A Study of the Impacts of Tariff Reductions on Agriculture, Livestock, and Fishery Sectors in Taiwan - an Application of Single-Country Multiple-Sector CGE Model

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Abstract

This study used a single-country 50-sector CGE model to evaluate the impacts of 24.03%, 23.72%, and 33.11%, tariff reductions on agriculture, livestock, and fishery, respectively, after Taiwan's accession to the WTO.   Results show that imports of agriculture, livestock, and fishery would increase by 52.98%, 86.48%, and 216.57%, respectively, and the domestic production of agriculture would experience the biggest reduction of 16.2%.

Keywords: Tariff Reduction, CGE Model, Taiwan

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Background and Motivation

The WTO's Agriculture Agreement was negotiated in the 1986 to1994 Uruguay Round and is a significant first step towards fairer competition and a less distorted resource allocation. Taiwan is committed to trade liberalization and the globalization of its domestic markets. It is generally perceived as a party "willing and able" to meet the WTO's implicit requirements as well as the requirements of its trading partners. In 2000, Taiwan has concluded bilateral negotiations on all products with almost all of the interested World Trade Organization (WTO) members.

In line with the spirit of trade liberalization, Taiwanese government has pursued tariff reductions over last several years. The nominal tariff on agricultural products fell from 12.7% in 1985 to 11.77% in 1999, while the tariff on industrial goods fell from 6.11% to 2.40% over the same period. Especially, a significant tariff reduction on agriculture, livestock, and fishery will be expected in 2004 when Taiwan joins the World Trade Organization

Upon joining the WTO in 2001, Taiwan will eliminate its direct import control regulations and after three years of membership or in 2004, the average tariff rates of agriculture, livestock, and fishery will drop 24.03%, 23.72%, and 33.11%, respectively, after Taiwan's accession to the WTO in 2004. Though it is agreed that free trade will benefit all nations and that trade liberalization is highly in demand, one can hardly deny the process of adjustment toward a free trade regime can be time-consuming and costly. When Taiwan be allowed to join the WTO, and the accession commitments be implemented immediately. The impacts could be considerably large in agriculture, livestock, and fishery sectors. As a consequence, the value of imports is expected to grow in the near future, and the domestic agriculture may experience enormous challenge for most of agriculture production in Taiwan lack of international competitions.

In 1996, Taiwan's total output value (calculating in producers' price) of agriculture, livestock, and fishery sectors is about 3.15% of the total output value in Taiwan, but their share of Taiwan's total employment is about 7.43%. From the decomposition of primary factor input payment, the primary factors (labor and profits) payment of agriculture, livestock, fishery is about 61.18%, 17.38%, and 59.99% of the total inputs value, i.e., both agriculture and fishery sectors uses more primary inputs from other sectors than primary inputs. Especially, labor payment in agriculture and fishery sectors is about 44.67% and 29.76% of the total output value, respectively. In short, both agriculture and fishery sectors are labor-intensive sectors.

Of most importance is that the average unskilled labor in these three sectors accounts for 97.52% of the total labor force, which is much higher than the average unskilled percentage (51.85%) in other sectors. It is expected that after joining in

WTO, Taiwan have advantage to raise GDP and import-export quantity. The effects toward individual industry is based on the competitiveness of industry in comparing to foreign industry. Huge unemployed unskilled labor force is expected to occur in agriculture, livestock, and fishery sectors.

This study attempts to analyze the impacts of tariff reductions on agriculture, livestock, and fishery sectors in Taiwan. By utilizing the most current released input-output data in 1996, this paper specifies a multi-sector, computable general equilibrium (CGE) model of the Taiwan's economy which is constructed to evaluate the economy-wide impacts of tariff reductions on agriculture, livestock, and fishery and to evaluate impacts of tariff reductions on agriculture, livestock, and fishery imports in Taiwan based on WTO trade negotiation results.

