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Compilation of Real Global Input-Output Tables

Nagendra SHRESTHA

Yokohama National University

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Abstract

This paper attempts to estimate the Global Input-Output tables in real terms using Inter Country Input-Output tables published by OECD, industry-specific producers price indices (for 14 manufacturing industries), Consumers Price indices (for two non-manufacturing industries), and exchange rates with respect to base year 2005. We also conduct conventional basic input-output analysis to see the inter-continent (Asia, North America, and Europe) linkage subject to respective final demand and output based on reorganized nominal and real inter-continent input-output tables for 2022.

Keywords: Global Input-Output tables in constant price, Production inducements, Economic impact, Basic price, Producers' price

***JEL classifications**: C67, F60*

1. Introduction

Recently Input-Output (IO) analysis has been popularly used in various fields related to Economics. Estimation of directly unobserved phenomena, known as indirect or induced effects, numerically is one of the major reasons for the popularity. Specifically in global context, international economic linkages can be assessed precisely because of its capability to address complex interactions among countries and industries. As such, various input-output datasets with international coverage are available. A few examples of the datasets are Inter Country Input-Output (ICIO) Tables published by OECD, Asian Development Bank's (ADB) Multi Regional Input-Output (MRIO) tables, and World Input-Output Database (WIOD) by the WIOD project among others.[1]

In general IO tables are valued in current price or in nominal terms, which means that the price factor remains unaddressed. Moreover, in international economic framework an exchange rate factor, which is directly related to price in international trade, is also overlooked. However, comparison of economic phenomena over time or country or region in nominal terms may mislead the outcome of an analysis due to change in price and exchange rate over the period or area of concern. For example, if drastic fluctuation of exchange rates around the world during Global Financial Crisis in 2008 is overlooked in an economic analysis, the results and conclusions may not have significant meaning.

In this paper, we attempt to estimate Global Input-Output (GIO) tables in constant price and exchange rate or in real terms by incorporating price and exchange rate fluctuation to overcome the critical issue stated above. To address such issues, ADB

[1] See details on OECD (https://www.oecd.org/sti/ind/inter-country-input-output-tables.htm), ADB (https://www.adb.org/what-we-do/data/regional-input-output-tables), and WIOD (https://www.rug.nl/ggdc/valuechain/wiod/?lang=en) in respective links.

estimates and provides constant price MRIO by assigning Consumers Price indices (CPI) to all industries as price factor despite different industrial characteristics and pricing mechanism. Further, WIOD publishes real term World Input-Output Tables (WIOT) using Previous Year Prices (PYP) to deflate the WIOTs.[2] It has, of course, great contribution and relevance for the global analysis. However, we argue that results based on PYP deflation method makes comparison complicated if comparison period consists over two years. In addition, use of basic price system to deflate may not fully incorporate production structures, specifically for manufacturing industries as basic price includes subsidy that may differ among sample countries. Moreover, PYP WIOTs are quite outdated as 2014 is the latest data available.[3]

In contrast to existing approaches, we associate 14 industry-specific Producers or Wholesale Price indices (PPI or WPI) for manufacturing industries (primarily collected to estimate Industry-Specific Real Effective Exchange Rates (IREER) for Research Institute of Economy, Trade and Industry (RIETI) project)[4], CPI for non-manufacturing industries, and exchange rates with the OECD ICIO tables to get 30 countries (excluding Rest of the World, ROW), 16 industries (14 manufacturing industries, 6 final demand categories, and one value added category GIO tables with respect to constant price and exchange rate in 2005[5]. The annual Real GIO tables cover 28 years starting from 1995 to 2022 and the amounts are presented in Million US dollars.

As an application of the Real GIO tables, we first reorganize 2022 Nominal and Real

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[2] See Los et.al. (2014) for construction process of PYP WIOTs.

[3] Availability of PYP WIOTs as of 2024/8/15

[4] See https://www.rieti.go.jp/users/eeri/en/ for RIETI's IREER project. Also see Sato et al. (2013, 2015) for the details on IREER.

[5] See Appendices 1, 2 and 3 for list of countries, industries, and final demand categories.

GIO table into three continent-three sector inter continent IO tables and conduct a basic production inducement analysis to calculate Production Inducement Coefficients (PIC) and Production Inducement Shares (PIS) showing linkage between industrial production activities with final demand and gross output respectively. The result shows that the price and exchange rate effects are more prominent in PIC due to magnifying nature of complex interactions of price and exchange rate from the demand-side aspect.

The remaining of the paper is organized as follows. Section 2 describes estimation strategy with respect to basic relationship of variables in nominal and real terms. We provide details of data used and compilation procedures in Sections 3 and 4 respectively. Section 5 conducts and discusses IO based production inducement analysis and its results. Finally, the paper is concluded in Section 6.

2. Estimation strategy

Here, we try to establish relationship of an economic variable[6], say Y, in nominal and real terms. Nominal Y (say Y^N) is defined as product of price (P), exchange rate (E) and quantity (Q) all in current year $T=t$ as shown in equation (1), whereas real Y (say Y^R) is product of price and exchange rate in base year $B=0$, and quantity in current year T as expressed in equation (2).

$$Y^N = P^{T=t} E^{T=t} Q^{T=t} \tag{1}$$

$$Y^R = P^{T=0} E^{T=0} Q^{T=t} \tag{2}$$

Here, Y is expressed in US dollars, P in local currency, E in US dollar per unit local

[6] In this paper we deal with economic variables of different countries expressed in US dollars and price variables in local currencies. It means that further treatment of price in local currency is necessary with the bilateral exchange rates with respect to US dollar.

currency, and Q in quantity measure. Using equations (1) and (2), we can derive real valued Y as equation (3).

$$Y^R = \left[\frac{P^{T=0}}{P^{T=t}} \frac{E^{T=0}}{E^{T=t}} \right] Y^N \tag{3}$$

Where $\left[\frac{P^{T=t}}{P^{T=0}} \frac{E^{T=t}}{E^{T=0}} \right]$ is combined price and exchange rate deflator.[7]

Remaining of this section describes how two country (denoted with C_A and C_B respectively) - single sector nominal GIO table in to real term GIO table with the help of equation (3) for a given base year and target year prices and exchanges rates. We can extend the estimation process to multi-country and multi-sector framework, without loss of generality, as each country-sector input and output structures (or equivalently, demand and supply structures) are independent.

