

Incorporating Global Value Chains into the Dynamic GTAP Model [tentative results]

Ken Itakura*

April 15, 2019

In this paper, we introduce global value chains (GVCs) in intermediate transactions to the recursively dynamic computable general equilibrium (CGE) model. Then, we explore how the introduction of GVCs affects impact of trade policy, by making comparisons between the policy effects obtained from the model incorporating the GVCs and those obtained from a conventional model. To compare economic effects of trade policy, we run a set of policy simulations of the Regional Comprehensive Economic Partnership (RCEP) agreement between the ASEAN member countries and Japan, China, Korea, Australia, New Zealand, and Singapore.

We modify the dynamic GTAP model developed by Ianchovichina & McDougall (2001) and Ianchovichina & Walmsley (2012), which is an extension of the comparative static version of the GTAP model (Hertel 1997, McDougall 2003), to incorporate GVCs. Also, we extend the GTAP 9 Data Base (Aguiar et al. 2016), aggregated to 17 regions and 14 sectors, to capture the GVC structure. To extend the GTAP 9 Data Base, we utilize the multi regional input output (MRIO) tables published by OECD, the Inter-Country Input-Output Tables (Organization for Economic Co-operation and Development 2018).

For our simulations, we first set up the baseline scenario for the 17 regions over the period 2011– 2035. Policy scenario of the RCEP is assumed to be implemented over the period 2021– 2035. The first set of policy shocks consists of removal of tariffs among the member countries, except for agriculture and food products. The second set is made up of reduction in ad valorem tariff equivalents of non-tariff barriers on services trade, and the third set is on cut in time cost of trade.

*Graduate School of Economics, Nagoya City University, 1 Yamanohata, Mizuho, Nagoya, Aichi, 467-8501, Japan (e-mail: itakura@econ.nagoya-cu.ac.jp).

We modify the import demand in the dynamic GTAP model to reflect the Global Value Chains (GVCs) in which each agent, such as producer, consumer, and government, determines demand for imports.¹ To describe the GVCs with data, we rely on multi regional input output tables for a consistent way to disentangle the internationally connected production structure, by distinguishing the source and the destination of goods in details. A MRIO table can show how much of one industry's intermediate inputs are sourced from other industries in foreign countries as well as domestic industries. Similarly, the sources of final demands can be traced back to the origin where an industry produces that goods. Thus, in a MRIO table, imports are uniquely recorded by source, destination, and agents who are producers, consumers, and governments.

We use the Inter-Country Input-Output (ICIO) Tables (OECD, 2018). With the ICIO tables, we are able to incorporate agent specific import demand into the dynamic GTAP model, following the model extension in Itakura & Oyamada (2015). Import demand is defined for each agent, rather than defined for each country, and the corresponding price indices as well as the trade flows are also defined as agent specific in the database and the model. In Figure 1 at the bottom nest, for each agent imports Q_{irs} are sourced from foreign regions. For the agent specific import demand, we define the bottom nest aggregation of imports and domestic product for each agent.

The tentative results obtained from the policy scenario show that incorporating the GVC structure affect the impact of RCEP on real GDP (Table 1). Furthermore, the impact on bilateral trades of goods are significantly altered. For example, the case of Japanese exports of machinery is depicted in Figure 2. Under the GVCs model, Japanese exports of machinery show large increase to the RCEP countries, except for Brunei, Singapore and RoASEAN.

¹Import composite used in the double-nests Armington structure in the standard GTAP model is absent from the single-nest Armington specification used in the model with GVCs. Once the substitution elasticity of the upper nest in the double-nest Armington is set to identical as the lower nest, or vice versa, then the simulation results are same in both models.