Research Methodology

The method applied in this study is derived from ORANI and implemented by the GEMACK software, which is developed from Monash University in Australia (Dixon, Parmenter, Sutton and Vincent, 1982: Dixon, Parmenter, Powell, and Wilcoxen, 1992). For the detailed model specifications see Dixon et al., 1982 and 1992. ORANI model allows each industry to produce several commodities in using as inputs domestic and imported commodities. The primary inputs contain labor, land, capital, and other costs. Furthermore, commodities destined for export are distinguished from those for local use. The multi-input, multi-output production specification is kept manageable by a series of separability assumptions. Figure 1 shows the nesting production structure of CGE model.

The input demand of industry production in CGE Model is formulated by a four-level nested structure, and the production decision-making of each level is independent. Assuming the product market and factor market that producers faced are all completely competitive market, that is, no matter what producers are in product market or in factor market are all price-taker. In cost minimization and technology constraint at each level of production, producers will make optimal input demand decisions. At the top level, industry product is produced by combining aggregated primary inputs with aggregated intermediate inputs under the assumption of Leontief production function. It is assumed that primary inputs and intermediate inputs are separable and the production technology bears the features of separability and constant return to scale. Consequently, they are all demanded in direct proportion to the industry activity. The aggregated intermediate input is calculated, under Armington assumption and constant elasticity of substitution (CES) form.

At the second level, each commodity composite is a CES function of domestic goods and the imported equivalent (the Armington assumption). And at the third level, the primary-factor composite is specified as a constant ratio of elasticities of substitution, homothetic (CRESH) functional form to aggregate three types of primary inputs, such as labor, land, and capital. At the fourth level, the labor composite is a CES aggregation of skilled and unskilled workers.

The input-output database was compiled from the 160-sector of the 1996 Taiwan's Input-Output tables. Various behavior equations are specified for

producers, private households, government, and import-exporters. An absorption matrix, a make matrix, and an import duty vector compose the database and satisfy the following balance equations: (1) market clearing for tradable goods; (2) market clearing for (mobile) endowment; (3) zero profit condition; (4) household budget balance; and (5) investment-savings balance.

Data

For the most recently published 1996 Taiwan's Input-Output tables, there consist of 160 commodities and sectors. Agriculture sector is represented as paddy rice, other common crops, sugarcane, other special crops, fruits, vegetables, other horticultural crops, agricultural services sectors, frozen foods and misc. food products. Livestock sector is represented as hogs and other livestock products. However, the fishery sector is overlooked as one single sector in the original 160 input-output sectors. Even though the fishery products are highly substituted among consumers, the far-sea fishery in Taiwan targets the export market and the domestic market is the target of aquaculture, offshore and coastal fishery. In addition, the major cost item in far-sea, offshore and coastal fishery is fuel/oil cost, but the feed expense is the major cost in aquaculture fishery. Based on the differences in production activity and the input cost structure, it is of interest to disaggregate the output value into three sectors, such as aquaculture fishery, far-sea fishery, and offshore & coastal fishery.

Finally, this study defines a 50-sector and -commodity which contains ten agricultural sectors, two livestock sectors, and three fishery sectors. Table 1 shows the percentage value of domestic and imports demand for major agriculture, livestock and fishery sectors, including intermediate inputs of products, investment, household consumption, exports, inventory, and import demand. From table 1, we can know that paddy rice, sugarcane, other special crops, hogs, other livestock, and agricultural services are almost flowing to other industry to be used as intermediate inputs. In household consumption, fruits, vegetables, other horticultural crops, aquaculture products, offshore and coastal fishery products are consumed the most. In the export aspect, far-sea fishery products and misc. food products have greater parts.

Cost share of intermediate inputs and primary endowments of major agriculture, livestock and fishery sectors are showed in Table 2. The agriculture sectors such as paddy rice, other common crops, sugarcane, etc., are the fundamental industries all using a great deal of intermediate inputs and labor inputs and account for labor-intensive sectors. Livestock industry such as hogs and other horticultural crops are both using a large number of intermediate inputs which is higher than 70%. In fishery aspect, aquaculture fishery uses the most of intermediate inputs and labor inputs; far-sea fishery uses most of capital; offshore and coastal fishery use the most of labor and capital inputs. Frozen and misc. food industry have the most of use in intermediate inputs.