Let us assume that Figure 1 represents two-country (say, C_A and C_B) single sector GIO table in nominal term. All the values, by definition, subject to intermediate and final goods transactions, gross outputs (or, equivalently, total inputs), and value-added are valued at given year ($T = t$) price and exchange rate levels. Here, we can define combined price and exchange rate level in two countries C_A and C_B as expressed in equations (4) and (5) respectively. Note here that effect of the combined price and exchange rate is already included in the transaction values, so it does not appear on Figure 1.

$$P_A^{T=t} E_A^{T=t} = \left[P_A^{T=t} E_{\$/LCA}^{T=t} \right] \tag{4}$$

$$P_B^{T=t} E_B^{T=t} = \left[P_B^{T=t} E_{\$/LCB}^{T=t} \right] \tag{5}$$

Where, exchange rates are measured in US dollars per unit of local currencies in

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[7] Combined price and exchange rate deflators in vector form can be defined as diagonal elements of $\left(\hat{\mathbf{p}}^{T=t}\hat{\mathbf{e}}^{T=t}\right)\left(\hat{\mathbf{p}}^{T=0}\hat{\mathbf{e}}^{T=0}\right)^{-1}$ such that $\hat{\mathbf{p}}$ and $\hat{\mathbf{e}}$ are diagonal matrices of price and exchange rate vectors at given year ($T = t$) and base year ($T = 0$) respectively.

respective countries.

Figure 1: GIO Table in Nominal Term

	Intermediate demand		Final demand		Gross output
	C_A	C_B	C_A	C_B	
C_A	Z_{AA}	Z_{AB}	F_{AA}	F_{AB}	X_A
C_B	Z_{BA}	Z_{BB}	F_{BA}	F_{BB}	X_B
Value-added	V_A	V_B			
Total input	X_A	X_B			

Notes:

1. *Z, F, V and X represent intermediate goods transactions, final goods transactions, value-added and gross output respectively expressed in US dollars.*
2. *In double letter country suffix, first suffix represents the country of production and second represents the country of use subject to intermediate and final goods.*

Further, we assume price and exchange rate levels at base year (*T=0*) as equations (6) and (7).

$$P_A^{T=0} E_A^{T=0} = \left[P_A^{T=0} E_{\$/LCA}^{T=0} \right] \tag{6}$$

$$P_B^{T=0} E_B^{T=0} = \left[P_B^{T=0} E_{\$/LCB}^{T=0} \right] \tag{7}$$

From the supply-side perspective (along the row-direction in the GIO table), each country's sales in real term can be calculated as a multiplication of nominal sales values and inverse of combined price and exchange rate deflators $\left(\frac{P_A^{T=0}}{P_A^{T=t}} \frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}} \right)$ for country A and $\left(\frac{P_B^{T=0}}{P_B^{T=t}} \frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}} \right)$ for country B, thus we get two rows of real term sales of both country as illustrated in Figure 2. Now, from the demand side perspective (along the column-direction of the GIO table) total inputs will be same as total outputs $\left(\frac{P_A^{T=0}}{P_A^{T=t}} \frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}} \right) X_A$ for country A, and intermediate input purchases of country A form the domestic market and country B will be $\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)Z_{AA}+\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)Z_{BA}$ in total represented by first, second and last elements of the country A's column in Figure 2.

Finally, the value-added for each country is estimated as a difference of total inputs and total purchase of intermediate goods to fulfil basic supply-demand equilibrium assumption in Input-Output theory. Thus, equations (8) and (9) are used to calculate value-added in real terms for country A and B respectively.

$$V_A^R=\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)X_A-\left\{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)Z_{AA}+\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)Z_{BA}\right\} \tag{8}$$

$$V_B^R=\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)X_B-\left\{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)Z_{AB}+\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)Z_{BB}\right\} \tag{9}$$

The above-mentioned estimation processes enable us to convert nominal valued GIO table into a real valued table as shown in Figure 2 for the given price and exchange rate series for each country-industry the GIO deals with.

Figure 2: GIO Table in Real Term

	Intermediate demand		Final demand		Gross output
	C_A	C_B	C_A	C_B	
C_A	$\left[\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\frac{P_A^{T=0}}{P_A^{T=t}}\right]Z_{AA}$	$\left[\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\frac{P_A^{T=0}}{P_A^{T=t}}\right]Z_{AB}$	$\left[\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\frac{P_A^{T=0}}{P_A^{T=t}}\right]F_{AA}$	$\left[\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\frac{P_A^{T=0}}{P_A^{T=t}}\right]F_{AB}$	$\left[\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\frac{P_A^{T=0}}{P_A^{T=t}}\right]X_A$
C_B	$\left[\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\frac{P_B^{T=0}}{P_B^{T=t}}\right]Z_{BA}$	$\left[\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\frac{P_B^{T=0}}{P_B^{T=t}}\right]Z_{BB}$	$\left[\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\frac{P_B^{T=0}}{P_B^{T=t}}\right]F_{BA}$	$\left[\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\frac{P_B^{T=0}}{P_B^{T=t}}\right]F_{BB}$	$\left[\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\frac{P_B^{T=0}}{P_B^{T=t}}\right]X_B$
Value-added	V_A^R	V_B^R			
Total input	$\left[\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\frac{P_A^{T=0}}{P_A^{T=t}}\right]X_A$	$\left[\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\frac{P_B^{T=0}}{P_B^{T=t}}\right]X_B$			

Notes:

1. *Z, F, V and X represent intermediate goods transactions, final goods transactions, value-added and gross output respectively expressed in US dollar.*
2. *In double letter country suffix, first suffix represents the country of production and second represents the country of use subject to intermediate and final goods.*
3. *E, P, T = 0 and T = t represents exchange rate (US dollars per unit local currency), price index, values at base year and target year respectively.*
4. *Value-added in real term is estimated as the difference of respective gross output and total of intermediate inputs.*

In general, one expects all transactions in the GIO table including value-added to be non-negative as negative transactions are difficult to explain from the economic perspective. However, a few of value-added components produce negative values, while converting nominal GIO tables into real tables. Such phenomenon occurs when composite effect of change in purchasing price (combined effect of price and exchange rate levels) of intermediate goods is higher than the change in sales price for a specific industry (Or equivalently, when total intermediate goods purchase exceeds total inputs in real terms, and hence total input coefficient exceeds 1) negative value-added do exists in real life. It can be shown that $\frac{\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)} > 1$ for country A and $\frac{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)}{\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)} > 1$ for country B are necessary conditions using equation (8), that leads to negative value-added in real term.[8] In other words, mathematically, if the effect of combined price and exchange rate movement in foreign countries are higher than that in domestic market, negative value-added in real term is unavoidable.

Moreover, negative value-added occurs, as noted by Los et.al. (2014), due to distortions caused by inappropriate price deflators. We are fully aware of this issue and try to minimize it by using producers price variable that excludes distortion-prone components such payable or deductible tax, subsidy, transport charges and other margins. In contrast, use of basic or consumer prices increases chances of distortion because these prices include all or a few of above-mentioned distortion-prone components.

