An Economy-wide Analysis of Impacts on Taiwan of Reducing Tariff Escalation on Agriculture-Related Products in WTO Doha Round Negotiations

Huey-Lin Lee

Assistant Professor, Dept. of Economics, National Chen-Chi University, Taipei, Taiwan, R.O.C. Email: hlee@nccu.edu.tw

Ching-Cheng Chang,

Research Fellow, Institute of Economics, Academia Sinica, and Professor, Department of Agricultural Economics, National Taiwan University, Taipei, Taiwan, R.O.C. Email: emily@econ.sinica.edu.tw

Yung-Ho Weng

Professor, Dept. of Economics, National Chen-Chi University, Taipei, Taiwan, R.O.C. Email: yweng@nccu.edu.tw

Sheng-Ming Hsu

Research Assistant, Department of Agricultural Economics, ,National Taiwan University, Taipei, Taiwan, R.O.C. E-mail: smhsu1978@ntu.edu.tw

Shih-Hsun Hsu

Professor, Department of Agricultural Economics, National Taiwan University, Taipei, Taiwan, R.O.C. E-mail: m577@ntu.edu.tw

Please send all the correspondences to the following address: Dr. Shih-Hsun Hsu, Department of Agricultural Economics, National Taiwan University, No. 1, Roosevelt Road, Section 4, Taipei, 106-17, Taiwan, R.O.C. E-mail: m577@ntu.edu.tw

An Economy-wide Analysis of Impacts on Taiwan of Reducing Tariff Escalation on Agriculture-Related Products in WTO Doha Round Negotiations

Abstract

Tariff escalation becomes one of the major issues in the new Doha Round negotiation because it is viewed as a stumbling block to the industrialization development for the developing countries. When tariffs on products escalate with the stage of processing, the effective rate of protection, or the tariff expressed as fractions of value-added after deducting intermediate inputs from product value, also increases. Thus, tariff escalation potentially signals high rates of protection for value-added or processed products, and can inhibit international trade in these goods. The major purpose of this study is to examine the degrees of tariff escalations in Taiwan's agriculture-related commodities and the economic consequences to reduce them. A simplified theoretical model is first established to illustrate the structural impacts and welfare implications of reducing tariff escalation. Then a computable general equilibrium (CGE) model of Taiwan is applied to simulate the economy-wide impacts of three alternative reduction proposals.. The model distinguishes 160 sectors, 6 types of labor, 8 types of margins and 160 commodities compiled from the Input-Output tables of 2004. Simulation results indicate that if welfare improvement is the major policy concern, then Taiwan should favor the reduction because it improves the overall welfare of Taiwan. However, if farmers' welfare is the major policy concern, then Taiwan should act against the reduction. In case the consensus to reduce tariff escalations has been determined, then the second-best choice would be to offer upstream industries relatively smaller tariff reduction rates than the downstream industries.

Keywords: tariff escalation, tariff wedge, computable general equilibrium model

JEL classifications: F13, C68, Q17

1. Introduction

Tariff escalation (tariff increases, or escalates, as a commodity becomes more processed) is a commonly adopted measure, especially by developed countries, to protect the processed agricultural products sector by taxing low on its inputs and high on the foreign equivalents. Returns to production factors of the processing sectors become larger than otherwise. In such case the effective rate of protection for the processing (or downstream) sector increases. This may distort patterns of production and trade.

Tariff escalation helps protect the processed foods sector of developed countries, but creates higher trade barrier for developing countries to export processed products to countries with tariff escalation. This hinders industrialization of developing countries and less developed countries that tend to export unprocessed agricultural products. As such, in WTO negotiations, developing and less developed countries have been asking industrialized countries to reduce tariff escalation.

Among theoretic analyses of tariff escalation, Corden (1966) first proposed the concept of “effective rate of protection (ERP)”, which takes into account not only nominal tariff rates but also changes in value-added of production. Tariff escalation tends to increase value-added of processed products production, which explains for its popularity in developed countries for protection. Weng and Liu (1998) proposed a theoretic model of competition between domestic and foreign firms to explain for the motivation of tariff escalation and the trade pattern of simultaneous imports and exports of raw materials and processed products. Wu and Hwang (2002) finds that the tariff on processed products is a possible motive for tariff escalation, in addition to the competition between domestic and foreign firms.

Lindland (1997), Elamin and Khaira (2004) and Swedish Board of Agriculture (2001) measure tariff escalation in the U.S., Canada, Japan, and European Union by calculating effective rate of protection (ERP) and tariff wedge from nominal tariff rates.