Results and Simulations

It is very important to define the exogenous and endogenous variables in this study, for the suitable choice of exogenous variables of CGE Model applies in the

purpose of policy simulation.   It is so-called the closure set.   In this study, a short-run static analysis is used to analyze the impacts after the reductions of tariff on agriculture, livestock and fishery sectors.   Capital, land, technology changes of basis factors, and the hobby of household consumption are all defined as exogenous variables in the short-run.   In addition, assuming the nominal wage is fixed and the temporary unemployment exists.   Further, Taiwan is a small imports country and the amount of imports will not affect the world's price.   Finally, the import tariff is defined as an exogenous variable in the model.   Figure 2 is a closed closure flow chart.

The tariff reductions are treated as shocks in the model.   These shocks can be defined as the percentage changes and be used in the model for other common crops (-15.57 %), other special crops (-32.04 %), fruits (-27.94 %), vegetables (-17.32 %), other horticultural crops (-13.43 %), other livestock (-7.66 %), aquaculture products (-44.45 %), far-sea fishery products (-23.41 %), offshore and coastal fishery products (-52.82 %), frozen foods (-15.07 %), and misc. food products (-25.38 %), respectively.

The variations of Input-Output can be seen through Fan Decomposition mechanism which are local market effect, import share effect, and export share. Table 3 shows the Fan Decomposition of related domestic products under tariff reductions on agriculture, livestock, and fishery sectors in Taiwan.   Only 2 sectors, far-sea fishery and frozen foods, have positive total effects for these two sectors are export-oriented.   Among the rest of 13 sectors, offshore and coastal fishery sector has the highest total effect, i.e., -7.97.   In other words, this sector will suffer the greatest impacts from the tariff reductions.

The percentage changes of selective economic various factors under tariff reductions on agriculture, livestock, and fishery sectors are also shown in Table 4. The economic various factors used in this study include commodities output for domestic market, basic price of domestic goods, total supplies of imported goods, employment by industry, and investment.   Take the offshore and coastal fishery sector as an example.   The output of offshore and coastal fishery sector for domestic market will decrease by 8.06% upon the tariff reductions.   Consequently, the employment by this sector will cut 2.45% of labor force.   In addition, the basic price of this sector will also decrease almost 20%.   At the same time, the total supplies of imported goods of previous sector will significantly increase by 337% due to the tariff cut.   And imports of agriculture, livestock, and fishery will increase by 52.98%, 86.48%, and 216.57%, respectively, and the domestic production of agriculture would experience the biggest reduction of 16.2%.   Table 5 shows the impacts of tariff reductions from the viewpoint of dollar value.

Table 6 lists the percentage changes of selective various macroeconomic variables under tariff reductions on agriculture, livestock, and fishery sectors in Taiwan.   The figures in Table 6 indicate a decrease of 0.47% in real GDP from the expenditure side and a decrease of 2.74% in consumer price index.

Concluding Remarks

This study used a single-country 50-sector CGE model to evaluate the impacts of 24.03%, 23.72%, and 33.11% tariff reductions on agriculture, livestock, and fishery, respectively, after Taiwan's accession to the WTO.   Results show that imports of agriculture, livestock, and fishery will increase by 52.98%, 86.48%, and 216.57%, respectively, and the domestic production of agriculture would experience the biggest reduction of 16.2%.

Among individual sector, offshore and coastal fishery sector suffers the greatest impacts of decreasing 8.06% output for domestic market, 2.45% of labor force loss, and 20% down of the basic price.   However, the total supplies of imported goods of offshore and coastal fishery sector will significantly increase by 337%.   As a consequence, the value of seafood imports is expected to grow after Taiwan joining the WTO.

