, positive aggregate trade comovement coefficient. In Columns 1 and 8, the coefficient at the aggregate level explains 31–35% of the corresponding coefficients from the data (Table 1). In Column 2, the coefficient for the good-good sectors explains up to 57% of the corresponding coefficient from the data, although the coefficients for the service-service and good-service sectors fail to replicate the data moment.

In the GVC case ($gvc^{x}_{jit}(s', s) \neq 0$), the model results are closer to the data moments than the baseline case and better explain the trade-comovement puzzle. In Columns 1 and 8, the coefficient at the aggregate level explains 43–55% of the corresponding coefficient from the data. In Column 2, the coefficient for good-good sectors explains up to 66% of the corresponding coefficient from the data.

Table 3 presents the simulated results of trade comovement with output growth for uncorrelated shocks ($cov(Z_{it}(s), Z_{jt}(s')) = 0$). In general, compared to Table 2, the model's explanatory power decreases. As Johnson (2014) demonstrated, accounting for correlated shocks is important when explaining the trade comovement puzzle using a model that considers the dominance of intermediate goods producers in GVCs.

4. Conclusion

This paper extends an IRBC model encompassing two sectors and numerous countries, integrating input trade and foreign value-added in the forward linkages of GVCs. The model simulation enhances our comprehension of the trade comovement puzzle. Following a domestic productivity shock, downstream countries increase their input use, leading to gross output comovement between the domestic country and the downstream input users. However, as in previous literature, input trade does not resolve the trade-comovement puzzle straightforwardly. Notably, the inclusion of value-added rents in GVCs within intermediate goods trade boosts the explanatory power significantly.

Although adding input trade information does not replicate the empirical finding enough to resolve the trade-comovement puzzle within the IRBC-style framework, as Johnson (2014) pointed, this might highlight the limitations of the framework itself. For instance, the model overlooks the fact that a large portion of intermediate goods are traded within multinational firms, and the concentration of input trade among the largest firms in the economy may lead to shocks from intermediate suppliers having a stronger impact on aggregate outcomes. The limitations of both our work and Johnson (2014) suggest that a more endogenous mechanism that correlates comovement with trade independently of the correlation between trade and comovement of TFPs should be introduced in the IRBC model. Future research would benefit from a more detailed examination of the microeconomic characteristics of input trade.

Table 2. Simulation results with correlated shocks

	Real value-added				Gross output			
Dependent	Aggregate (1)	Goods (2)	Services (3)	Cross (4)	Aggregate (1)	Goods (2)	Services (3)	Cross (4)
Baseline case: $gvc^{x}_{jit}(s',s) = 0$								
Log bilateral trade	0.015	0.032***	−0.001	0.008	0.017**	0.031***	0.003	0.006
	(0.009)	(0.010)	(0.010)	(0.007)	(0.008)	(0.008)	(0.010)	(0.007)
Constant	0.350***	0.459***	0.114**	0.214***	0.477***	0.711***	0.177***	0.317***
	(0.048)	(0.054)	(0.053)	(0.037)	(0.046)	(0.045)	(0.054)	(0.040)
Observation	351	351	351	702	351	351	351	702
R Squared	0.01	0.04	0.00	0.00	0.01	0.07	0.00	0.00
GVC case: $gvc^{x}_{jit}(s',s) \neq 0$								
Log bilateral trade	0.026**	0.037***	0.013	0.017**	0.021*	0.024**	0.012	0.012
	(0.011)	(0.013)	(0.012)	(0.009)	(0.011)	(0.011)	(0.012)	(0.009)
Constant	0.388***	0.455***	0.180***	0.247***	0.479***	0.655***	0.213***	0.340***
	(0.050)	(0.059)	(0.055)	(0.039)	(0.048)	(0.050)	(0.055)	(0.042)
Observation	351	351	351	702	351	351	351	702
R Squared	0.02	0.04	0.00	0.01	0.01	0.03	0.00	0.00

Note(s): Robust standard errors are in parentheses. ***, **, and * are significant at the 1, 5, and 10% levels, respectively
Source(s): Table by author

