Import preference change and its impacts on the effects of trade liberalization policy*

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Abstract

In the recent years, the import shares of intermediate inputs for Taiwan's manufacturing sector and that of household manufacture consumption continues to rise even with the relative import price increase. This phenomenon may be due to the global trend of production outsourcing, the increase of imported product variety and the persistence of trade barriers, which altogether are called the imported preference change in this article. But most of the macroeconomic models did not consider the change of import preference in their import demand and therefore may generate biased empirical results. By establishing a single country Computable General Equilibrium (CGE) model including the import preference factor, this paper first calibrates the change of import preference of the sample period, then applies the model to the simulation of a trade liberalization policy. By comparing the empirical results with and without the concern of the import preference change, the bias from neglect of the preference change may be revealed.

Keywords: import preference, trade liberalization, Armington assumption, CGE model

JEL Classification: F12, F13, F14

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1. Introduction

Over the past 20 years, the rate of value-added in Taiwan's manufacturing outputs shows a steadily downward trend[1]. Meanwhile, the import share of the intermediate inputs for its manufacturing production and that of the household manufacture consumption continue to rise. As shown in Table 1, the import share of household manufacture consumption in 2006 was 33.4%, compared with 25.8% in 1999. The import share of intermediate manufacture inputs for the manufacturing sector was 40.7% in 2006, higher than the share of 35.9% in 1999.

Table 1. The import shares of household manufacture consumption and intermediate inputs for the manufacturing sector

Unit: %

	1999	2001	2004	2006
The import share of household manufacture consumption	25.8	26.2	29.9	33.4
The import share of intermediate manufacture inputs for the manufacturing sector	35.9	34.0	36.4	40.7

Source: Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C.(Taiwan), Input-Output Tables, various years.

With constant increase in the import value and import share of manufacturing products, we may expect that the import relative prices may show a decreasing trend so that the imported products became more competitive and hence substituted the demand for the domestic products. But this is not the case. In the last two decades, the import relative prices fluctuated erratically from time to time. This scenario reveals a fact that the demand for imported products may not determined largely by the relative price. The non-price factor could be equally or even more important. This paper aims to establish a model to analyze the effects of price and non-price factors on import demand, and to find out how the non-price factors affect the economic growth in the process of trade liberalization.

In many empirical studies of trade issues, the Armington assumption (Armington 1969, 1970) is adopted to describe the behavior of import demand. It describes the same type of products from different source countries as substitutive yet differentiated

[1] The only exception is in 2003-2005, at which years the value-added ratio showed a temporary increase.

products. This setting together with firm's optimization in cost minimization can be used to explain the relative distribution of domestic and imported demand. This design not only captures the feature of product differentiation in the monopolistic competition market, but also solves the problem of two-way trade of the same product. Indeed, this design has its advantage in reflecting the demand effect due to relative (domestic/import) price change, which is called in this paper the "price effect".

However, the effect of non-price factors on imports demand has drawn attention from empirical researchers in the recent years. Buetre and Ahmadi-Esfahani (2000) indicate that, in the real world, producers may have to purchase parts and components from a specific country or of a specific brand responding to the request of their contractors. Rigoberto (2005) also points out that the existence of trade protection measures may alter the choice between domestic and imported inputs, which therefore cannot be properly described by the cost minimization with the Armington assumption. If the non-price factors are not taken into consideration, the empirical results may be biased.

Taiwan as a small and highly open economy has played a role of intermediate products suppliers and contract producers in the global production chain. It is very common for it to provide production services for the brand owners with the patterns of original equipment manufacturing (OEM) or original design manufacturing (ODM). When performing only a part of the complete production processes managed by the brand owners, the choice of its input source is usually not according to the relative price but constrained by the requirements of the brand owners. On the other hand, when producing final goods (such as automobiles) for the domestic market, domestic firms may also be constrained by the foreign suppliers of the key components with the technological alliance. All these reasons may turn the choice of domestic/imported input demand away from the decision made according to price consideration only. It has to be adjusted with non-price factors. The import demand change caused by the non-price factors mentioned above is summarized in this study as the "preference effect" in contrast to the "price effect".

To complement the lack of the concern of preference change in the general models, this paper adopts the design of Horridge (2004) including the mechanism of the preference effect in the general demand function. By accommodating the modified import/domestic relative demand function into a CGE model, we first apply the model to calibrate the preference change between 1999 and 2004.[2] With the results, we then

[2] The sample period is chosen due to the availability of the input-output data for the years of 1999 and 2004 as well as the trade liberalization policies applied at this period for the entry of Taiwan into WTO in 2002.

simulate the economic effects of the trade liberalization policy conducted at the period, and compare the results with and without the consideration of the preference change. Thus the bias from the neglect of the preference effect may be revealed.

The rest of the paper is organized as the following. The next section gives the literature review. The third section derives the equations relevant to import demand and preference change. In the fourth section, we explain the simulation method. The empirical results are presented and interpreted in the fifth section. The sixth section is the conclusion.

2. Literature Review

2.1 Production globalization and import demand change

Along with the vigorous development of economic globalization, the extraordinary growth of trade has drawn much attention from economists. Some of them interpret the scenario focusing on the feature of product differentiation that the disproportionately expansion of import demand is partly induced by the increase of product varieties. By quantifying the degree of product variety and including it in his model, Feenstra (1994a) points out that neglecting the product variety may generate the biased result of overvalued income elasticity and incorrect substitution elasticity of import demand. Feenstra and Markusen (1994b) further explain that if the imported products are heterogeneous intermediate inputs or capital goods, the openness of trade may provide more choices to better suit the different needs of the domestic producers with different scale and product characteristics. In this case, the increase of varieties can reduce the domestic production costs, improve production efficiency, and therefore induce higher import demand and domestic production at the same time. But if the imported goods are consumption goods, the increased varieties may induce more domestic consumption, while the demand for domestic products may be partly replaced by the imported ones. Hence the overall effect of importing differentiated products on domestic production is uncertain. In addition, the price elasticity could also be affected by the increase of product variety. Feenstra and Taylor (2008) suggest that consumers will become more price sensitive when they have more varieties to choose.

In addition to the aspect of product variety, other economists emphasize the development of production fragmentation and outsourcing. Feenstra and Taylor (2008) and Robertson (2004) both notice that the global trend of production outsourcing not only induce a more rapid growth of the trade in intermediate goods, but also result in the geographical concentration of each specific type of production activities, which may lead to smaller share of value-added in each region. The finer production fragmentation causes not only the wider wage gap between the skilled and unskilled

workers, but also the more frequent flows of goods and components across borders, which are reflected by the extraordinary growth of imports and exports.

The above-mentioned studies all indicate the importance of non-price effect on import demand, and provide some evidence of the bias that may be caused by neglecting the effect. Yet the degree of the preference change has not been explicitly measured and its effect evaluated. In the following section, we first establish a quantitative model to trace the path of the change of import preference, and then to evaluate the effect of the preference change on the domestic economic growth.