Here, it is important to note that gross value-added consist of labor cost, operating surplus, consumption of fixed capitals and taxes less subsidies, a negative value-added does not imply negative values for all components as it is sum of these value-added

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[8] See Appendix 4 for the derivation.

components. It means that if we have access to disaggregated value-added components, we can find positive value-added components.

3. Data

We use 2025 version of inter-country input-output (ICIO)[9] tables published by Organization for Economic Co-operation and Development (OECD) consisting annual tables from 1995 to 2022, 81 countries and regions (including Rest of the World, ROW), and 50 industrial classifications expressed in current basic price to estimate the new constant price GIO tables.

Industry-specific price indices necessary to convert nominal values into real values are borrowed from the Research Institute of Economy, Trade and Industry (RIETI) project named "Industry-Specific Nominal and Real Effective Exchange Rates of 25 Countries Worldwide".[10] The RIETI project uses monthly Producers Price Indices (PPI) or Wholesale Price indices (WPI) for 28 countries and 13 manufacturing industries starting from January 2001 to latest published month (February 2026 as of 2026/03/23) with year 2005 as base year. We extend the existing price data for 30 countries and 14 industries to comply with our research objectives.[11] We use current and constant US Dollar GDP of the World and 30 sample countries obtained from World Development Indicators (WDI and National Statistics, Taiwan for Taiwanese GDP) to calculate proxy for ROW's price

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[9] See https://www.oecd.org/sti/ind/inter-country-input-output-tables.htm (accessed on 2023/08/29) for the details of OECD ICIO tables.

[10] See https://www.rieti.go.jp/users/eeri/en/ (accessed on 2023/03/03) for the details on Industry-specific Real Effective Exchange Rates.

[11] See Appendices 1 and 2 for the list of newly estimated Real GIO table's country and industry coverage.

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Further, we use annual exchange rates provided by UNSD, National Accounts for the 29 countries except Taiwan, and National Statistics, Republic of China (Taiwan) for Taiwanese exchange rate.

4. Compilation of GIO Tables in Real Terms

First, we convert price data for manufacturing industries (borrowed from RIETI project) with monthly frequency to annual frequency by taking simple average. For non-manufacturing industries and a few manufacturing industries price data, which are unfortunately unavailable[12], we use annual Consumer Price Indices (CPI) of respective country as the price data. Using these annual price and exchange rate information, we then calculate the annual price and exchange rate deflator $\left[\frac{P^{T=t}}{P^{T=0}}\frac{E^{T=t}}{E^{T=0}}\right]$ as defined in section 2.

Second, the most crucial part of estimation process, we attempt to convert basic price valuation of ICIO variables into producers' price valuation in following three steps. 1) we proportionally add taxes less subsidies to respective intermediate and final goods amount to get the intermediate and final goods sales in producers' price valuation. 2) Gross output is calculated by adding sales subject to each country and industry. And 3) we subtract total of intermediate inputs from gross output, both valued in producers' price, to get the value-added in producers' price.

Third, we reorganize producers' price valued ICIO tables into 30 countries and 16

[12] See Appendix 5 for the list of countries and industries for which price data are unavailable.

industries (out of which Producers Price Index data are available for 14 manufacturing industries and remaining two industries use Consumers Price Index) as per price data availability to get the real priced GIO tables.

Finally, we deflate the nominal GIO tables into Real GIO tables using the price and exchange rate deflator. Note that explicit price data for ROW is not available, we estimate GDP deflator for ROW and use it as proxy for price in ROW.[13] Our annual real priced GIO tables starts from 1995 to 2022 and consist of 30 countries (excluding ROW), 16 industries (two nonmanufacturing and 14 manufacturing industries), and six final demand categories[14] with 2005 as base year for price and exchange rate. As we use PPI for 14 manufacturing industries in 30 sample countries, our data provides better economic linkages in global context accelerated by international trade and global value chains.

Once we compile the Real GIO tables for 1995 to 2022, for this paper, we summarize and present the latest year 2022 transactions within and between three continents (Asia, North America, and Europe) and three industries (Agriculture, Manufacturing and Services) in Tables 1 and 2 for nominal and real (base year 2005) tables respectively.

The difference between values in nominal and real terms attributes to the change in price and exchange rate level in target year with respect to base year. Positive value in nominal minus real term values imply that the aggregate price and exchange rate level in

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[13] First, we collect current and constant GDP in US dollars for the World, 29 sample countries from World Development Indicators (WDI) and National Statistics, Republic of China (Taiwan) for Taiwanese data. Second, we estimate the current and constant (2005 =100) GDP in US dollar for ROW by subtracting values of 30 sample countries from the World value. Finally, we calculate the GDP deflator for ROW and use it as a proxy for the ROW's price variable.

[14] See Appendices 1, 2 and 3 for list of country, industry, and final demand categories coverages.

target year is higher than that in base year. In general, region with same price and exchange rate level as base year must be same for both real term and nominal term values. However, ROW+ in Tables 1 and 2 includes Australia and New Zealand that results in distinct values.

Table 1: 2022 Nominal inter-continent GIO Table

		Asia			N. America			Europe			ROW+			Final Demand				Gross
		AGR	MFG	SER	AGR	MFG	SER	AGR	MFG	SER	AGR	MFG	SER	Asia	N. America	Europe	ROW+	Output
Asia	AGR	3,164	1,356	1,406	9	1	7	10	4	6	23	9	15	3,116	44	41	81	9,292
	MFG	579	11,847	5,447	22	162	189	15	221	167	77	472	337	4,922	581	463	765	26,267
	SER	1,189	4,222	9,556	12	28	173	11	53	239	38	78	240	20,437	270	244	343	37,134
N. America	AGR	32	65	31	548	540	403	7	43	27	25	30	18	37	1,291	20	44	3,159
	MFG	7	122	55	230	1,377	1,630	4	66	42	25	110	84	84	2,388	102	175	6,502
	SER	21	69	144	925	1,421	13,345	13	58	259	35	54	152	161	22,451	195	308	39,612
Europe	AGR	17	64	41	7	4	8	740	293	368	38	43	41	62	59	1,282	122	3,190
	MFG	16	290	156	17	100	112	187	2,164	1,585	57	319	241	280	341	2,038	536	8,441
	SER	23	123	325	17	33	224	774	2,074	10,741	71	121	472	333	305	14,385	602	30,624
ROW+	AGR	131	933	384	43	81	44	78	163	119	2,008	661	721	270	177	336	2,416	8,567
	MFG	22	374	216	17	131	152	20	268	213	340	1,860	1,526	337	551	613	2,026	8,664
	SER	43	187	384	20	38	173	37	119	528	1,046	1,244	6,248	622	439	684	13,437	25,248
Gross Value Added		4,048	6,614	18,988	1,293	2,586	23,152	1,294	2,916	16,328	4,783	3,662	15,152					
Gross Input		9,292	26,267	37,134	3,159	6,502	39,612	3,190	8,441	30,624	8,567	8,664	25,248					