Their results show that tariff escalation is quite commonly for both industrialized and developing countries. This would hinder the growth of processed food sectors and the exports of developing countries. Elamin and Khaira (2004) also points out that ERP and tariff wedge does not help the understanding of change in welfare and trade induced by tariff escalation. It will be desirable to further measure the effect of tariff escalation on demands for products of different degree of processing

Most researches discusses about the incentive for tariff escalation and its measurement. Assessment of impact on individual sectors and macroeconomy from reducing tariff wedge between unprocessed and processed products is rarely seen in literature. Further, the tiered formula will be adopted in assessing market access barrier in the new round of WTO negotiations. This will possibly change current tariff wedge between unprocessed and processed products. A computable general equilibrium would be a good choice of analyzing tool in simulating the impact of reducing tariff escalation on the raw materials and processed products, and other related sectors.

In this paper, we attempt to analyze the impact on the Taiwan economy of reducing tariff escalation in agricultural products. In section 2, we set up a theoretic model for qualitative analysis of reducing tariff escalation. Further we use a computable general equilibrium (CGE) model of Taiwan to simulate the economy-wide impact of reducing tariff and also tariff wedge between agricultural products and processed foods. Section 3 is the introduction of the tariff data we used for simulations of reducing tariff escalation with a computable general equilibrium (CGE) model of Taiwan. We introduce in section 4 the Taiwan CGE model and the simulation design. Simulation results are reported and analyzed in section 5. Section 6 concludes this paper.

2. Theoretical Analysis

A theoretical model is proposed to analyze the impact on the industry structure and social welfare of reducing the tariff wedge between the unprocessed and processed products. There are three linked markets in this model: (1) the market for raw materials

(output of upstream activity), (2) the market for processing service; and (3) the market for final products (output from downstream activity). Raw materials and final products are tradable, while processing service is not tradable. The processing sector converts raw materials (domestically produced and imported) with other domestic intermediate inputs and factors (non-tradable) into final products.

Figure 1 shows the demand and supply schedules of the three markets. P_R, P_P, P_F are the prices of raw materials, processing, and final products, respectively. Q_R, Q_P, Q_F are the quantities. The home country is assumed to be a price taker for the raw materials and final products. S_R and S_P are the supply curves of domestically produced raw materials and processing service, respectively. The positive slope indicated increasing marginal production cost. P_{WR} refers to the world price of raw materials. t_0 is the tariff rate per unit of imported raw materials. For simplicity, Leontief function for the production of final products is assumed with one unit of raw materials (domestically produced or imported) and one unit of domestic processing service would produce one unit of final products.

As shown in Figure 1, both domestically produced and imported raw material would be used to produce the final products if domestic demand for raw materials is greater than $0Q_2$. If the total demand for raw materials is $0Q_0$ units, first $0Q_2$ units are domestically produced and the remaining Q_2Q_0 units are imported. The price of imported raw materials is ($P_{WR} + t_0$). If domestic demand for raw materials is between Q4 and Q2, only domestically produced raw materials would be used for producing final products. In such a case, the price is between P_{WR} and ($P_{WR} + t_0$), and t_0 becomes a prohibitive tariff—no import nor export of raw materials. If domestic demand is less than $0Q_4$, only domestically produced raw materials would be used and the remaining be exported, at the price P_{WR}.

To sum up, for a small open economy with a tariff rate of t_0, the supply curve of raw materials is the curve of P_{WR}xfd. With the assumption of Leontief production for final products out of raw materials and processing service, the supply curve of domestically produced final products, at the tariff rate of t_0 for raw materials, is the curve of $ghuvbS_F^{t_0}$, which is the vertical summation of curve P_{WR}xfd and curve S_P. The demand curve for final products is D_F, world price is P_{WF}, with a unit tariff rate on imported final products of T_0. At the price of ($P_{WF} + T_0$), domestic demand for final products is ac, among which ab is supplied domestically, and bc is imported.

To supply ab units of final products, ed units of raw materials and ij units of processing service are needed, at the prices of ($P_{WR} + t_0$) and 0i, respectively. Domestic raw materials take ef units and imported takes the remaining fd units. Consumer surplus is the area of acy. Producer surplus for final products is the area of abvuhg, for processing service is the area of ij0, for raw materials is the area of ef0. Tariff revenue from imported final products is the area of bclk, from imported raw materials is the area of fdnm. Total domestic social welfare is the sum of domestic consumer surplus, producer surplus fro final products, processing service, and raw materials, and tariff revenue from imported final products and raw materials.