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Table 1. Percentage Value of Domestic and Imports Demand for Major Agriculture, Livestock and Fishery Sectors

Commodity	Domestic Demand[1]					Import Demand (%)	Total Import (Mil. NT$)
	Intermediate Input (%)	Investment (%)	Household Consumption (%)	Export (%)	Inventory (%)		
Paddy Rice	107.43	0.00	0.00	1.23	-8.68	0.01	39,355
Other Common Crops	6.65	0.00	9.84	0.04	-1.42	84.89	78,440
Sugarcane	100.63	0.00	0.00	0.00	-0.63	0.00	5,364
Other Special Crops	31.17	0.00	9.25	0.48	-0.03	59.13	28,990
Fruits	9.60	0.00	74.69	2.35	-0.14	13.50	63,323
Vegetables	14.97	0.00	75.89	5.41	-0.19	3.93	29,647
Other Horticultural Crops	20.98	3.39	63.88	4.58	-0.31	7.48	37,885
Hogs	96.69	3.15	0.00	0.07	0.05	0.04	121,361
Other Livestock	59.60	0.73	31.20	0.50	0.53	7.45	69,713
Agricultural Services	100.00	0.00	0.00	0.00	0.00	0.00	40,690
Aquaculture Products	19.24	0.00	66.76	7.78	-0.13	6.35	37,189
Far-Sea Fishery Products	3.92	0.00	36.09	56.13	-0.06	3.92	44,812
Offshore and Coastal Fishery Products	13.57	0.00	77.75	0.96	-0.01	7.73	25,079
Frozen Foods	7.96	0.00	0.08	0.00	0.04	91.91	91,286
Misc. Food Products	2.75	0.00	36.53	40.98	0.08	19.66	695,803

[1] The Value is defined as the percentage in total import.

Source: Input-Output Table (160 Sectors) in Taiwan Area, Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Republic of China, 1996.

Table 2. Cost Share of Intermediate Inputs and Primary Endowment of Major Agriculture, Livestock and Fishery Sectors

Sector	Domestic Intermediate Input (%)	Import Intermediate Input[1] (%)	Primary Inputs[2]						Total Costs (Mil. NT$)
			Margin (%)	Labor (%)	Capital (%)	Land (%)	Net Commodity Taxes (%)	Other Costs (%)	
Paddy Rice	49.76	1.14	1.38	34.73	12.97	0.00	0.00	0.02	39,351
Other Common Crops	48.08	3.30	2.27	33.27	12.65	0.42	0.00	0.01	11,850
Sugarcane	42.38	2.01	2.54	42.52	10.18	0.30	0.00	0.07	5,364
Other Special Crops	31.71	1.81	2.83	48.22	15.19	0.24	0.00	0.01	11,847
Fruits	31.59	2.70	3.35	52.95	8.33	0.84	0.00	0.24	54,777
Vegetables	36.66	2.17	2.94	43.44	14.51	0.24	0.00	0.05	28,483
Other Horticultural Crops	26.49	2.52	2.41	54.82	13.45	0.24	0.00	0.07	35,051
Hogs	75.89	1.27	6.24	6.03	9.84	0.43	0.00	0.30	121,317
Other Livestock	71.98	2.27	6.92	10.58	7.39	0.31	0.00	0.56	64,521
Agricultural Services	20.69	4.00	2.37	37.82	34.49	0.00	0.00	0.63	40,690
Aquaculture Products	37.31	6.80	6.44	37.85	6.04	4.18	0.00	1.38	34,826
Far-Sea Fishery Products	7.87	24.77	1.24	19.29	45.03	0.42	0.00	1.38	43,054
Offshore and Coastal Fishery Products	17.98	9.28	8.28	37.05	25.25	0.79	0.00	1.38	23,140
Frozen Foods	67.98	2.69	15.46	7.62	5.74	0.03	0.00	0.49	73,337
Misc. Food Products	50.07	17.62	7.95	10.22	5.33	-0.04	0.55	8.31	578,790

[1].Including net import duties.

[2].The value in defined as the percentage in total cost.

Source: Input-Output Table (160 Sectors) in Taiwan Area, Directorate-General of Budget, Accounting and Statistics, Executive Yuan, Republic of China, 1996.