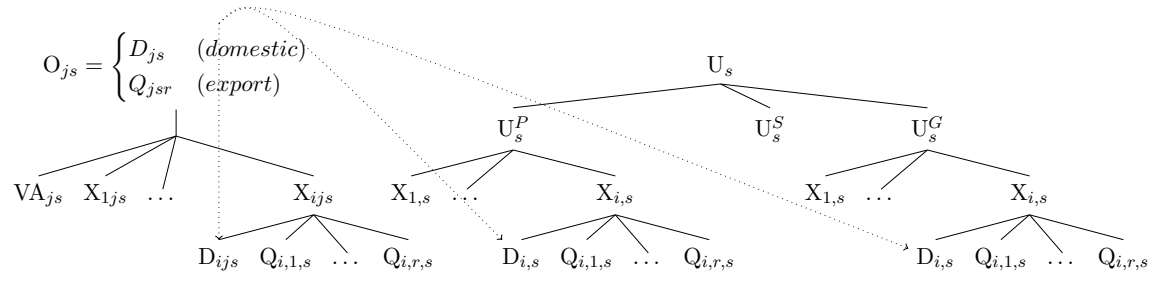
References

- Aguiar, A., Narayanan, B. & McDougall, R. (2016), ‘An overview of the gtap 9 data base’, *Journal of Global Economic Analysis* **1**(1), 181–208.
URL: <https://www.gtap.agecon.purdue.edu/resources/jgea/ojs/index.php/jgea/article/view/23>
- Hertel, T. W., ed. (1997), *Global Trade Analysis: Modeling and Applications*, Cambridge University Press, New York.
- Ianchovichina, E. & McDougall, R. (2001), ‘Theoretical Structure of Dynamic GTAP’, *GTAP Technical Paper, Purdue University* **17**.
- Ianchovichina, E. & Walmsley, T., eds (2012), *Dynamic Modeling and Applications for Global Economic Analysis*, Cambridge University Press, New York.
- Itakura, K. & Oyamada, K. (2015), Extending GTAP Data Base and A CGE Model with Global Input-Output Linkage, *in* S. Otsubo, ed., ‘Globalization and Development: Leading Issues in Development with Globalization’, Routledge, chapter 12, pp. 344–363.
- McDougall, R. (2003), ‘A New Regional Household Demand System for GTAP’, *GTAP Technical Paper, Purdue University* **20**, 1–57.
- Organization for Economic Co-operation and Development (2018), *Inter-Country Input-Output (ICIO) Tables*, OECD, Paris.
- Walmsley, T., Hertel, T. W. & Hummels, D. (2014), Developing a GTAP-Based Multi-Region, Input-Output Framework for Supply Chain Analysis, *in* B. Ferrarini & D. Hummels, eds, ‘Asia and Global Production Networks: Implications for Trade, Incomes and Economic Vulnerability’, Asian Development Bank and Edward Elgar, Cheltenham, chapter 2, pp. 16–80.

Table 1: Impact of RCEP on GDP, 2035
(percent changes relative to the baseline)

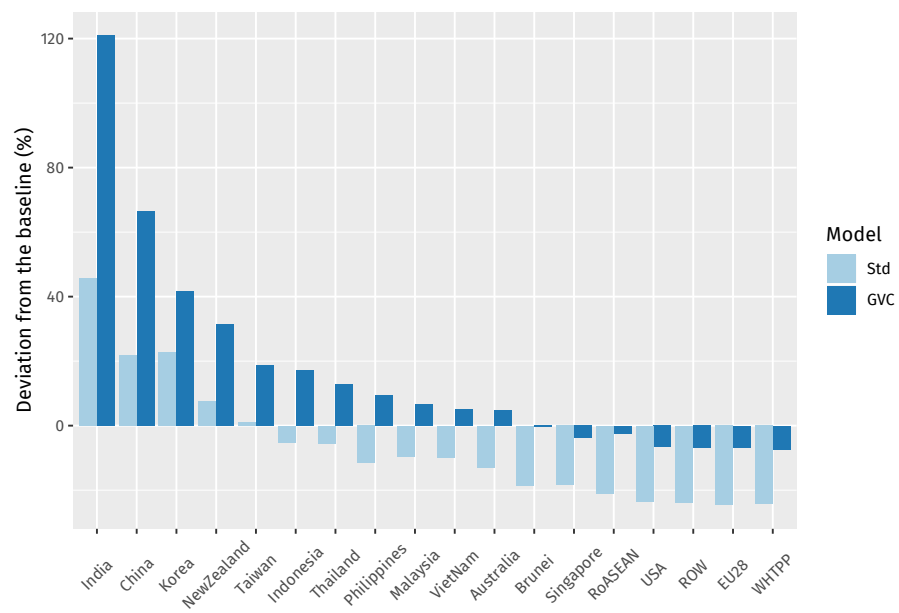
	Std	GVC
Japan	1.8	1.2
China	3.1	2.6
Korea	6.3	4.3
Taiwan	2.8	3.6
Singapore	3.0	1.4
Brunei	1.1	1.2
Indonesia	3.2	3.5
Philippines	4.7	5.4
Malaysia	5.2	6.0
Thailand	9.6	8.7
Viet Nam	6.1	5.3
RoASEAN	2.4	1.0
Australia	0.6	1.2
New Zealand	2.7	3.0
India	4.9	4.3
USA	-0.4	-0.2
WHTPP	-0.9	-0.5
EU28	-0.8	-0.4
ROW	-0.8	-0.4

Source: Author's simulation results.



