

Supplementary Information

The Impact of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership and Regional Comprehensive Economic Partnership on the Global Value Chain of Manufacturing

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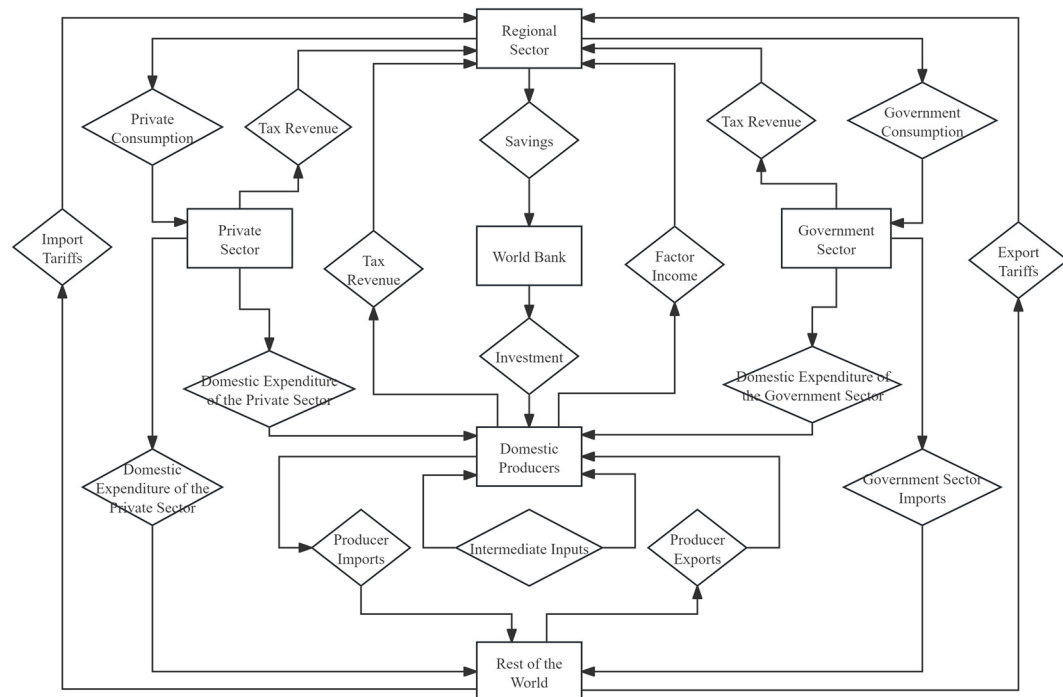
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Supplementary Figure S1 The internal framework of the GTAP model.

Summary of the GTAP 10.0 database

Given the large and complex nature of the data in the GTAP database, this study presents only its core structure and key indicators, as outlined in Supplementary Table S1.

Supplementary Table S1: Core Data Summary of the GTAP 10.0 Database

Data type	Describe
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Region	141 countries and regions, including aggregated regions
Sector	65 production sectors
Factor	8 categories of elements
Macroeconomic Data	Gross Domestic Product, private consumption, gross fixed capital formation, government consumption, capital stock, and depreciation
Trade	Bilateral trade flows and trade costs
Tariff and Non Tariff Barriers	Most-favored-nation tariffs, preferential tariffs, and non-tariff barriers
Basic data	Population, employment, and input-output table

Mathematical model of the GTAP model

Household consumption is modelled using the Constant Difference of Elasticities (CDE) function, which is represented as follows:

$$U = f(x_1, x_2, \dots, x_n) \quad (1)$$

In equation (1), U denotes the total utility level of consumers, and x_i represents the quantity of the i -th product consumed by households.

Government consumption is modelled according to the Cobb-Douglas function:

$$U = A \prod_{i=1}^n x_i^{\alpha_i} \quad (2)$$

In equation (2), A represents the total efficiency factor, and α_i denotes the fixed expenditure ratio of the government on various commodities.

Manufacturers operate under the assumption of profit maximization in a perfectly competitive market. The Constant Elasticity of Substitution (CES) production function is employed in the production process to describe the substitution relationship between different production factors:

$$Q = A \left(\sum_i \delta_i X_i^\rho \right)^{\frac{1}{\rho}} \quad (3)$$

In equation (3), Q represents the final output, X_i denotes the input of production factors, A is the technical efficiency parameter, δ_i represents the weight of factor inputs, $\rho = 1 - 1/\sigma$ is the substitution parameter, and σ refers to the elasticity of factor substitution.

Additionally, the GTAP model incorporates the Armington hypothesis to model the substitution relationship between domestic and imported goods using the CES import demand function.

$$Q = A (\delta X_d^\rho + (1 - \delta) X_m^\rho)^{\frac{1}{\rho}} \quad (4)$$

In equation (4), X_d and X_m represent the consumption quantities of domestic and imported goods, respectively.

The GTAP model is a general equilibrium model, and its equilibrium conditions are as follows:

$$Q_s = Q_d \quad (5)$$

Equation (5) states that the supply in all markets equals the demand.

$$K_s = K_d \quad (6)$$

$$L_s = L_d \quad (7)$$

Equations (6) and (7) describe the supply-demand equilibrium for capital and labour, where K represents capital and L represents labour.

$$\sum (X - M) = 0 \quad (8)$$

Equation (8) reflects the condition that global total exports and imports are equal.