2.2 Import demand function and Armington assumption

In the empirical studies of trade policies, the Armington (1969, 1970) assumption is most frequently applied to describe the substitutive relationship between imports and domestic products. The Armington assumption treats the same products imported from different countries or regions as differentiated yet substitutive products. By deriving the optimal behavior of producers in minimizing cost and that of consumers in maximizing utility with exogenous substitution elasticity, the relative demand of imports in terms of domestic products is generated. The process not only properly addresses the price mechanism but also reflects the feature of product differentiation in the monopolistic competition market. Moreover, it solves the problem of dealing with the scenario of simultaneously exporting and importing the same products. With these merits, it is adopted in most of the trade models, such as Alston et al. (1990) in analyzing American trade in cotton and wheat and Küster et al. (2007) in evaluating the effect of energy policy on labor market, to name a few.

The setting of import demand with fixed substitution elasticity and Armington assumption is appropriate for static comparative policy analysis or the short-run analysis when domestic production structure and conditions remain stable. But for the longer term or dynamic analysis, especially with the development of production fragmentation deepening, the setting without considering the preference change may derive biased results.

3. Methodology

The method we apply to carry out the study is CGE modeling. General speaking, there are two prototypes of CGE model, one is the so-called DMR model, established by Dervis et al. (1982) for the World Bank to conduct a series of studies of the development issues in the developing countries. DMR model consists of not only the flows of goods and factors within and among different markets but also those of income and expenditure in different sectors. The equilibrium solution is simultaneously resolved directly from the original nonlinear equations by using the

technique of linear programming. Because of the complexity and difficulty of resolving a large set of nonlinear equations, the expansion of model is somewhat constrained. In the recent years, the ORANI model developed by the Center of Policy Studies, Monash University, Australia is widely adopted for trade policy research.[3] The main difference between DMR-type and ORANI-type model is that ORANI model does not require the formulation of social accounting matrix (SAM) but only the data of input-output tables. It focuses more on the analysis of resource allocation efficiency and less concerns the flows of income and expenditure. The policy simulation is resolved by using the linear transformation technique of Johansen (1960), which transforms the original nonlinear equations into the linear equations of percentage change. With the help of multi-step extrapolation, the solution can easily be reverted from the solution of percentage change to the solution of value without much sacrifice of accuracy. This process largely simplifies the technique required for equilibrium solution and makes it feasible for economists to develop and solve a large and more detailed model.

The CGE model we apply here is adapted from Yang and Su (2002) based on the structure of the ORANI model, which consists of a complete set of equations describing the input-output relations among industries, the producers' and consumers' optimal behavior and market equilibrium conditions. To complement the lack of the links between income and final demand in the ORANI model, we refer to the DMR model to include the income-expenditure equations, so that the model is complete in both production and income aspects.

For the industrial production behavior, the nested CES inputs demand functions are adopted for the choice of input combination between domestic and import inputs; and CET output sale function are applied for the decision of domestic sale and exports. The primary factors contains labor, capital and land, which are governed by a CES function to reflect the choice of firms in factor combination under the rule of minimizing cost and technology constrains. The linear expenditure system is used to describe the consumers' behavior that the expenditure shares to different goods can vary when income changes. The main structure and key equations of the model are reported in the Appendix B.

3.1 Data

The data we use in the model can be divided into two sets:

(1) The data of input-output relations is adopted from the Input-Output Tables

[3] See Dixion et al.(1982) for model details.

published by the Directorate-General of Budget, Accounting and Statistics (DGBAS), Executive Yuan, R.O.C.**,** which sets the foundation for inter-industrial and inter-sectional network structure.

(2) The data of income and expenditure is collected from the *National Income Accounts* and the *Survey of Family Income and Expenditure*, also published by the DGBAS.

To build up the flows and links between the production sectors and final demand sectors, we connect the industrial payment to the primary inputs, intermediate inputs and indirect taxes with the revenue of the households, businesses and government, in which the decisions of consumption, investment and government purchase are made. The flows and interactions of different sets of data are depicted in Figure 1.

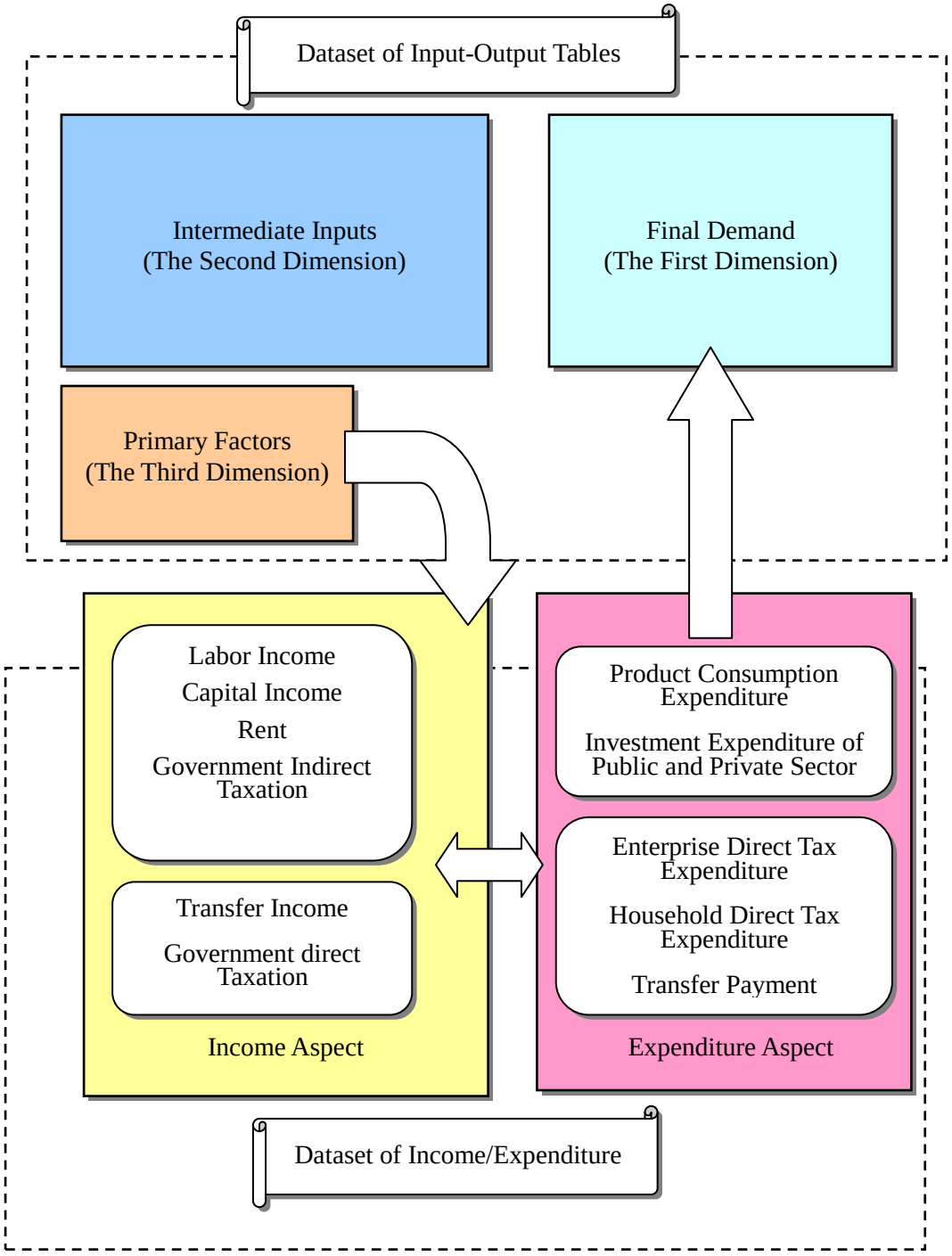

Figure 1. The flows and interactions between data sets

3.2 The mechanism of preference change

The application of the Armington assumption can capture the change of relative import demand responding to the relative import price change. Yet it cannot reflect the import demand change due to non-price factors. To include the consideration of the non-price factors, we add a domestic/imports preference change mechanism into the production function. The decision-making behavior is described as below.