Source: Author.

Figure 1: Schematic View of the GDyn with GVCs Model Structure



Source: Author's simulation results

Figure 2: Machinery Export from Japan in 2035
(percent changes relative to the baseline)

Table A1: Regional Aggregation

No.	Country	GTAP 140 regions
1	Japan	Japan.
2	China	China.
3	HongKong	Hong Kong.
4	Korea	Korea.
5	Taiwan	Taiwan.
6	Singapore	Singapore.
7	Indonesia	Indonesia.
8	Philippines	Philippines.
9	Malaysia	Malaysia.
10	Thailand	Thailand.
11	VietNam	Viet Nam.
12	RoASEAN	Brunei Darassalam; Cambodia; Lao People's Democratic Republ; Rest of Southeast Asia.
13	Australia	Australia.
14	NewZealand	New Zealand.
15	India	India.
16	USA	United States of America.
17	WHTPP	Canada; Mexico; Chile; Peru.
18	EU28	Austria; Belgium; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; Netherlands; Poland; Portugal; Slovakia; Slovenia; Spain; Sweden; United Kingdom; Bulgaria; Croatia; Romania.
19	ROW	Rest of Oceania; Mongolia; Rest of East Asia; Bangladesh; Nepal; Pakistan; Sri Lanka; Rest of South Asia; Rest of North America; Argentina; Bolivia; Brazil; Colombia; Ecuador; Paraguay; Uruguay; Venezuela; Rest of South America; Costa Rica; Guatemala; Honduras; Nicaragua; Panama; El Salvador; Rest of Central America; Dominican Republic; Jamaica; Puerto Rico; Trinidad and Tobago; Caribbean; Switzerland; Norway; Rest of EFTA; Albania; Belarus; Russian Federation; Ukraine; Rest of Eastern Europe; Rest of Europe; Kazakhstan; Kyrgyzstan; Rest of Former Soviet Union; Armenia; Azerbaijan; Georgia; Bahrain; Iran Islamic Republic of; Israel; Jordhan; Kuwait; Oman; Qatar; Saudi Arabia; Turkey; United Arab Emirates; Rest of Western Asia; Egypt; Morocco; Tunisia; Rest of North Africa; Benin; Burkina Faso; Cameroon; Cote d'Ivoire; Ghana; Guinea; Nigeria; Senegal; Togo; Rest of Western Africa; Central Africa; South Central Africa; Ethiopia; Kenya; Madagascar; Malawi; Mauritius; Mozambique; Rwanda; Tanzania; Uganda; Zambia; Zimbabwe; Rest of Eastern Africa; Botswana; Namibia; South Africa; Rest of South African Customs ; Rest of the World.

Source: Author's aggregation based on Aguiar et al. (2016)

Table A2: Sectoral Aggregation

No.	Sector	GTAP 57 sectors
1	Agric	Paddy rice; Wheat; Cereal grains nec; Vegetables, fruit, nuts; Oil seeds; Sugar cane, sugar beet; Plant-based fibers; Crops nec; Cattle,sheep,goats,horses; Animal products nec; Raw milk; Wool, silk-worm cocoons; Forestry; Fishing.
2	Mining	Coal; Oil; Gas; Minerals nec.
3	FoodProd	Meat: cattle,sheep,goats,horse; Meat products nec; Vegetable oils and fats; Dairy products; Processed rice; Sugar; Food products nec; Beverages and tobacco products.
4	TextApparel	Textiles; Wearing apparel; Leather products.
5	PetroChem	Petroleum, coal products; Chemical,rubber,plastic prods.
6	Metals	Ferrous metals; Metals nec; Metal products.
7	Machinery	Machinery and equipment nec.
8	ElecEquip	Electronic equipment.
9	Auto	Motor vehicles and parts.
10	TransEquip	Transport equipment nec.
11	OthMnfct	Wood products; Paper products, publishing; Mineral products nec; Manufactures nec.
12	ConstUtil	Electricity; Gas manufacture, distribution; Water; Construction.
13	TradeTrans	Trade; Transport nec; Sea transport; Air transport.
14	Services	Communication; Financial services nec; Insurance; Business services nec; Recreation and other services; PubAdmin/Defence/Health/Educat; Dwellings.

Source: Author's aggregation based on Aguiar et al. (2016)