Notes:

1. *Source: Authors' reorganization from OECD ICIO version 2025 tables*
2. *Units in Billion US dollars*
3. *ROW+ includes Australia and New Zealand*
4. *AGM: Agriculture and Mining, MFG: Manufacturing, SER: Services*

Table 2: 2022 Real inter-continent GIO Table

		Asia			N. America			Europe			ROW+			Final Demand				Gross
		AGR	MFG	SER	AGR	MFG	SER	AGR	MFG	SER	AGR	MFG	SER	Asia	N. America	Europe	ROW+	Output
Asia	AGR	3,364	1,425	1,473	9	1	7	10	4	6	24	9	16	3,328	44	41	84	9,845
	MFG	685	13,166	6,186	25	171	196	17	238	177	89	492	368	4,918	551	452	767	28,497
	SER	1,233	4,385	9,845	11	28	181	11	53	243	39	80	246	21,128	278	247	351	38,360
N. America	AGR	42	84	40	710	704	521	9	55	35	32	39	23	48	1,655	26	57	4,079
	MFG	11	159	82	351	1,928	2,490	6	89	59	40	154	136	104	3,095	129	238	9,070
	SER	27	90	187	1,194	1,836	17,188	16	75	335	45	70	196	208	28,941	252	398	51,058
Europe	AGR	21	93	56	9	5	10	922	379	446	47	61	56	73	68	1,515	142	3,903
	MFG	19	347	186	20	117	130	232	2,683	1,967	71	386	301	305	376	2,355	611	10,109
	SER	28	147	387	20	39	271	942	2,453	12,820	85	143	563	394	362	17,277	716	36,649
ROW+	AGR	165	1,178	484	54	101	55	97	204	150	2,517	829	905	337	221	420	3,021	10,738
	MFG	28	471	271	21	165	190	25	335	266	426	2,330	1,915	421	688	766	2,532	10,852
	SER	54	234	482	25	47	217	46	149	661	1,316	1,561	7,883	780	550	856	16,896	31,758
Gross Value Added		4,169	6,719	18,682	1,629	3,928	29,602	1,568	3,392	19,483	6,006	4,699	19,149					
Gross Input		9,845	28,497	38,360	4,079	9,070	51,058	3,903	10,109	36,649	10,738	10,852	31,758					

Notes:

1. *Source: Authors' estimation*
2. *2005 as base year*
3. *Units in Billion US dollars*
4. *ROW+ includes Australia and New Zealand*
5. *AGR: Agriculture and Mining, MFG: Manufacturing, SER: Services*

5. Production Inducement Analysis with new data sets

In this section we use the conventional production inducement analysis based on the newly estimated nominal and real GIO tables for 2020. As our main objective of this paper is to compile GIO table in real terms, we present very conventional application of newly compiled Real GIO tables.

The conventional total production inducement vector **X** can be estimated from the basic IO equation[15] as shown in equation (4) with respect to GIO table presented in Table 1.

$$\mathbf{X} = \begin{pmatrix} X_A \\ X_B \\ X_C \end{pmatrix} = \begin{pmatrix} L_{AA} & L_{AB} & L_{AC} \\ L_{BA} & L_{BB} & L_{BC} \\ L_{CA} & L_{CB} & L_{CC} \end{pmatrix} \begin{pmatrix} F_A \\ F_B \\ F_C \end{pmatrix} \tag{4}$$

Where $\mathbf{L} = \begin{pmatrix} L_{AA} & L_{AB} & L_{AC} \\ L_{BA} & L_{BB} & L_{BC} \\ L_{CA} & L_{CB} & L_{CC} \end{pmatrix} = \begin{pmatrix} 1-\frac{Z_{AA}}{X_A} & -\frac{Z_{AB}}{X_B} & -\frac{Z_{AC}}{X_C} \\ -\frac{Z_{BA}}{X_A} & 1-\frac{Z_{BB}}{X_B} & -\frac{Z_{BC}}{X_C} \\ -\frac{Z_{CA}}{X_A} & -\frac{Z_{CB}}{X_B} & 1-\frac{Z_{CC}}{X_C} \end{pmatrix}^{-1}$ is the Leontief inverse matrix and $\mathbf{F} = \begin{pmatrix} F_A \\ F_B \\ F_C \end{pmatrix} = \begin{pmatrix} F_{AA}+F_{AB}+F_{AC} \\ F_{BA}+F_{BB}+F_{BC} \\ F_{CA}+F_{CB}+F_{CC} \end{pmatrix}$ is the final demand vector. We can easily express equation (4) as bilateral transactions of production inducements given be equation (5) without any loss of generality.

$$\begin{pmatrix} x_{AA} & x_{AB} & x_{AC} \\ x_{BA} & x_{BB} & x_{BC} \\ x_{CA} & x_{CB} & x_{CC} \end{pmatrix} = \begin{pmatrix} L_{AA} & L_{AB} & L_{AC} \\ L_{BA} & L_{BB} & L_{BC} \\ L_{CA} & L_{CB} & L_{CC} \end{pmatrix} \begin{pmatrix} f_{AA} & f_{AB} & f_{AC} \\ f_{BA} & f_{BB} & f_{BC} \\ f_{CA} & f_{CB} & f_{CC} \end{pmatrix} \tag{5}$$

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[15] See Miller and Blair (2009) for the derivation of basic IO equation (4).

Such that $\mathbf{X}=\begin{pmatrix} x_{AA} & x_{AB} & x_{AC} \\ x_{BA} & x_{BB} & x_{BC} \\ x_{CA} & x_{CB} & x_{CC} \end{pmatrix}\begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$ is the gross output vector. Here, any bilateral production inducements represent the production induced directly and indirectly in country with prior subscripts because of final demand in country of post subscripts. For example, x_{BC} is the directly and indirectly generated production inducements in country *B* because of the final demands f_{AC}, f_{BC} and f_{CC} that are produced in countries *A*, *B* and *C* respectively and then supplied to country *C*.