Table 3. Simulation results with uncorrelated shocks

Dependent	Real value-added				Gross output			
	Aggregate (1)	Goods (2)	Services (3)	Cross (4)	Aggregate (1)	Goods (2)	Services (3)	Cross (4)
Baseline case: $gvc^{x}_{jit}(s',s) = 0$								
Log bilateral trade	0.009***	0.012***	0.007**	0.003	0.019***	0.032***	0.012***	0.010**
	(0.003)	(0.004)	(0.003)	(0.002)	(0.006)	(0.006)	(0.004)	(0.004)
Constant	0.060***	0.112***	0.036**	0.020	0.159***	0.346***	0.079***	0.086***
	(0.020)	(0.020)	(0.015)	(0.012)	(0.036)	(0.036)	(0.024)	(0.023)
Observation	351	351	351	702	351	351	351	702
R Squared	0.11	0.10	0.06	0.01	0.11	0.15	0.07	0.03
GVC case: $gvc^{x}_{jit}(s',s) \neq 0$								
Log bilateral trade	0.012***	0.015***	0.010***	0.002	0.026***	0.037***	0.021***	0.013***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.008)	(0.008)	(0.005)	(0.005)
Constant	0.064***	0.114***	0.045***	0.013	0.179***	0.342***	0.107***	0.093***
	(0.021)	(0.021)	(0.016)	(0.013)	(0.037)	(0.039)	(0.023)	(0.024)
Observation	351	351	351	702	351	351	351	702
R Squared	0.11	0.09	0.08	0.00	0.14	0.13	0.14	0.03

Note(s): Robust standard errors are in parentheses. *** and ** are significant at the 1 and 5% levels, respectively
Source(s): Table by author

Notes

1. The countries are Australia, Austria, Belgium, Brazil, Canada, China, the Czech Republic, Denmark, Finland, France, Germany, India, Indonesia, Italy, Japan, Korea, Mexico, the Netherlands, Poland, Russia, Slovakia, Slovenia, Spain, Sweden, Turkey, the United Kingdom, and the United States.
2. Data on labor productivity are obtained from the World Bank Development Indicator. We transform the estimated productivity process described in equation (9) into an equivalent stochastic process for gross output TFP. This involves converting the shocks $\varepsilon_{it}^{LP}(s)$, which pertain to value-added TFP, into equivalent shocks for gross output TFP. To achieve this, each residual is multiplied by the steady-state ratio of value-added to gross output: $\varepsilon_{it}(s) \equiv \varepsilon_{it}^{v}(s)\varepsilon_{it}^{LP}(s)$. Due to the lack of recent data on total factor productivity or value-added productivity for the sample countries and industries, the calibration of the model's productivity parameters was calculated following Johnson's methodology, using data from the World Bank.
3. We do not consider the case of trade between sectors within a country.

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Appendix

Table A1. Descriptive statistics of trade comovement data

Variable	Obs	Mean	S.D.	Min	p25	p50	p75	Max
Dependent variable: aggregate								
VAD growth correlation	351	0.282	0.297	−0.541	0.084	0.345	0.509	0.901
Output growth correlation	351	0.408	0.279	−0.503	0.223	0.465	0.615	0.913
Dependent variable: goods								
VAD growth correlation	351	0.314	0.329	−0.790	0.117	0.363	0.551	0.965
Output growth correlation	351	0.483	0.301	−0.548	0.362	0.539	0.686	0.975
Dependent variable: services								
VAD growth correlation	351	0.371	0.422	−0.723	0.078	0.417	0.748	0.964
Output growth correlation	351	0.394	0.398	−0.758	0.109	0.463	0.741	0.975
Dependent variable: cross								
VAD growth correlation	702	0.281	0.359	−0.782	0.034	0.322	0.557	0.926
Output growth correlation	702	0.374	0.311	−0.665	0.176	0.399	0.633	0.948
Explanatory variable								
Trade intensity	351	0.039	0.124	0.001	0.005	0.011	0.02	1.281

Source(s): Table by author

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