Table 3. Fan Decomposition of Related Domestic Products under Tariff Reductions on Agriculture, Livestock, and Fishery Sectors in Taiwan

Unit: %

Sector and Commodity	Local Market Effects	Import Share Effects	Export Effects	Total Effects[1]
Paddy Rice	-2.627	0.0007	0.0064	-2.6199
Other Common Crops	-0.4053	-4.342	0.0015	-4.7458
Sugarcane	-2.8026	0	0	-2.8026
Other Special Crops	2.2089	-9.1572	0.006	-6.9424
Fruits	4.9104	-8.5618	0.0143	-3.6371
Vegetables	0.4478	-1.1715	0.029	-0.6946
Other Horticultural Crops	-0.3876	-1.9492	0.0256	-2.3113
Hogs	-2.3792	0.0071	0.0003	-2.3717
Other Livestock	-1.3961	-0.2531	0.0028	-1.6464
Agricultural Services	-5.2689	0	0	-5.2689
Aquaculture Products	5.1129	-10.1142	0.0428	-4.9585
Far-Sea Fishery Products	0.4627	-1.741	1.9659	0.6876
Offshore & Coastal Fishery Products	10.8349	-18.812	0.0054	-7.9717
Frozen Foods	1.3164	-6.5827	6.155	0.8887
Misc. Food Products	3.1071	-8.3729	0.0317	-5.2341

[1] Total effect is defined as the sum of local market effects, import share effects, and export effects.

Table 4. Percentage Changes of Economic Various Factors under Tariff Reductions on Agriculture, Livestock, and Fishery Sectors in Taiwan

Unit: %

Sector and Commodity	Commodities Output for domestic market	Basic price of domestic goods	Total supplies of imported goods	Employment by industry	Investment
Paddy Rice	-2.6591	-7.7528	-9.3455	-7.632	-9.4436
Other Common Crops	-4.7614	-12.4197	0.3684	-8.3115	-10.2922
Sugarcane	-2.8026	-7.1121	0	-8.7856	-10.9071
Other Special Crops	-7.0302	-18.6697	9.3309	-7.9164	-9.7816
Fruits	-3.7557	-9.5437	69.0855	-6.5191	-7.9552
Vegetables	-0.7669	-4.7038	31.5283	-3.6254	-4.1928
Other Horticultural Crops	-2.4589	-0.7915	25.4031	-3.9412	-4.5976
Hogs	-2.3736	-8.1198	-20.9899	-7.2207	-5.9294
Other Livestock	-1.6581	-5.3325	1.7585	-10.0368	-11.7132
Agricultural Services	-5.2689	-5.133	0	-0.5759	-0.2618
Aquaculture Products	-5.4549	-12.0221	205.4532	-10.4464	-12.983
Far-Sea Fishery Products	-3.1094	-0.5893	70.1717	0.1346	0.5063
Offshore & Coastal Fishery Products	-8.062	-20.2079	336.9704	-3.4512	-4.1293
Frozen Foods	-10.758	-1.9817	32.3562	-1.8589	-2.1642
Misc. Food Products	-5.612	-13.7704	48.9922	-3.5926	-4.3176

Table 5. Impacts of Various Economic Factors under Tariff Reductions on Agriculture, Livestock, and Fishery Sectors in Taiwan