Table 3 shows the production inducements calculated from the Nominal (Table 1) and Real (Table 2) GIO tables, and the differences between inducements in nominal and real terms in 2022. The results illustrated in last column of Table 3 clearly show the difference, as expected, subject to current and constant pricing systems. The negative value in difference illustrates that the price level in US dollars in 2022 has significantly decreased compared to that in 2005. The difference of -38.2 trillion US dollars in total global inducements in 2022 valued in current and 2005 constant price may be attributed to substantial decline in US dollar price in 2022 relative to 2005. The reason behind such outcome can be justified by COVID-19 shock in 2020, while economic activities was comparatively more active before the Global Financial Crisis (GFC) in 2008.

Table 3: Production Inducements in 2022

		Production Inducements														
		Asia			N. America			Europe			ROW+			Total		
		Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.
Asia	AGR	8,139.0	8,662.4	-523.4	343.4	346.4	-3.0	312.5	319.2	-6.7	497.0	517.0	-20.1	9,291.9	9,845.0	-553.1
	MFG	19,079.7	20,908.8	-1,829.1	2,250.4	2,321.9	-71.5	1,933.5	2,046.7	-113.2	3,003.5	3,219.2	-215.7	26,267.0	28,496.6	-2,229.6
	SER	33,147.1	34,308.1	-1,161.0	1,230.0	1,244.5	-14.5	1,175.0	1,189.9	-14.9	1,581.7	1,618.0	-36.2	37,133.8	38,360.4	-1,226.6
N. Americ	AGR	245.5	319.6	-74.1	2,567.6	3,309.0	-741.4	152.1	196.3	-44.3	194.1	254.1	-60.0	3,159.2	4,079.0	-919.8
	MFG	413.8	569.1	-155.3	5,243.9	7,307.2	-2,063.3	337.2	462.2	-125.0	507.1	731.8	-224.7	6,502.0	9,070.4	-2,568.4
	SER	868.8	1,122.9	-254.1	36,793.8	47,412.6	-10,618.8	910.9	1,174.2	-263.3	1,038.0	1,348.5	-310.5	39,611.5	51,058.1	-11,446.6
Europe	AGR	316.3	411.9	-95.6	188.7	231.1	-42.4	2,308.6	2,787.9	-479.4	376.2	471.9	-95.7	3,189.7	3,902.8	-713.1
	MFG	1,147.9	1,365.0	-217.1	965.1	1,120.7	-155.6	4,822.0	5,814.6	-992.6	1,505.7	1,808.5	-302.8	8,440.7	10,108.8	-1,668.1
	SER	1,815.1	2,164.2	-349.0	1,396.2	1,649.9	-253.7	24,994.8	29,955.2	-4,960.4	2,417.6	2,879.6	-462.0	30,623.7	36,648.9	-6,025.2
ROW+	AGR	2,118.9	2,679.6	-560.7	758.0	939.4	-181.3	1,109.9	1,386.3	-276.4	4,580.1	5,733.0	-1,153.0	8,566.9	10,738.3	-2,171.4
	MFG	1,403.1	1,766.8	-363.7	1,276.9	1,592.1	-315.2	1,492.8	1,867.7	-374.9	4,491.6	5,625.5	-1,133.9	8,664.4	10,852.1	-2,187.7
	SER	2,201.5	2,774.7	-573.2	1,319.5	1,649.8	-330.3	2,116.8	2,654.8	-538.0	19,609.9	24,679.2	-5,069.3	25,247.6	31,758.4	-6,510.8
Total		70,896.6	77,053.1	-6,156.4	54,333.5	69,124.5	-14,791.0	41,666.1	49,855.1	-8,189.0	39,802.3	48,886.2	-9,083.9	206,698.5	244,918.9	-38,220.4

Notes:

1. *Source: Authors' estimation based on equation* (5)
2. *2005 is base year for Real term values*
3. *Units in Billion US dollars*
4. *Diff. is difference of Nominal and Real values of production inducement*
5. *ROW+ includes Australia and New Zealand*
6. *AGR: Agriculture and Mining, MFG: Manufacturing, SER: Services*

Now, we calculate two conventional measures of production inducements namely "Inducement Coefficient, **PIC**" indicating the extent of production inducements per unit of final demand and "Inducement Share, **PIS**" showing the extent of inducements per unit gross output as given in equations (6) and (7) respectively and present in Tables 4 and 5.

$$\mathbf{PIC} = \begin{pmatrix} \frac{x_{AA}}{f_{AA}+f_{BA}+f_{CA}} & \frac{x_{AB}}{f_{AB}+f_{BB}+f_{CB}} & \frac{x_{AC}}{f_{AC}+f_{BC}+f_{CC}} \\ \frac{x_{BA}}{f_{AA}+f_{BA}+f_{CA}} & \frac{x_{BB}}{f_{AB}+f_{BB}+f_{CB}} & \frac{x_{BC}}{f_{AC}+f_{BC}+f_{CC}} \\ \frac{x_{CA}}{f_{AA}+f_{BA}+f_{CA}} & \frac{x_{CB}}{f_{AB}+f_{BB}+f_{CB}} & \frac{x_{CC}}{f_{AC}+f_{BC}+f_{CC}} \end{pmatrix} \tag{6}$$

$$\mathbf{PIS} = \begin{pmatrix} \frac{x_{AA}}{X_{AA}+X_{AB}+X_{AC}} & \frac{x_{AB}}{X_{AA}+X_{AB}+X_{AC}} & \frac{x_{AC}}{X_{AA}+X_{AB}+X_{AC}} \\ \frac{x_{BA}}{X_{BA}+X_{BB}+X_{BC}} & \frac{x_{BB}}{X_{BA}+X_{BB}+X_{BC}} & \frac{x_{BC}}{X_{BA}+X_{BB}+X_{BC}} \\ \frac{x_{CA}}{X_{CA}+X_{CB}+X_{CC}} & \frac{x_{CB}}{X_{CA}+X_{CB}+X_{CC}} & \frac{x_{CC}}{X_{CA}+X_{CB}+X_{CC}} \end{pmatrix} \tag{7}$$

PIC and **PIS** measures the relationship between production inducement subject to final demand and gross output respectively. Here, it is important to notice that these measures account for complex interactions among industries and countries, which is impossible to address with the direct observations. Higher value of **PIC** (or **PIS**) indicates higher dependence on final demand (or gross output)