For producer j, let X_i ($i = d$: domestic goods, m: import goods) be the quantity of input. The domestic input X_d and imported input X_m are composed with a CES function and form the composite input Z. The optimal behavior of j can be expressed as:

$$\text{Min} \sum_i P_i X_i \quad \text{, subject to} \quad Z = \left(\sum_i \delta_i X_i^{-\rho} \right)^{-1/\rho} \tag{1}$$

By using Lagrange, the first order condition can be derived as:

$$P_k = \Lambda \frac{\partial Z}{\partial X_k} = \Lambda \delta_k X_k^{-(1+\rho)} \left(\sum_i \delta_i X_i^{-\rho} \right)^{-(1+\rho)/\rho} \quad j, k=d,m \quad j \neq k \tag{2}$$

Hence the relative price can be expressed as:

$$\frac{P_k}{P_i} = \frac{\delta_k}{\delta_i} \left(\frac{X_i}{X_k} \right)^{1+\rho} \tag{3}$$

$$\text{or} \quad X_i^{-\rho} = \left(\frac{\delta_i P_k}{\delta_k P_i} \right)^{-\rho/(\rho+1)} X_k^{-\rho} \tag{4}$$

Substituting the equation (4) back to the CES function in (1), we can obtain:

$$Z = X_k \left(\sum_i \delta_i \left[\frac{\delta_k P_i}{\delta_i P_k} \right]^{\rho/(\rho+1)} \right)^{-1/\rho} \tag{5}$$

This gives the factor demand function:

$$X_k = Z \left(\sum_i \delta_i \left[\frac{\delta_k P_i}{\delta_i P_k} \right]^{\rho/(\rho+1)} \right)^{1/\rho} \tag{6}$$

$$\text{or} \quad X_k = Z \ \delta_k^{1/(\rho+1)} \left[\frac{P_k}{P_{ave}} \right]^{-1/(\rho+1)} \tag{7}$$

$$\text{where} \quad P_{ave} = \left(\sum_i \delta_i^{1/(\rho+1)} \ P_i^{\rho/(\rho+1)} \right)^{(\rho+1)/\rho} \tag{8}$$

The equation (7) represents the standard price mechanism in determining the input combination of domestic and imported goods. And P_{ave} is the price of the composite input Z. By taking the percentage change form of (7) and (8) and using the lowercase of the characters to represent the percentage change of the variables, we can get the transformed linear equation:

$$x_k = z - \sigma \left(p_k - p_{ave} \right) \tag{9}$$

$$p_{ave} = \sum_i S_i p_i \tag{10}$$

where $\sigma = \frac{1}{\rho+1}$, $S_i = \delta_i^{1/(\rho+1)} P_i^{\rho/(\rho+1)} \Big/ \sum_k \delta_k^{1/(\rho+1)} P_k^{\rho/(\rho+1)}$

Finally, we add the term of preference change (a_i):

$$x_i - a_i = z - \sigma\left(p_i + a_i - \tilde{p}_{ave}\right) \tag{11}$$

$$\tilde{p}_{ave} = \sum_i S_i (p_i + a_i) \tag{12}$$

a_i appears twice in the equation (11). $a_i < 0$, $i=m$ represents the increase of the relative preference of imports that each unit of imported inputs can provide more production services compared to a unit of domestic input so that less physical units of imports are needed to generate the same level of output/utility, as shown at the left-hand side of equation (11). For example, surrender to the request of the contract partners to use the (imported) parts and components of the appointed brand will smooth the operation of production. At the high-hand side, the lower price of each effective unit of imports ($p_i + a_i$), $i=m$ will induce the substitution of domestic products with imports.

As reflected in equation (12), when $a_i < 0$, $i=m$, the price of the composite good P_{ave} is also reduced. It will bring to the change of the import demand x_i, $i=m$, as well as the change of (imported/domestic) input combination. The change of input combination will further induce the change of the cost structure, making the share of the input cost paid to the imported goods vary. Our task is to decompose the effect of price change and that of preference change given the path of input combination and cost structure.

Referring to Buetre and Ahmadi-Esfahani (2000) and Horridge (2004), we extend the equation (11) and (12) as the following:

$$x_d - a_d = z - \sigma\left(p_d + a_d - S_d(p_d + a_d) - S_m(p_m + a_m)\right)$$

$$= z - \sigma S_m\left((p_d + a_d) - (p_m + a_m)\right) \tag{13}$$

and $x_m - a_m = z - \sigma\left(p_m + a_m - S_d(p_d + a_d) - S_m(p_m + a_m)\right)$

$$= z + \sigma S_d\left((p_d + a_d) - (p_m + a_m)\right) \quad (14)$$

where $\tilde{p}_{ave} = \sum_i S_i (p_i + a_i) = R_d(p_m + a_m) - R_m(p_d + a_d)$ (15)

Let $t=(x_d - x_m)$ be a **twist variable**, representing the rate of relative change of domestic and imported inputs, given the condition that $p_d = p_m = \tilde{p}_{ave} = 0$. Then we have:

$$S_d a_d + S_m a_m = 0, \quad (16)$$

and $x_d - x_m = (1-\sigma)(a_d - a_m) = t$ (17)

Then a_d and a_m can be solved as: $a_d = S_m t/(1-\sigma)$ and $a_m = -S_d t/(1-\sigma)$ (18)

Substituting the equation (18) back to the demand function of domestic goods (13) and imported goods (14), we get:

$$x_d = z + S_m t/(1-\sigma) - \sigma S_m\left((p_d - p_m + S_m t/(1-\sigma)) + S_d t/(1-\sigma))\right), \quad (19)$$

and $x_m = z - S_d t/(1-\sigma) + \sigma S_d\left((p_d - p_m + S_m t/(1-\sigma)) + S_d t/(1-\sigma))\right)$ (20)

which can be further simplified as：

$$x_d = z + S_m t - \sigma S_m\left(p_d - p_m\right), \quad (21)$$

$$x_m = z - S_d t + \sigma S_d\left(p_d - p_m\right) \quad (22)$$

There are three components at the right hand side of equation (21) and (22). Each one can be expressed as:

(1) z: the ouput effect,

(2) $\sigma S_k(p_d - p_m)$: the price effect based on the Armington assumption ($k = d, m$), and

(3) $S_k t$: the preference effect.