As the Doha Round of WTO negotiations indicates a progressive tariff reduction schedule so that higher tariff rates take bigger reduction and lower tariff rates take smaller cut. We attempt to impose different reduction in the tariff rates for the upstream and downstream products in analyzing the impact of reducing the tariff wedge on all sectors. Assume that the tariff rates for final products and raw materials reduce by ΔT and Δt ($\Delta T > \Delta t$), respectively, to T_1 and t_1. Curve $P_{WR}xf'd'$ shows the supply schedule of raw materials at the tariff rate of t_1, and curve $ghub'S_F^{t_1}$ shows the supply schedule of final products. If the demand curve of final products remains as schedule D_F, total domestic demand for final products is $a'c'$, with $a'b'$ from local producers, and $b'c'$ from overseas, at the import price of $P_{WF} + T_1$. To produce $a'b'$ units of final products, it needs $e'd'$ units of raw materials—with $e'f'$ units from local, and $f'd'$ units from overseas—and $i'j'$ units of processing service, at the prices of $P_{WR} + t_1$ and $0i'$, respectively. In terms of social welfare, consumer surplus is the area of $a'c'y$, producer surplus for final products is area $a'b'uhg$, for processing service area $i'j'0$, and for raw materials are $e'f'0$. Tariff revenue from imports of final products is area $b'c'l'k'$, and from imports of raw materials area $f'd'n'm'$.

As tariff rates for imported raw materials and final products reduce from t_0 and T_0 to t_1 and T_1, respectively, domestic demand for final products increases from ac to $a'c'$, imports increase from bc to $b'c'$, and domestic production reduces by $k'k$. Domestic production of raw materials reduces from ef units to $e'f'$ units, while imports change from fd to $f'd'$. Domestic processing service reduces from ij units to $i'j'$ units. In terms of social welfare, domestic consumer surplus increase by the area of $acc'a'$; producer surplus of final products changes from area $abvuhg$ to

$a'b'uhg$; producer surplus of processing service reduces by the area of $ijj'i'$; producer surplus of raw materials falls by the area of $eff'e'$. Tariff revenue from final products imports changes from the area of $bclk$ to $b'c'l'k'$; from raw materials changes from $fdnm$ to $f'd'n'm'$. It is uncertain if the impact of reducing tariff wedge on domestic social welfare is positive or negative, considering the ambiguity, as alluded to above, in the changes of consumer surplus, the producer surpluses for processing services, raw materials and final products, as well as the tariff revenues from imported final products and raw materials.

From the qualitative analysis above, we figure that it would need quantitative analysis to identify the impact of tariff wedge reduction on domestic sectors in terms of magnitude. This is because industry structure, inter-industry linkage, and tariff structure, differ from country to country. So we use an computable general equilibrium model of the Taiwan economy to simulate the impact of tariff wedge reduction for agriculture products and associated processed foods. We introduce in the next section the phenomenon of tariff escalation in the agricultural products and associates in Taiwan. Simulation design is introduced in section 4 and results are discussed in section 5.

3. Tariff Escalation in Taiwan's Agro-food Sector

To examine for tariff escalation in Taiwan's agricultural imports and related processed foods, we need to first classify the products according to the vertical linkage (i.e., upstream or downstream) relationship between products. We use the FAOSTAT classification system (FAO, 1994), as it is based on the input-output relationships between the pair of products, and it further identifies the degree (or stage) of processing.

There are two methods for measuring tariff escalation. One is nominal tariff escalation, and the other is effective rate of protection (ERP) as proposed by Corden (1966). Nominal tariff escalation refers to the difference (or wedge) in *ad valorem* tariff rates on the processed product and on its raw material. Nominal tariff escalation occurs if the tariff rate on the processed product is higher than that on its raw material; nominal tariff de-escalation in the opposite case. This method is easy to use as it needs only nominal tariff data, which is accessible. However, this method does not apply so well if the processed product has more than one input, or the same raw material is used by more than one processed product as input. Such nominal tariff wedge does not spell out the intensity of protection for the processed product, i.e., impact of the tariff structure on the value added of the processed product.

The effective rate of protection (ERP) measures the intensity of protection for a product by comparing unit value-added in presence of tariffs and under free trade. The ERP method is not limited to the one-to-one input-output relationship. The processed product is protected if its ERP is positive; it is de facto taxed if its ERP is negative. However, it requires accurate data on prices and input-output coefficients. Such data are not easy to access. Considering data availability, we adopt the nominal tariff escalation method in presenting the tariff escalation in Taiwan's processed food imports and associated inputs.