Table 4: Production Inducement Coefficients (**PIC**) in 2022

		Production Inducement Coefficients (Inducement/FD Total)														
		Asia			N. America			Europe			ROW+			Total		
		Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.
Asia	AGR	26.5	27.0	-0.5	1.2	0.9	0.2	1.5	1.3	0.2	2.4	2.0	0.4	9.2	8.3	0.9
	MFG	62.2	65.3	-3.0	7.8	6.3	1.5	9.5	8.4	1.1	14.4	12.5	1.9	26.1	23.9	2.1
	SER	108.1	107.1	1.0	4.3	3.4	0.9	5.8	4.9	0.9	7.6	6.3	1.3	36.8	32.2	4.6
N. America	AGR	0.8	1.0	-0.2	8.9	9.0	-0.1	0.7	0.8	-0.1	0.9	1.0	-0.1	3.1	3.4	-0.3
	MFG	1.3	1.8	-0.4	18.1	19.8	-1.7	1.7	1.9	-0.2	2.4	2.8	-0.4	6.4	7.6	-1.2
	SER	2.8	3.5	-0.7	127.3	128.7	-1.4	4.5	4.8	-0.4	5.0	5.2	-0.2	39.3	42.9	-3.6
Europe	AGR	1.0	1.3	-0.3	0.7	0.6	0.0	11.3	11.5	-0.1	1.8	1.8	-0.0	3.2	3.3	-0.1
	MFG	3.7	4.3	-0.5	3.3	3.0	0.3	23.6	23.9	-0.3	7.2	7.0	0.2	8.4	8.5	-0.1
	SER	5.9	6.8	-0.8	4.8	4.5	0.4	122.5	123.1	-0.6	11.6	11.2	0.4	30.4	30.8	-0.4
ROW+	AGR	6.9	8.4	-1.5	2.6	2.6	0.1	5.4	5.7	-0.3	22.0	22.2	-0.2	8.5	9.0	-0.5
	MFG	4.6	5.5	-0.9	4.4	4.3	0.1	7.3	7.7	-0.4	21.5	21.8	-0.3	8.6	9.1	-0.5
	SER	7.2	8.7	-1.5	4.6	4.5	0.1	10.4	10.9	-0.5	94.0	95.6	-1.6	25.0	26.7	-1.6
Total		231.2	240.5	-9.2	188.0	187.7	0.3	204.2	204.8	-0.6	190.9	189.4	1.5	205.0	205.8	-0.7

Notes:

1. *Source: Authors' estimation based on equation* (6)
2. *2005 is base year for Real term values*
3. *Units in percent of total final demand*
4. *Diff. is difference of Nominal and Real values of production inducement*
5. *ROW+ includes Australia and New Zealand*
6. *AGR: Agriculture and Mining, MFG: Manufacturing, SER: Services*

Production inducement coefficients (**PIC**), as illustrated in Table 4 and observe the results in vertical direction, measure the extent of gross production induced in continent-industry due to final demand structure of the continent. For example, regional and imported final demand in Asia induces 240.5% in real term (or equivalently, 231.2% in nominal term) production activity all over the World. In the meantime, manufacturing industry within Asia enjoys production inducement of 65.5% (62.2% in nominal term) in real terms. The difference of -3.0% may be attributed to collective effect of price and exchange rate decrease in 2022 compared to the base year 2005. It is important to note that the variation in differences (negative values in Table 4) in real term and nominal term production inducement coefficients evidently indicate that the composite price and exchange rate effect works differently for production inducements (all negative differences in Table 3) and its coefficients with significant number of positive differences as large as 4.6% for Asia-Total in Table 4. This shows the complicated behavior of price in global value chain process.

Table 5: Production Inducement Shares (**PIS**) in 2022

		Production Inducement Shares (Inducement/Gross Output)														
		Asia			N. America			Europe			ROW+			Total		
		Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.	Nominal	Real	Diff.
Asia	AGR	87.6	88.0	-0.4	3.7	3.5	0.2	3.4	3.2	0.1	5.3	5.3	0.1	100.0	100.0	0.0
	MFG	72.6	73.4	-0.7	8.6	8.1	0.4	7.4	7.2	0.2	11.4	11.3	0.1	100.0	100.0	0.0
	SER	89.3	89.4	-0.2	3.3	3.2	0.1	3.2	3.1	0.1	4.3	4.2	0.0	100.0	100.0	0.0
N. America	AGR	7.8	7.8	-0.1	81.3	81.1	0.1	4.8	4.8	0.0	6.1	6.2	-0.1	100.0	100.0	0.0
	MFG	6.4	6.3	0.1	80.7	80.6	0.1	5.2	5.1	0.1	7.8	8.1	-0.3	100.0	100.0	0.0
	SER	2.2	2.2	-0.0	92.9	92.9	0.0	2.3	2.3	-0.0	2.6	2.6	-0.0	100.0	100.0	0.0
Europe	AGR	9.9	10.6	-0.6	5.9	5.9	-0.0	72.4	71.4	0.9	11.8	12.1	-0.3	100.0	100.0	0.0
	MFG	13.6	13.5	0.1	11.4	11.1	0.3	57.1	57.5	-0.4	17.8	17.9	-0.1	100.0	100.0	0.0
	SER	5.9	5.9	0.0	4.6	4.5	0.1	81.6	81.7	-0.1	7.9	7.9	0.0	100.0	100.0	0.0
ROW+	AGR	24.7	25.0	-0.2	8.8	8.7	0.1	13.0	12.9	0.0	53.5	53.4	0.1	100.0	100.0	0.0
	MFG	16.2	16.3	-0.1	14.7	14.7	0.1	17.2	17.2	0.0	51.8	51.8	0.0	100.0	100.0	0.0
	SER	8.7	8.7	-0.0	5.2	5.2	0.0	8.4	8.4	0.0	77.7	77.7	-0.0	100.0	100.0	0.0
Total		34.3	31.5	2.8	26.3	28.2	-1.9	20.2	20.4	-0.2	19.3	20.0	-0.7	100.0	100.0	0.0

Notes:

1. *Source: Authors' estimation based on equation* (7)
2. *2005 is base year for Real term values*
3. *Units in percent of gross output*
4. *Diff. is difference of Nominal and Real values of production inducement*
5. *ROW+ includes Australia and New Zealand*
6. *AGM: Agriculture and Mining, MFG: Manufacturing, SER: Services*

Production inducement shares (**PIS**) are presented in Table 5 along horizontal direction, and it tells us about the share of gross production with respect to different continents. According to the table, direct and indirect contribution of Asia to Asia, North America, Europe, and ROW+ are 73.4%, 8.1%, 7.2% and 11.3% in real terms on the gross output of manufacturing industry in Asia. If we carefully check the difference between nominal and real term **PIS**, the magnitude is not so large (the highest being 208% for Total-Asia) as compared to **PIC** in Table 4. As **PIS** indicates the supply structure of an industry-continent, only a single price and exchange rate is associated with the result and hence the difference becomes marginal. However, in case of **PIC**, demand structure of production is associated with complex interactions of price and exchange rate of various industries and continents, which magnifies the effect of price and exchange rate and hence the difference becomes prominent.