Beware that the signs of the second and third items are the opposite for equation (21) and (22). That is, when t >0, consumers' preference turns toward domestic goods that given the relative price, they intend to purchase more domestic goods and less imported goods; while t <0, consumers' preference turns toward imported goods that given the relative price, they intend to purchase less domestic goods and more imported goods.

4. Empirical Simulations

In this section, we use the Taiwan data from 1999 to 2004 to simulate its preference change during the period and the economic effects caused by the change. We first introduce the trend of macroeconomic indicators, which will be used to calibrate the preference change. The calibrated result will be applied to simulate the economic impacts of the preference change.

4.1 The trend of Taiwan's macroeconomic indicators and the parameters of substitution elasticity

In this section, we present the growth rates of key macroeconomic variables of Taiwan from 2000 to 2004, so that the accumulative growth rate over the five years can be calculated and used for the calibration of the preference change and the simulation of the trade liberalization policy caused by the change.

Table 2 The growth rates of key macroeconomic variables of Taiwan, 2000-2004

Unit：%

variables	2000	2001	2002	2003	2004	accumulated growth rate
Real Household Expenditure	4.59	0.67	2.60	1.48	4.46	14.52
Real Investment	9.02	-19.91	1.07	1.72	19.46	7.23
Real Government Expenditure	0.71	0.53	2.06	0.57	-0.54	3.36
Real Export	18.86	-7.76	10.63	10.38	14.40	53.16
Real Import	15.04	-13.02	6.62	7.66	18.63	36.26
Number of Household	2.28	1.80	1.80	1.76	1.88	9.91
Labor Input	1.13	-1.14	0.76	1.26	2.23	4.27
Real GDP	**5.77**	**-2.17**	**4.64**	**3.5**	**6.15**	**18.96**

Source: Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C., Macro Statistic Database. http://www.stat.gov.tw/public/data/dgbas03/bs4/nis93/np14.xls

To analyze the preference change, we collect the data of import price and import value for each product as shown in Table 3.

Table 3 Import Data by Commodity, 1999 and 2004

Products	1999 import value (NT$1000) (1)	2004 import value (NT$1000) (2)	% change of import value [(2)/(1)]-1 (%)	% change of import price (%)
Agriculture and Animal Husbandry	76,253	87,447	14.68	23.10
Forest Products	8,758	11,640	32.91	23.10
Fishing	11,561	10,293	-10.97	23.10
Minerals	246,735	675,812	173.90	73.90
Food Processing	107,953	118,896	10.14	7.29
Beverage	24,108	49,529	105.45	7.29
Tobacco	19,062	44,941	135.76	7.29
Textiles	46,560	32,616	-29.95	6.77
Apparel, Clothing Accessories	70,834	87,356	23.32	6.77
Wood and Wood Products	40,313	43,607	08.17	15.99
Papers, Paper Products & Printing	75,104	91,303	21.57	16.16
Chemical Products	221,016	345,707	56.42	36.73
Synthetic Fiber	6,358	9,083	42.86	36.73
Plastics	63,219	78,013	23.40	33.28
Plastic Goods	35,882	100,355	179.68	33.28
Other Chemical Products	165,676	285,667	72.42	27.39
Refined Petroleum Products	76,881	147,924	92.41	27.39
Non-metallic Mineral Products	45,232	78,737	74.07	73.90
Iron and Steel	145,704	338,456	132.29	68.88
Other Metal	156,371	241,793	54.63	43.00
Metal Products	40,928	58,393	42.67	57.25
Machinery	463,990	632,973	36.42	-5.55
Household Appliances	24,436	53,728	119.87	-17.97
Electronics Products	997,282	1,246,119	24.95	-32.26
Electrical Equip. & Appliances	130,560	449,157	244.02	-27.60
Transport Equipment	163,318	244,910	49.96	4.58
Other Mfg. Products	236,473	38,764	-83.61	-2.98
Total	4,275,630	6,372,769	49.05	14.88

Source: Directorate-General of Budget, Accounting and Statistics, Executive Yuan, R.O.C..

The Armington substitute elasticity parameters that we adopt for simulation are reported in Appendix B, which are estimated by the Center for Applied Economic Modeling, Chun-Yuan Christian University, Taiwan, R.O.C. The details of the estimation formula are also included in the Appendix B.

4.2 The simulation method

Three simulations are taken in sequence for the purposes of calibrating the change of preference (historical simulation), identifying the impacts of the preference change (decomposition simulation), and estimating the economic impacts of the trade liberalization policy (policy simulation). The results of the last simulation are compared with the results without the concern of the preference change.

A. Historical Simulation

By plugging the observable input-output and macroeconomic data into our CGE model, we are able to calibrate the change of unobservable variables, such as productivity change, preference change, and the autonomous change in different types of final demand. This process is called historical simulation. We adopt this process in our modified CGE model accommodated with the factor of preference change. The results are shown in section 5.

B. Decomposition Simulation

By plugging the calibrated preference changes into the model as exogenous shocks, we are able to estimate their impacts. The economic effects caused by them can then be identified. This process is called decomposition simulation.

C. Policy Simulation

In the last stage, we simulate the economic impacts of the tariff reduction Taiwan had pledged to take for the entry into WTO. The empirical results are compared with the ones without the consideration of the import preference change. The difference may reflect the possible bias.

4.3 The simulation results

4.3.1 The results of historical simulation

We first test the reliability of the model in presenting the performance of the Taiwanese economy by plugging in the data of different types of final demand, the input-output interactions and the income and expenditure structure of the households in 1999 and 2004. The simulated result of the 5-year accumulated real GDP growth rate is 18.96%, a little lower than the growth rate of 19.51% published by the government. The difference in average annual growth rate is 0.56%.[4] If we convert the growth rate into value, the simulated real GDP is NT$9,389 billions, close to NT$9,346 billions published by the government. The difference is only 0.46%.

[4] This simulation does not control the inventory changes, which may cause the discrepancy between our simulation and the published data.

The calibrated results of the preference change by product are reported in Table 4. Although the import prices kept rising during the sample period, the purchase of imported products didn't decrease. This scenario reflects that the domestic preference is inclined toward the imported products ($t < 0$). Among the 27 products, only 5 products (forest products, textiles, paper, paper products & printing, non-metallic mineral products, metal products) had a decrease in import preference.