Unit: Million NT Dollars

Tariff	Change of Commodity Outputs' Value	Change of Import Value	Change of Value Labor Payments	Change of Investment
Agriculture Products	-23,490.17	1,962.31	-5,208.68	-59.03
Paddy Rice	-4,046.58	-0.37	-1,042.99	0.00
Other Common Crops	-2,029.95	226.54	-327.72	0.00
Sugarcane	-531.82	0.00	-200.40	0.00
Other Special Crops	-3,009.20	1,471.11	-452.26	0.00
Fruits	-7,086.72	71.85	-1,890.73	0.00
Vegetables	-1,470.52	9.77	-448.61	0.00
Other Horticultural Crops	-1,082.84	183.41	-757.34	-59.03
Agricultural Services	-4,232.53	0.00	-88.62	0.00
Livestock Products	-17,207.93	65.50	-1,213.18	-298.28
Hogs	-12,721.78	0.00	-528.27	-229.29
Other Livestock	-4,486.15	65.50	-684.91	-68.99
Fishery Products	-12,716.77	6,527.20	-1,661.78	0.00
Aquaculture Products	-5,581.11	2,276.42	-1,377.06	0.00
Far-Sea Fishery Products	-662.14	891.18	11.18	0.00
Offshore and Coastal Fishery Products	-6,473.52	3,359.59	-295.89	0.00
Other Foods	-109,981.51	20,009.08	-2,229.40	0.00
Frozen Foods	-4,577.50	172.13	-103.84	0.00
Misc. Food Products	-105,404.01	19,836.94	-2,125.56	0.00
Industry Products	-77,797.77	-11,889.66	-22,975.10	7,040.49

Table 6. The Percentage Changes of Various Macroeconomic Variables under Tariff
Reductions on Agriculture, Livestock, and Fishery Sectors in Taiwan