6. Concluding remarks

This paper attempts to compile Global Input-Output Tables in real terms from the nominally valued basic price Inter-Country Input-Output tables published by OECD (Version 2025). We use producers price (or wholesale price) indices of 30 countries (listed in Appendix 1) and 14 manufacturing industries (see Appendix 2), consumers price indices for same 30 countries and two non-manufacturing industries (namely, Agriculture and Services), and exchange rates to estimate the Global Input-Output tables in real terms with 30 countries (10 countries in Asia, 2 countries each in Oceania and North America, and 16 European countries), and 16 industries (14 manufacturing, an agriculture, and a service sectors) for the period 1995 to 2022. It is a unique and contributing attempt of this paper to use the price data in disaggregated level as existing constant price international input-output tables (for example, MRIO published by Asian Development Bank and PYP WIOT published by WIOD project) uses CPI or basic price as price factor and it is not clear whether they address foreign exchange rates or not. A distinct difference, compared to existing attempts, lies in the use of PPI for manufacturing industries to incorporate industry-specific production structures in manufacturing and minimizing the effect of distortion-prone components of pricing system.

A simple example, illustrated in this paper, of inter-continent input-output analysis shows that the composite effect of price and exchange rate works differently in supply-side and demand-side aspect. The supply-side aspect shows a composite marginal effect of price and exchange rate. In contrast, the demand-side aspect tends to magnify the complex interactions of price and exchange rate among industries and countries.

Existence of Real Global Input-Output tables enable us to address price and exchange rate factor in economic analyses that most of the existing data sets are not capable of. Further, without loss of generality, assuming the values expressed in real terms as a hypothetical volume, we can apply it in other field of studies such as environment analysis.

Declarations

Availability of data and materials: available on request

Competing interests: Not applicable

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Data Sources

PPI or WPI for manufacturing industries:

Country	Code	Data source	Link
Japan	JPN	Bank of Japan	http://www.boj.or.jp/
Korea	KOR	The Bank of Korea	http://eng.bok.or.kr/eng/engMain.action
China	CHN	1. CEIC 2. *China Monthly Statistic* 3. *China Statistical Yearbook*	
Taiwan	TWN	CEIC (include output data)	
Singapore	SGP	Statistics Singapore	http://www.singstat.gov.sg/
Malaysia	MYS	CEIC	
Thailand	THA	CEIC	
Indonesia	IDN	1. BPS, *Economic Indicators* 2. CEIC	
Philippines	PHL	1. National Statistics Office 2. *Philippine Yearbook*	http://www.census.gov.ph
India	IND	Office of Economic Adviser	http://eaindustry.nic.in/
Australia	AUS	Australian Bureau of Statistics	http://www.abs.gov.au/
New Zealand	NZL	CEIC	
USA	USA	1. FEDSTATS 2. Bureau of Labor Statistics (BLS)	http://www.bls.gov/ppi/#data
Canada	CAN	Statistics Canada	http://www5.statcan.gc.ca
UK	GBR	CEIC	
Germany	DEU	GENESIS-Online Database	https://www-genesis.destatis.de
France	FRA	National Institute of Statistics and Economic Studies	http://www.bdm.insee.fr
Italy	ITA	CEIC	
Spain	ESP	National Statistics Institute	http://www.ine.es
Austria	AUT	CEIC	
Belgium	BEL	CEIC	
Denmark	DNK	CEIC	
Finland	FIN	CEIC	
Greece	GRC	1.CEIC 2.National Statistical Service	http://www.statistics.gr
Ireland	IRL	CEIC	
Netherlands	NLD	Statistics Netherlands Statline Database	http://statline.cbs.nl/StatWeb/?LA = en
Norway	NOR	Statistics Norway	http://statbank.ssb.no
Sweden	SWE	CEIC	
Switzerland	CHE	CEIC	
Russia	RUS	CEIC	

Other Data:

Data	Data source	Link
Consumer Price Indices	CEIC	
Input -Output Tables	OECD Inter-Country Input-Output (ICIO) Tables	https://www.oecd.org/sti/ind/inter-country-input-output-tables.htm
Exchange Rates	UNSD National Accounts	https://unstats.un.org
GDP and Exchange Rate (Taiwan)	National Statistics, Republic of China (Taiwan)	https://eng.stat.gov.tw
GDP	World Development Indicators, World Bank	https://databank.worldbank.org/source/world-development-indicators

Appendix 1: List of Country Coverage (with country codes) in GIO table

Asia	
1	Japan (JPN)
2	Korea (KOR)
3	China (CHN)
4	Taiwan (TWN)
5	Singapore (SGP)
6	Malaysia (MYS)
7	Thailand (THA)
8	Indonesia (IDN)
9	Philippines (PHL)
10	India (IND)

North America	
13	United States (USA)
14	Canada (CAN)

Rest of the World+ (ROW+)	
11	Australia (AUS)
12	New Zealand (NZL)
31	Rest of the World (ROW)

Europe	
15	United Kingdom (GBR)
16	Germany (DEU)
17	France (FRA)
18	Italy (ITA)
19	Spain (ESP)
20	Austria (AUT)*
21	Belgium (BEL)
22	Denmark (DNK)
23	Finland (FIN)
24	Greece (GRC)
25	Ireland (IRL)*
26	Netherlands (NLD)
27	Norway (NOR)
28	Sweden (SWE)
29	Switzerland (CHE)
30	Russian Federation (RUS)

Note:

1. *Numbers represent the order of a country in the GIO Tables*

2. *Countries without RIETI coverage are indexed * .*

Appendix 2: List of Industry Coverage of Real GIO table

Real GIO		Details	Code
Y01		Agriculture and Mining	Agriculture
Manufacturing			
	Y02	Food products, beverages and tobacco	Food
	Y03	Textiles, textile products, leather and footwear	Textiles
	Y04	Wood and products of wood and cork	Wood
	Y05	Pulp, paper, paper products, printing and publishing	Paper
	Y06	Coke, refined petroleum products and nuclear fuel	Petroleum
	Y07	Chemicals and pharmaceuticals	Chemicals
	Y08	Rubber and plastics products	Rubber
	Y09	Other non-metallic mineral products	Non-metal
	Y10	Basic and fabricated metals	Basic metal
	Y11	Machinery and equipment, nec	Machinery
	Y12	Computer, electronic and optical products	Office
	Y13	Electrical equipment	Electrical
	Y14	Motor vehicles, trailers and semi-trailers	Motor
	Y15	Other transport equipment	Other transport
Y16		Manufacturing nec; Services and Others	Others

Notes:

1. *Y01 and Y16 are not covered by RIETI industrial classifications.*
2. *Y14 and Y15 are combined as Transport Equipment in RIETI industry coverage.*