Table 4 The calibration results of import preference change by product

Products	Total change of import preference (%)	Average annual change of import preference[1] (%)
Agriculture and Animal Husbandry	-61.94	-17.57
Forest Products	78.9	12.34
Fishing	-48.27	-12.35
Minerals	-94.68	-8.90
Food Processing	-9.25	-1.92
Beverage	-62.72	-17.91
Tobacco	-95.62	-8.90
Textiles	17.38	3.26
Apparel, Clothing Accessories	-27.97	-6.35
Wood and Wood Products	-3.71	-0.75
Papers, Paper Products & Printing	12.45	2.37
Chemical Products	-33.86	-7.94
Synthetic Fiber	-15.71	-3.36
Plastics	-14.11	-3.00
Plastic Goods	-48.98	-12.59
Other Chemical Products	-35.84	-8.49
Refined Petroleum Products	-11.78	-2.48
Non-metallic Mineral Products	26.78	4.86
Iron and Steel	-45.24	-11.35
Other Metal	-108.03	-15.45
Metal Products	15.79	2.98
Machinery	-96.94	-8.90
Household Appliances	-79.77	-27.36
Electronics Products	-96.48	-8.90
Electrical Equip. & Appliances	-100.12	-15.45
Transport Equipment	-50.57	-13.14
Other Mfg. Products	596.24[2]	-8.90[2]

Note：1. Average annual preference change $=100 \times 1 + \left[\left(\text{twist variable t}/_{100}\right)^{1/5} - 1\right]$

2. The import preference change of the other manufacturing products is extraordinarily high. It might be caused by some trade disputes in the early period, which was resolved later on. To avoid overestimation, we use the average import preference change to replace the original

4.3.2 The results of decomposition simulation

We decompose the factors that impacted the economic growth into five aspects. They are the increase in total factor productivity (TFP), the growth of autonomous final demand, the change in exchange rate and import price, the change of import preference and the change of wage. The results are shown in Table 6.

Among the five aspects, the increase in total factor productivity (TFP effect) contributes the most to the economic growth. The decrease of wage also bestows the economy the momentum of growth, while the increase in autonomous final demand helps in a smaller scale.

On the other hand, the increase of import price, either from the depreciation of exchange rate or the increase in international price, brings negative impact on the Taiwan economy. The preference change toward imported goods also mitigates the economic growth. It is not only bad for the real income growth (-9.60%) but also has an adverse effect on real consumption (-8.62%) and investment growth (-9.06%). Yet it helps the export growth. This may reflect the close interaction between Taiwan's exports and imports as well as the increase of import contents in its exports.

By summing up the five independent results horizontally, the total effects of real consumption (C), investment (I), government expenditure (G), and net import (X-M) can be concluded as the overall growth effect of real GDP.

Table 5 The results of the decomposition simulation

Variable	TFP Effect	Final Demand Effect	Exchange Rate & Import Price	Import Preference Effect	Wage Effect	Total Effect
Real GDP	27.01	4.56	-12.50	-9.60	10.05	19.51
Real Consumption	14.03	22.03	-13.59	-8.62	2.05	15.90
Real Investment	25.83	-6.23	-11.92	-9.06	9.62	8.25
Real Export	48.82	-12.58	-17.57	11.63	22.57	52.87
Government Expenditure	0.00	3.36	0.00	0.00	0.00	3.36
Real Import	25.26	3.45	-15.34	12.35	9.81	35.53

4.3.3 The result of policy simulation

In this section, we adopt the data of tariff reduction from Lin et al. (2003) as policy shocks to conduct the simulation of the trade policy. The long-run and short-run scenarios are set to test the effects of the policy in the two different conditions. The results are then compared with the ones without import preference change.

Table 7 The average tariff rates by product

products	Tariff rate before WTO entry (1)	Target Tariff (2)	Tariff Reduction (2)-(1)	Power of Tariff change (%) (3)*
Agricultural Products	12.48	11.18	-1.30	-1.16
Mining Products	3.24	2.92	-0.32	-0.31
Fundamental Industry Products	4.90	3.87	-1.03	-0.98
Technology Intensive Products	6.04	4.48	-1.56	-1.47
Traditional Industry Products	9.97	8.45	-1.52	-1.38

Source: Lin et al. (2003)

* Power of Tariff change = $\left(\frac{(1+\text{Target Tariff}/100)}{(1+\text{Tariff befor WTO}/100)}-1\right)*100$

As shown in Table 8, tariff reduction diminishes the price of the imported products. Though the cost of the imported inputs becomes lowered and may thus benefit the domestic production, the substitution effect may be harmful. In the case of not considering import preference change, no matter in the long run or the short run, the positive effect excels in all different items of real final demand. But when we take into account the import preference change, tariff reduction may induce negative effect on real consumption and government purchase. On the other hand, under the short-run condition of fixed capital capacity and wage rigidity, the effects of tariff reduction are smaller in magnitude than those in the long run, either in positive or negative term.

Table 8 The results of policy simulation

	Short-Run		Long-Run	
	Without Import Preference Change	With Import Preference Change	Without Import Preference Change	With Import Preference Change
Real GDP	0.18	0.01	0.21	0.02
Real Import Volume	0.55	2.36	0.68	2.53
Real Investment	0.18	0.01	0.21	0.02
Real Consumption	0.38	-0.11	0.43	-0.12
Real Export	0.22	2.43	0.29	2.61
Government Expenditure	0.38	-0.11	0.43	-0.12

D. Conclusion

In the recent years, the share of imports in Taiwan's domestic consumption and manufacturing intermediate inputs continues to rise. This phenomenon may be due to the global trend of production outsourcing and the increase of product variety. But most of the macroeconomic models did not consider the change of import preference in their import demand function and therefore may generate biased empirical results. To overcome the shortcomings, this study adds the factor of preference change into the analysis of trade policy.

By establishing a single country Computable General Equilibrium (CGE) model including the import preference factor, we first calibrate the change of import preference. The calibration results show that, among the 27 products, only 5 products show import preference decrease. All others reveal an increase in import preference. We also find that the overall import preference change mitigates the momentum of economic growth. Under the short-run condition of fixed capital capacity and wage rigidity, the overall preference change reduces the rate of economic growth to 0.17%, and under the long run condition to 0.19%. These results reflect the fact the empirical results of trade liberalization without considering the preference change might be too optimistic.

Appendix A: The Main Structure and Equations of the CGE Model

1. **Substitution between Domestic and Imported Products**[5]

(a) $$X_{(is)}^{(u)} = X_{(i.)}^{(u)} \Psi_{(is)}^{(u)} (P_{(i1)}^{(u)}; P_{(i2)}^{(u)})$$

(b) $$x_{(is)}^{(u)} = x_{(i.)}^{(u)} - \sigma_i^{(u)} \left[p_{(is)}^{(u)} - \sum_{t=1,2} \{V(i,t,(u))/V(i,.,(u))\} p_{(it)}^{(u)} \right],$$

$i = 1,...,g; \quad s = 1,2; \quad (u) = (3),(4)$ and $(kj); \quad k = 1,2 \quad j = 1,...,h$

$X_{(is)}^{(u)}$ is the demand of commodity and factor by user (u), $X_{(i.)}^{(u)}$ is the demand of composite commodities and composite factor by user (u). $\Psi_{(is)}^{(u)}$ is a function based on the assumptions of cost minimization, revenue maximization of classical school. The combination of input demands is CES function. By contrast, the combination of output supply is CET function. $P_{(is)}^{(u)}$ is purchasers' price for commodity and factor by user (u).