Detailed method for converting GTAP data into an MRIO table.

Supplementary Table S2:GTAP Data and MRIOT Element Comparison Table

GTAP	IOT	Definition
Domestic data		
$vd fm_{ij}^r$	Z^{rr}	purchases of domestic i for use by j in region r
$vd pm_i^r$		private consumption expenditure on domestic i in r
$vd gm_i^r$		government consumption expenditure on domestic i in r
$vd km_i^r$		domestic investment purchases on industry i in region r
$vd pm_i^r$ + $vd gm_i^r + vdkm_i^r$	y^{rr}	domestic final goods consumption purchases by region r in industry i
vst_k^r	t^r	international transportation exports of category k from region r
$vxmd_i^{rs}$	e^{rs}	exports of industry i from region r to region s (at exporter's market prices)
vom_i^r	X^r	total output of industry i in region r
Import data		
$vifm_{ij}^s$	Z^m	import purchases by industry j in region s from industry i
$vipm_i^s$		import purchases by households in region s from industry i
$vigm_i^s$		import purchases by the government in region s from industry i
$vikm_i^s$		import investment purchases in region s from industry i
$vipm_i^s + vigm_i^s$ + $vikm_i^s$	y^m	import purchases in region s from industry i
vim_i^s		imports by region s from industry i
International trade		

$vims_i^{rs}$	imports by region s from industry i in region r , valued at importer's market prices
$viws_i^{rs}$	imports by region s from industry i in region r , valued at world prices of region s
$vxwd_i^{rs}$	exports from industry i in region r to region s , valued at region r 's market prices
International costs	
$vtwr_{ki}^{rs}$	type k transportation cost for shipping product i from region r to region s
vtw_k	supply and use of type k international transportation costs
Value added	
vfm_{ij}^r	firm purchases of production factor i by sector j in region r
$ftrv_{ij}^r$	tax revenue from production factor i generated by sector j in region r
$fbep_{ij}^r$	subsidies on production factor i received by sector j in region r
$isep_{ij}^r$	production input subsidies on factor i received by sector j in region r
$osep_j^r$	subsidies on output received by sector j in region r
International taxation	
$tfrv_i^{rs}$	import tariff on goods from sector i of region r into region s
adv_i^{rs}	anti-dumping duties on sector i products traded from region r to region s
$mfrv_i^{rs}$	export tax equivalent of the Multi-Fibre Arrangement (MFA) quota rent on sector i exports from region r to region s
$purv_i^{rs}$	export tax equivalent of price undertaking on sector i exports from region r to region s
$vrrov_i^{rs}$	export tax equivalent of the voluntary export restraint (VER) on sector i exports from region r to region s
$xtrv_i^{rs}$	general import subsidies on sector i products imported from region r to region s

Total Output Row Identity:

$$X^r = Z^{rr} + Y^{rr} + t^r + \sum_s e^{rs} = Z^{rr} + Y^{rr} + t^r + \sum_s (Z^{rs} + Y^{rs}) \quad (9)$$

Total Input Column Identity:

$$X^r = \sum_i vdfm_{ij}^r + \sum_i vifm_{ij}^r + \sum_i vfm_{ij}^r + \sum_i ftrv_{ij}^r -$$

$$\sum_i fbep_{ij}^r - \sum_i isep_{ij}^r - osep_j^r \quad (10)$$

Total Output (valued at exporter's market prices):

$$X_i^r = vom_i^r = \sum_j vdfm_{ij}^r + vdp_m^r + vdgm_i^r + vdkm_i^r + vst_k^r + \sum_s vxmd_i^{rs} \quad (11)$$

Domestic Intermediate Supply Matrix (valued at exporter's market prices):

$$Z^{rr} = vdfm_{ij}^r \quad (12)$$

Domestic Final Goods Supply Matrix (valued at exporter's market prices):

$$Y^{rr} = vdp_m^r + vdgm_i^r + vdkm_i^r \quad (13)$$

International Trade Transportation Costs:

$$t^r = vst_k^r \quad (13)$$

Given that Z^{rs} and Y^{rs} are measured at the domestic market prices of the importing region s , it is necessary to convert them into the domestic market prices of the exporting region r . To achieve this, the bilateral export flows e_i^{rs} are proportionally decomposed to ensure consistent price valuation.

Exports of Intermediate Goods (valued at exporter's market prices):

$$Z_{ij}^{rs} = \frac{(Z^m)_{ij}^s}{vim_i^s} e_i^{rs} \quad (14)$$

Exports of Final Goods (valued at exporter's market prices):

$$y_i^{rs} = \frac{(y^m)_i^s}{vim_i^s} e_i^{rs} \quad (15)$$

Total Imports (valued at importer's market prices):

$$vim_i^r = \sum_r vims_i^{rs} = \sum_j vifm_{ij}^s + vipm_i^s + vigm_i^s + vikm_i^s \quad (16)$$

Bilateral Exports (valued at exporter's market prices):

$$e^{rs} = vxmd_i^{rs} \quad (17)$$

Imports of Intermediate Goods (valued at importer's market prices):

$$(Z^m)_{ij}^s = vifm \quad (18)$$

Imports of Final Goods (valued at importer's market prices):

$$(y^m)_i^s = vipm_i^s + vigm_i^s + vikm_i^s \quad (19)$$