Appendix 3: Final demand coverage

Final Demand List	FD Code
Household Final Consumption Expenditure	HFCE
Non-Profit Institutions Serving Households	NPISH
General Government Final Consumption	GGFC
Gross Fixed Capital Formation	GFCF
Changes in Inventories and Valuables	INVNT
Direct purchases abroad by residents	DPABR

Appendix 4: Derivation of Real term value-added by difference in the Global IO Table

Let us assume a typical single sector two-country (country A and country B) nominal GIO table as illustrated in Figure 1 and that in real term (with respect to price and exchange rate) as shown in Figure 2. Let us assume, without loss of generality, that the value-added is strictly positive (in general value-added in nominal term is non-zero) so that value-added for country A can be obtained by difference of total inputs and total purchase of intermediate goods in nominal term as shown in equation (A-1)

$$V_A = X_A - Z_{AA} - Z_{BA} > 0 \qquad \text{(A-1)}$$

Based on the real term values of total inputs/outputs, and intermediate and final goods transactions (converted from nominal valuation using price and exchange rate data), we get real term value-added for country A as given in equation (8), which can be rewritten as in equation (A-2)

$$V_A^R = \left(\frac{P_A^{T=0}}{P_A^{T=t}} \frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}} \right) \left[X_A - Z_{AA} - Z_{BA} \right] - \left[\left(\frac{P_A^{T=0}}{P_A^{T=t}} \frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}} \right) - \left(\frac{P_B^{T=0}}{P_B^{T=t}} \frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}} \right) \right] Z_{BA} \qquad \text{(A-2)}$$

A careful observation at equation (A-2), there are three possible cases resulting whether V_A^R is zero or positive or negative. Each case is simplified and derived the conditions to fulfill the sign of real term value-added as follow.

Case 1: $V_A^R = 0$

We can rewrite equation (A-2) as

$$\left(\frac{P_A^{T=0}}{P_A^{T=t}} \frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}} \right) \left[X_A - Z_{AA} - Z_{BA} \right] - \left[\left(\frac{P_A^{T=0}}{P_A^{T=t}} \frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}} \right) - \left(\frac{P_B^{T=0}}{P_B^{T=t}} \frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}} \right) \right] Z_{BA} = 0$$

On simplification,

$$\left[X_A - Z_{AA} - Z_{BA}\right] - \left[\frac{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right) - \left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)}\right] Z_{BA} = 0$$

Allows us to conclude that $\frac{\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)} = 1$ for positive $\left[X_A - Z_{AA} - Z_{BA}\right]$ and Z_{BA}.

Case 2: $V_A^R > 0$

We can rewrite equation (A-2) as

$$\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)\left[X_A - Z_{AA} - Z_{BA}\right] - \left[\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right) - \left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)\right] Z_{BA} > 0$$

On simplification,

$$\left[X_A - Z_{AA} - Z_{BA}\right] - \left[\frac{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right) - \left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)}\right] Z_{BA} > 0$$

Allows us to conclude that $\frac{\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)} < 1$ for positive $\left[X_A - Z_{AA} - Z_{BA}\right]$ and Z_{BA}.

Case 3: $V_A^R < 0$

We can rewrite equation (A-2) as

$$\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)\left[X_A - Z_{AA} - Z_{BA}\right] - \left[\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right) - \left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)\right] Z_{BA} < 0$$

On simplification,

$$\left[X_A - Z_{AA} - Z_{BA}\right] - \left[\frac{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right) - \left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)}\right] Z_{BA} < 0$$

Allows us to conclude that $\frac{\left(\frac{P_B^{T=0}}{P_B^{T=t}}\frac{E_{\$/LCB}^{T=0}}{E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}}{P_A^{T=t}}\frac{E_{\$/LCA}^{T=0}}{E_{\$/LCA}^{T=t}}\right)} > 1$ for positive $\left[X_A - Z_{AA} - Z_{BA}\right]$ and Z_{BA}.

Following table summarizes necessary conditions for sign of value-added in real terms with respect to price and exchange rate.

Real term value-added	**Country A**	**Country B**
Zero	$\frac{\left(\frac{P_B^{T=0}\,E_{\$/LCB}^{T=0}}{P_B^{T=t}\,E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}\,E_{\$/LCA}^{T=0}}{P_A^{T=t}\,E_{\$/LCA}^{T=t}}\right)}=1$	$\frac{\left(\frac{P_A^{T=0}\,E_{\$/LCA}^{T=0}}{P_A^{T=t}\,E_{\$/LCA}^{T=t}}\right)}{\left(\frac{P_B^{T=0}\,E_{\$/LCB}^{T=0}}{P_B^{T=t}\,E_{\$/LCB}^{T=t}}\right)}=1$
Positive	$\frac{\left(\frac{P_B^{T=0}\,E_{\$/LCB}^{T=0}}{P_B^{T=t}\,E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}\,E_{\$/LCA}^{T=0}}{P_A^{T=t}\,E_{\$/LCA}^{T=t}}\right)}<1$	$\frac{\left(\frac{P_A^{T=0}\,E_{\$/LCA}^{T=0}}{P_A^{T=t}\,E_{\$/LCA}^{T=t}}\right)}{\left(\frac{P_B^{T=0}\,E_{\$/LCB}^{T=0}}{P_B^{T=t}\,E_{\$/LCB}^{T=t}}\right)}<1$
Negative	$\frac{\left(\frac{P_B^{T=0}\,E_{\$/LCB}^{T=0}}{P_B^{T=t}\,E_{\$/LCB}^{T=t}}\right)}{\left(\frac{P_A^{T=0}\,E_{\$/LCA}^{T=0}}{P_A^{T=t}\,E_{\$/LCA}^{T=t}}\right)}>1$	$\frac{\left(\frac{P_A^{T=0}\,E_{\$/LCA}^{T=0}}{P_A^{T=t}\,E_{\$/LCA}^{T=t}}\right)}{\left(\frac{P_B^{T=0}\,E_{\$/LCB}^{T=0}}{P_B^{T=t}\,E_{\$/LCB}^{T=t}}\right)}>1$

Notes:

Where P refers to price, E refers to Exchange rate in dollar per unit of local currency (countries A and B), T =0 refers to base year values, and T =t refers to the values in given year.

Appendix 5: List of countries and industries for which price data are unavailable.

Y03	Textiles, textile products, leather and footwear	
	Singapore (SGP)	
Y06	Coke, refined petroleum products and nuclear fuel	
	India (IND)	Austria (AUT)
	Finland (FIN)	Ireland (IRL)
Y13	Computer, electronic and optical products	
	Denmark (DNK)	
	Switzerland (CHE)	