2. **Substitution between Labor and Capital**

(a) $$X_{(g+1,s)}^{(1j)} \Big/ A_{(g+1,s)}^{(1j)} = X_{(g+1.)}^{(1j)} \Psi_{(g+1,s)}^{(1j)} (P_{(g+1,1)}^{(1j)} \Big/ A_{(g+1,1)}^{(1j)}; P_{(g+1,2)}^{(1j)} \Big/ A_{(g+1,2)}^{(1j)})$$

(b) $$x_{(g+1,s)}^{(1j)} - a_{(g+1,s)}^{(1j)} = x_{(g+1.)}^{(1j)} - \sigma_{g+1}^{(1j)} \Big(p_{(g+1,s)}^{(1j)} - a_{(g+1,s)}^{(1j)}$$

$$- \sum_{t=1,2} \{V(g+1,t,(1j))/V(g+1,.,(1j))\} (p_{(g+1,t)}^{(1j)} - a_{(g+1,t)}^{(1j)}) \Big),$$

$j = 1,...,h; \quad s = 1,2;$

$X_{(g+1,s)}^{(1j)}$ is demand of capital in industry j, and $A_{(g+1,s)}^{(1j)}$ is total factor productivity in industry j.

3. **Household Demands for Composite Commodities**

(a) $$P_{(i.)}^{(3)} X_{(i.)}^{(3)} = \gamma_i P_{(i.)}^{(3)} Q + \beta_i \left(C - \sum_{j \in G} \gamma_j P_{(i.)}^{(3)} Q \right)$$

(b) $$V(i,.,(3))(p_{(i.)}^{(3)} + x_{(i.)}^{(3)}) = \gamma_i P_{(i.)}^{(3)} Q (p_{(i.)}^{(3)} + q)$$

[5] Equation (a): indicates level form, Equation (b): indicates percentage form

$$+\beta_i\left(C_C-\sum_{j\in G}\gamma_j P^{(3)}_{(i.)}Q(p^{(3)}_{(i.)}+q)\right),\quad i=1,...,g$$

$P^{(3)}_{(i\cdot)}$ is purchasers' price for commodities i. $X^{(3)}_{(i\cdot)}$ is household demand of commodity i. γ_i is a parameter which belong to basic demand in linear expenditure system(*LES*). β_i is a parameter that is marginal share of budget in linear expenditure system(*LES*). *C* is total consumption expenditure. Q is the number of household.

4. **Prices of Commodities to Households**

(a) $P^{(3)}_{(i.)}X^{(3)}_{(i.)}=\sum_{t=1,2}P^{(3)}_{(it)}X^{(3)}_{(it)}$

(b) $p^{(3)}_{(i.)}=\sum_{t=1,2}\{V(i,t,(3))/V(i,.,(3))\}p^{(3)}_{(it)}\ ;\qquad i=1,...,g$

5. **Intermediate and Investment Demands for Composites, Commodities and Primary Factors**

(a) $X^{(u)}_{(i.)}=Z^{(u)}A^{(u)}_i$

(b) $x^{(u)}_{(i.)}=z^{(u)}$

$(u)=(3),(4)\text{ and }(kj);k=1,2\qquad j=1,...,h$

$\text{if}\,(u)=(1j)\ \text{ then }\ i=1,...,g+1;\quad \text{if}\,(u)=(2j)\ \text{ then }\ i=1,...,g$

$Z^{(u)}$ is real output(k=1) and real investment(k=2) in industry j. $A^{(u)}_i$ is parameter of technology or preference for commodity i by user u.

6. **Foreign Demands (Exports) for Domestic Goods**

(a) $P^{(4)}_{(i1)}E=F^{(4)}_{(i1)}(X^{(4)}_{(i1)})^{-1/\eta_i}$

(b) $p^{(4)}_{(i1)}+e=f^{(4)}_{(i1)}-(1/\eta_i)x^{(4)}_{(i1)}\ ,\ i=1,...,g$

$F^{(4)}_{(i1)}$ is the shift of factor demand in foreign. η_i is foreign demand elasticity of domestic commodity. *E* is nominal exchange rate (foreign currency/ domestic currency).

7. **Margins Demands for Domestic Goods**

(a) $X_{(\gamma 1)}^{(is)(u)} = X_{(is)}^{(u)} A_{(\gamma 1)}^{(is)(u)}$ ， $r, i = 1,..., g$

$(u) = (3), (4)$ and (kj) ， $k = 1,2$， $j = 1,..., h$

(b) $x_{(\gamma 1)}^{(is)(u)} = x_{(is)}^{(u)}$ if $(u) = (4)$ ， then $s = 1$

if $(u) \neq (4)$ ， then $s = 1,2$

$X_{(\gamma 1)}^{(is)(u)}$ is demand of transportation service $A_{(\gamma 1)}^{(is)(u)}$ is a parameter, a share for the use of margin which purchasing per unit of good..

8. **Composition of Output by Industries**

(a) $X_{(i1)}^{(0j)} = Z^{(1j)} \Psi_{(i1)}^{(0j)} (P_{(11)}^{(0)}, P_{(21)}^{(0)},..., P_{(g1)}^{(0)})$

(b) $x_{(i1)}^{(0j)} = z^{(1j)} + \sigma^{(0j)} [p_{(i1)}^{(0)} - \sum_{t \in G} \{Y(t, j) / Y(\cdot, j)\} p_{(t1)}^{(0)}]$ ，

$j = 1,..., h$ ， $i = 1,..., g$

$X_{(i1)}^{(oj)}$ is real output of commodity i in industry j. $Z^{(1j)}$ is real output (k=1) in industry j.

9. **Demand Equals Supply for Domestic Commodities**

(a) $\sum_{j \in H} X_{(t1)}^{(0j)} = \sum_{(u) \in U} X_{(t1)}^{(u)} + \sum_{i \in G} \sum_{s=1,2} \sum_{(u) \in U^*} X_{(t1)}^{(is)(u)} + \sum_{i \in G} X_{(t1)}^{(i1)(4)}$

(b) $\sum_{j \in H} Y(t, j) x_{(t1)}^{(0j)} = \sum_{(u) \in U} B(t,1,(u)) x_{(t1)}^{(u)} + \sum_{i \in G} \sum_{s=1,2} \sum_{(u) \in U^*} M(t, i, s, (u)) x_{(t1)}^{(is)(u)}$
$+ \sum_{i \in G} M(t, i,1,(4)) x_{(t1)}^{(i1)(4)}$ ， $t = 1,..., g$

10. **Industry Revenue Equals Industry Costs**

(a) $\sum_{t \in G} X_{(t1)}^{(0j)} P_{(t1)}^{(0)} = \sum_{t \in G^*} \sum_{s=1,2} X_{(ts)}^{(1j)} P_{(ts)}^{(1j)}$

(b) $\sum_{t \in G} Y(t, j) p_{(t1)}^{(0)} = \sum_{t \in G^*} \sum_{s=1,2} V(t, s, (1j)) p_{(ts)}^{(1j)}$ ， $j = 1,..., h$

11. **Basic Price of Imported Commodities**

(a) $P_{(i2)}^{(0)} = (P_{(i2)}^{(0)} / E) T_{(i2)}^{(0)}$

(b) $p_{(i2)}^{(0)} = p_{(i2)}^{(0)} - e + t_{(i2)}^{(0)}$ ， $i = 1,...,g$

$P_{(i2)}^{(o)}$ is basic price of imported commodity (s=2). $T_{(i2)}^{(o)}$ is the rate of make-up tariff from commodity i (Rate of make-up tariff= 1+ imported tariff rate).