| Macroeconomics Variables	%
Real GDP from Expenditure Side	-0.47
Nominal GDP from Expenditure Side	-2.23
GDP Price Index from Expenditure Side	-1.76
Nominal GDP from Income Side	-1.75
Consumer Price Index	-2.74
Duty-Paid Imports Price Index	-1.86
Exports Price Index	-0.17
Export Volume Index	0.56
Import Volume Index, C.I.F. Weights	1.72
Aggregate Employment: Wage Bill Weights	-0.76
(Balance of Trade)/GDP	0.00
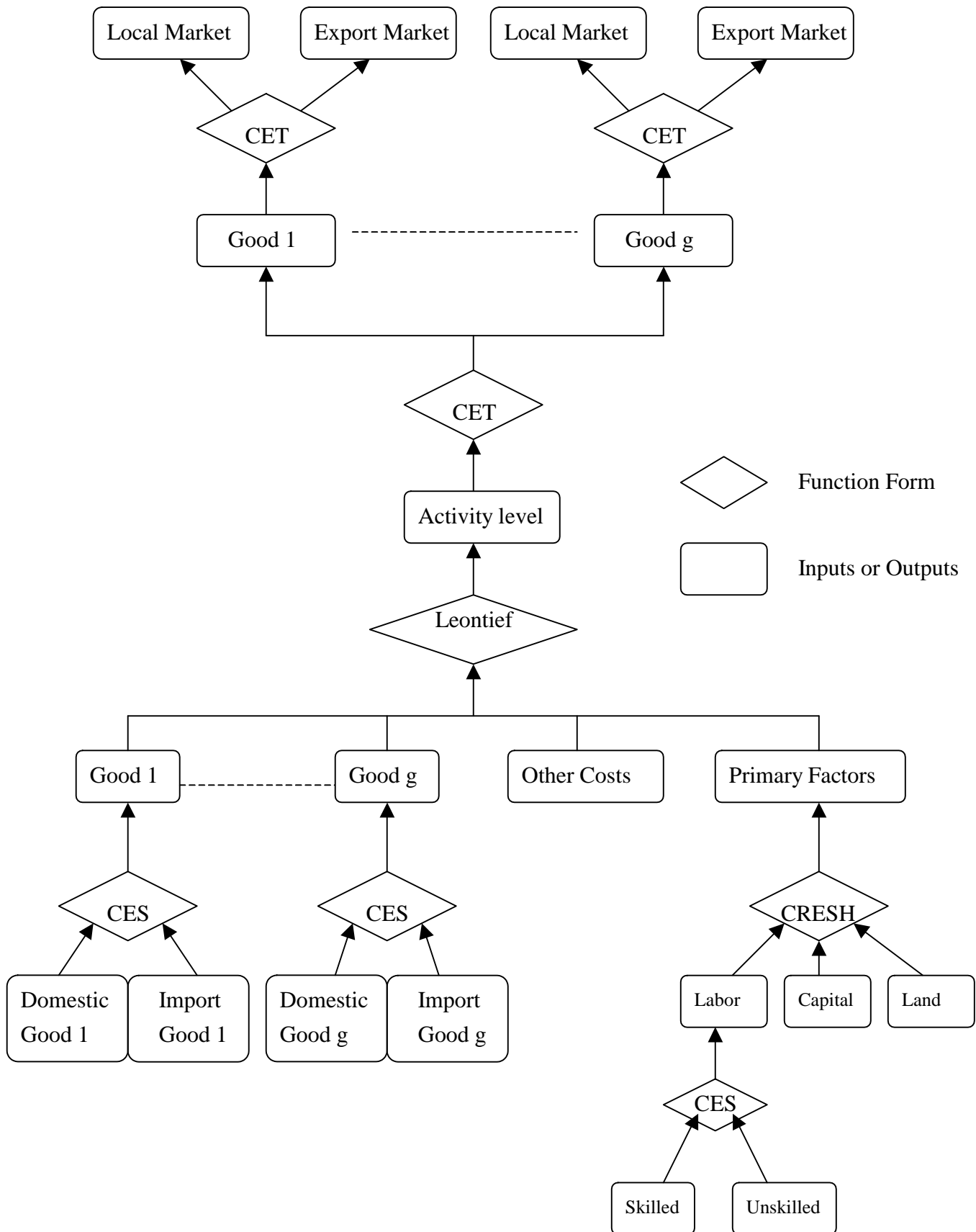
Figure 1. Productive Structure of CGE Model
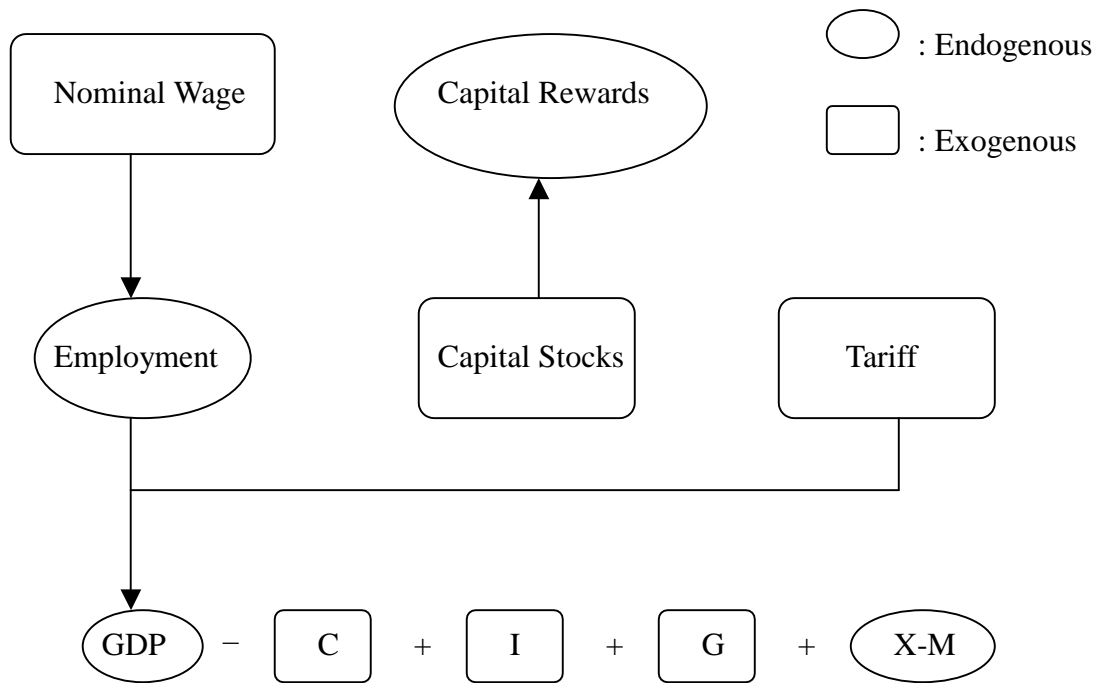
Figure 2. The Definition of Closed Closure