12. **Purchasers' Price Related to Basic Prices and Taxes**

(a) $P_{(is)}^{(u)} = P_{(is)}^{(0)} T(i,s,(u)) + \sum_{\gamma \in G} P_{(\gamma 1)}^{(0)} A_{(\gamma 1)}^{(is)(u)}$

(b) $V(i,s,(u)) p_{(is)}^{(u)} = (B(i,s,(u)) + T(i,s,(u)))(p_{(is)}^{(0)} + t(i,s,(u)))$

$$+ \sum_{\gamma \in G} M(\gamma,i,s,(u)) p_{(\gamma 1)}^{(0)}$$

$i = 1,...,g$ ； g ； $(u) = (3),(4),(kj)$ ，

$k = 1,2$ ， $j = 1,...,h$

if $(u) = (4)$ ，then $s = 1$ ；if $(u) \neq (4)$ ，then $s = 1,2$

$P_{(is)}^{(u)}$ is price of commodity from source by user. $P_{(is)}^{(o)}$ is the basic domestic (s=1) and imported (s=2).price of commodity. $T(i,s,(u))$ is the tariff rate of commodity is paid by user.

13. **Investment Behavior**

(a) $X_{(g+1,2)}^{(1j)}(1) / X_{(g+1,2)}^{(1j)} = F_k F_k^{(j)} [1 + (P_{(g+1,2)}^{(1j)} / P_k^{(1j)}) - \delta_j]^{\alpha_j}$

(b) $x_{(g+1,2)}^{(ij)}(1) - x_{(g+1,2)}^{(1j)} = f_k + f_k^{(j)}$

$$+ \alpha_j [P_{(g+1,2)}^{(1j)} + (1 - \delta_j) P_k^{(1j)})](p_{(g+1,2)}^{(1j)} - p_k^{(1j)})$$

$j = 1,...,h$

$X_{(g+1,2)}^{(1j)}(1)$ is capital stock in industry j in the end of period. $X_{(g+1,s)}^{(1j)}$ is capital stock in industry j in the beginning of period. F_k is the overall shifter in capital. $F_k^{(j)}$ is the shifter of capital in industry j. δ_j is the depreciation rate of capital in industry j. α_j is the sensitivity of rate of capital return to capital growth.

14. **Capital Accumulation**

(a) $X_{(g+1,2)}^{(1j)}(1) = X_{(g+1,2)}^{(1j)}(1-\delta_j) + Z^{(2j)}$

(b) $X_{(g+1,2)}^{(ij)}(1)x_{(g+1,2)}^{(1j)}(1) = X_{(g+1,2)}^{(1j)}(1-\delta_j)x_{(g+1,2)}^{(1j)} + Z^{(2j)}z^{(2j)}$,

$j = 1,...,h$

$X_{(g+1,2)}^{(1j)}(1)$ is capital stock in industry j in the end of period. $X_{(g+1,s)}^{(1j)}$ is capital stock in industry j in the beginning of period. δ_j is the depreciation rate of capital in industry j. $Z^{(2j)}$ is the real expenditure of investment (k=2) in industry j.

15. **Costs of Constructing Units of Capital for Industries**

(a) $P_k^{(1j)}Z^{(2j)} = \sum_{i\in G}\sum_{s=1,2} P_{(is)}^{(2j)}X_{(is)}^{(2j)}$

(b) $V(.,.,(2j))p_k^{(1j)} = \sum_{i\in G}\sum_{s=1,2} V(i,s,(2j))p_{(is)}^{(2j)}$, $j = 1,...,h$

$p_k^{(1j)}$ is the cost of constructing units of capital for industries.

16. **Wage Determination**

(a) $P_{(g+1,1)}^{(1j)} = (CPI)F_{(g+1,1)}^{(1j)}F_{(g+1,1)}$

(b) $p_{(g+1,1)}^{(1j)} = cpi + f_{(g+1,1)}^{(1j)} + f_{(g+1,1)}$; $j = 1,...,h$

$P_{(g+1,1)}^{(1j)}$ is the cost of labor in industry j in beginning of period. *CPI* is the Consumer Price Index. $F_{(g+1,2)}^{(1j)}$ is the shifting factor of wage in the industry. $F_{(g+1,1)}$ is the neutral shifting factor in wage.

17. **Consumer Price Index**

(a) $CPI = \prod_{i\in G}\prod_{s=1,2}(P_{(is)}^{(3)})^{\overline{V}(i,s,3)/\overline{V}(.,.,(3))}$

(b) $cpi = \sum_{i\in G}\sum_{s=1,2}\left(\overline{V}(i,s,3)/\overline{V}(.,.,(3))\right)p_{(is)}^{(3)}$

$p_{(is)}^{(3)}$ is the price of commodity purchased by household. $V(i,s,3)$ is the number of household in the transaction. *CPI* is a aggregation of different prices of commodities in household sector.

18. **Tax Rates on Sales to Households**

(a) $T(i,s,(3)) = T_b(i,.,(3))\, F_t(3)$

(b) $t(i,s,(3)) = t_b(i,.,(3)) + f_t(3) \quad , \quad i = 1,...,g \,, \quad j = 1,...,h$

$T(i,s,(3))$ is the tax on sales is to household. $T_b(i,\cdot,(3))$ is the tax rate of different commodities to household. $F_t(3)$ is the shifter of indirect tax.

19. **Ratio of Real Investment to Real Consumption**

(a) $I_R / C_R = FIC$

(b) $i_R / c_R = fic$

I_R is the Real Aggregate Expenditure of Investment. C_R is the Real Aggregate Expenditure of Consumption. *FIC* is the proportion of real investment to real expenditure of consumption.

20. **Balance of Payment in Industries**

(a). $VGOS = V1CAP\_I + V1OCT\_I + VROWGOS + VGOVGOS$

$$VGOSAV = VGOS - \sum_h VGOSHOU_{(h)} - VGOSGOV - VGOSTAX - VGOSROW$$

$$VGOSTAX = FGOSTAX \cdot VGOS$$

(b). $$VGOS \times wgos = V1CAP\_I \times w1cap\_i + V1LND\_I \times w1lnd\_i + VROWGOS \times wrowgos + VGOVGOS \times wgovgos$$

$$VGOSSAV \times wgossav = VGOS \times wgos - \sum_h VGOSHOU_{(h)} \times wgoshou_{(h)} - VGOSGOV \times wgosgov - VGOSTAX \times wgostax - VGOSROW \times wgosrow$$

$wgostax = fgostax + wgos$

Industrial Income:

Industry income (*VGOS*) is defined as the sum of industrial capital and land investment income (*V1CAP_I* and *V1LND_I*), transfer received from government (*VGOVGOS*) and from foreign (*VROWGOS*).

Industry expenditure and saving:

Industry expenditures includes dividends for investors (*VGOSHOU*), all transfer payment to government and foreign (*VGOSGOV* and *VGOSROW*), industry direct tax (*VGOSTAX*) and other expenses. The subtraction between income and expenditure are savings for the industry (*VGOSSAV*).

Industry Direct Tax:

Industry direct tax (*VGOSTAX*) is defined as the industry direct tax rate (*FGOSTAX*) multiplied by industrial income (*VGOS*).

21. **Balance of Payment in Households**

(a). $$VHOUSINC_{(h)} = VGOSHOU_{(h)} + V1LABINC\_O_{(h)} + \sum_{from} VHOUHOU_{(h,from)} + VGOVHOU_{(h)} + VROWHOU_{(h)}$$

$$VHOUSAV_{(h)} = VHOUSINC_{(h)} - V3TOT(h) - \sum_{to} VHOUHOU_{(to,h)} - VHOUGOV_{(h)} - VHOUROW_{(h)}$$

$$VHOUGOV_{(h)} = INCTAXRATE_{(h)} \cdot VHOUSINC_{(h)}$$

(b). $$VHOUSINC_{(h)} \times whousinc_{(h)} = VGOSHOU_{(h)} \times wgoshou_{(h)} + V1LABINC\_O_{(h)} \times w1labinc\_o_{(h)} + \sum_{from} VHOUHOU_{(h,from)} \times whouhou_{(h,from)} + VGOVHOU_{(h)} \times wgovhou_{(h)} + VROWHOU_{(h)} \times wrowhou_{(h)}$$

$$VHOUSAV_{(h)} \times whousav_{(h)} = VHOUSINC_{(h)} \times whousinc_{(h)} - V3TOT(h) \times w3tot(h) - \sum_{to} VHOUHOU_{(to,h)} \times whouhou_{(to,h)} - VHOUGOV_{(h)} \times whougov_{(h)} - VHOUROW_{(h)} \times whourow_{(h)}$$

$$whougov_{(h)} = whousinc_{(h)} + f\_inctaxrate_{(h)} + f\_inctaxrate\_h$$

Household income:

Household income (*VHOUSINC*) is the sum of transfer received from industry, government, and foreign (*VGOSHOU*, *VGOVHOU* and *VROWHOU*), labor income (*V1LABINC_O*), transfer inter-household (*VHOUHOU*) etc.

Household expenditure and saving:

Household expenditure includes household consumption expenditure (*V3TOT*, the total for the domestic and import goods with commodity tax and tariffs), transfer inter-household (*VHOUHOU*), direct tax (*VHOUGOV*) and transfer payment (*VHOUROW*). Household income minus household expenditure is equal to household savings (*VHOUSAV*).

Household direct tax:

Household direct tax (*VHOUGOV*) is set by household direct tax rate (*INCTAXRATE*) x household income (*VHOUSINC*).

22. **Balance of Payment in Government**

(a). $$VINCGOV = V0TAX\_CSI + VGOSGOV + VGOSTAX + \sum_h VHOUGOV_{(h)} + VROWGOV + V1OCT\_I$$

$$VGOVEXP = VGOVCUR + VGOVCAP$$

$$VGOVCUR = V5TOT + VGOVGOS + \sum_h VGOVHOU_{(h)} + VGOVROW$$

$$VGOVCAP = \sum_i GOVSHRINV_{(i)} \cdot V2TOT_{(i)}$$

(b). $$VINCGOV \times wincgov = V0TAX\_CSI \times w0tax\_csi + VGOSGOV \times vgosgov + VGOSTAX \times wgostax + \sum_h VHOUGOV_{(h)} \times whougov_{(h)} + VROWGOV \times wrowgov + V1OCT\_I \times w1oct\_i$$

$$VGOVEXP \times wgovexp = VGOVCUR \times wgovcur + VGOVCAP \times 2govcap$$

$$VGOVCUR \times wgovcur = V5TOT \times w5tot + VGOVGOS \times wgovgos + \sum_h VGOVHOU_{(h)} \times wgovhou_{(h)} + VGOVROW \times wgovrow$$

$$VGOVCAP \times wgovcap = \sum_i GOVSHRINV_{(i)} \cdot V2TOT_{(i)} \times w2tot_{(i)}$$

Government income:

Government income is the sum of indirect tax revenue (*V0TAX_CSI*), transfer received from industry and foreign (*VGOSGOV* and *ROWGOV*), industrial direct tax (*VGOSGOV*) , household direct tax (VHOUGOV) and other cost of industry (*V1OCT_I*).

Government expenditure:

Government expenditure are divided into recurrent expenditure (*VGOVCUR*) and fixed government investment (*VGOVCAP*).

Government recurrent expenditure:

Government expenditure includes government consumption (V5TOT) and all transfer payments (*VGOVGOS*, *VGOVHOU* and *VGOVROW*)

Government investment:

Government investment is a fixed proportion (GOVSHRINV) of all investments (V2TOT).

Appendix B: The estimation formula and the estimated parameters of Armington Substitute Elasticity by Industry

I. The estimated parameters of Armington Substitute Elasticity by Industry

Products	Armington Substitute Elasticity
Agriculture and Animal Husbandry	1.9
Forest Products	1.9
Fishing	1.9
Minerals	1.2
Food Processing	0.2
Beverage	0.8
Tobacco	1.9
Textiles	1.1
Apparel, Clothing Accessories	0.1
Wood and Wood Products	1.2
Papers, Paper Products & Printing	0.1
Chemical Products	1.2
Synthetic Fiber	1.2
Plastics	1.3
Plastic Goods	0.1
Other Chemical Products	0.1
Refined Petroleum Products	0.3
Non-metallic Mineral Products	0.3
Iron and Steel	0.8
Other Metal	0.6
Metal Products	0.2
Machinery	1.0
Household Appliances	1.1
Electronics Products	0.1
Electrical Equip. & Appliances	0.2
Transport Equipment	1.0
Other Mfg. Products	0.1

Source: The Center for Applied Economic Modeling, Chun-Yuan Christian University, Taiwan, R.O.C.

II. **The Estimation formula of Armington Substitution Elasticity of Taiwan**

We adopt the Armington substitution elasticity estimated by Center for Applied Economic Modeling, Chun-Yuan Christian University, R.O.C.

The theoretical model is as the following：

$$Q = \alpha[\beta M^{(\sigma-1/\sigma)} + (1-\beta)D^{(\sigma-1/\sigma)}]^{\sigma/\sigma-1} \quad (1)$$

σ is the substitution elasticity, M is import goods, D is domestic goods, and α and β are parameters.

We transform the theoretical model into the relative demand function ：

$$\log(\frac{M}{D}) = \sigma \log(\frac{\beta}{1-\beta}) + \sigma \log(\frac{P_D}{P_M}) \quad (2)$$

(2) can represented as the regression form：

$$y_t = b_0 + b_1 x_t + \varepsilon_t \quad (3)$$

$y_t = \log(\frac{M_t}{D_t}), x_t = \log(\frac{P_{Dt}}{P_{Mt}})$, ε_t is the error term, lower case t means the period, b_0 is constant, and b_1 is the substitute elasticity. Then, b_1 can be estimated by using OLS method to get the Armington substitute elasticity.

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