In Table 1 we show 30 pairs of processed-raw products of significance among the 1387 tariff lines of Taiwan's imported agricultural products. In column 1 of Table 1, the product name to the right of the dash (-) is the processed product, and to the left is the input. Column 4 shows the tariff wedge.

Among the 30 pairs of products, nearly three fifths of them are showing tariff escalation, around one fourth of them are showing tariff de-escalation, and the remaining are showing tariff parity (i.e., tariff on processed product equals to that on its input). The average tariff wedge of those pairs showing tariff escalation is about 11%, yet the average tariff wedge of the pairs showing tariff de-escalation is -127%. Table 1 indicates that tariff escalation is commonly seen, though not substantial, in the tariff structure of Taiwan's agricultural imports. Though there are only limited cases of tariff de-escalation, the magnitude of de-escalation is significant. Complicated reasons, such as lobbying and election, may involve in such tariff de-escalation.

Among the pairs showing substantial tariff escalation, beef (row 3), wheat (row 17), barley (row 19), oats (row 21), sweet corn (row 22), soy beans (row 26), and sugar cane (row 29) are minority products in Taiwan, so their tariff rates are low. Coffee beans (row 32), and cocoa (rows 33-34) are not produced in Taiwan, so they are free to enter the local markets. Rice (rows 23-24) is a politically sensitive product, so their tariff rates are tremendously high. The paddy rice – brown rice pair (row 23) is showing tariff de-escalation, which indicating politics under the protection for rice cultivation. Among other pairs showing substantial tariff de-escalation, raw milk (row 7), coconut (row 11), pineapple (row 13), and peanuts (row 28) are the products Taiwan is currently promoting, so they are highly protected by tariff rate quota (TRQ).

4. Model and Scenario Design

4.1 Model and Data

The Taiwan General Equilibrium Model (TAIGEM), with extension designed for

simulating issues related to WTO negotiations is used to simulate the effect of reducing tariff escalation of agro-food products on Taiwan's overall economy. The TAIGEM is the ORANI type model (Dixon et al, 1982), covering production, investment, private and government consumption, and exports, and assumes constant-returns-to-scale production technology, and perfect competition and market-clearing for all markets (intermediate inputs, final consumption, and factors). The TAIGEM-WTO model simulates the impact of changes in tariff rates on domestic production, demand for intermediate inputs and factors, final demands and other macro variables.

In the simulations of tariff wedge reduction, we allow labor market to reach equilibrium at the non-accelerating inflation rate of unemployment (NAIRU). We also assume constant production technology and total private consumption after the tariff wedge reduction, so as to observe the impact of changes only in tariff structure. The utility function specified in TAIGEM-WTO is the Klein-Rubin function, in which utility is proportional to total consumption. As we assume constant total private consumption (thus constant utility), real GDP could be used to measure the impact of tariff wedge reduction on social welfare.

The data base for TAIGEM-WTO is built from the 1999 Input-Output Accounts of Taiwan, which covers 160 sectors. Such disaggregated data base allows us to map the pairs of input-output products, so that we could identify the impact on the upstream and downstream sectors of tariff wedge reduction.

We map the 1387 tariff lines of Taiwan's to the 160 commodities of TAIGEM-WTO data base. For the tariff structure, we use the bound rate as submitted to WTO. For products that are protected by tariff rate quota (TRQ), we convert the specific tariff rate to ad valorem rate by the formula below.

$$AVE = \frac{SP}{(UV \times XR)} \times 100\%, \qquad (1)$$

where AVE is the ad valorem equivalent, SP is the specific tariff rate, XR is the exchange rate, UV is the unit value of imports. UV is calculated as import value divided by import volume. We use the data of UV calculated and submitted to WTO by the Taiwan WTO Center (TWTOC, 2004).

Table 2 lists the average bound rates of 9 agricultural (upstream) sectors and 15 related processed food (downstream) sectors in the TAIGEM-WTO data base. The average bound rates for the 9 agricultural (upstream) sectors are between 2% and 200%, among which the rate for 'paddy rice' is the highest and 'other common crops' is the

lowest. The average bound rates for the 15 processed food (downstream) sectors range from 1% to 393%, among which the rate for ‘processed rice’ is the highest and ‘animal feeds’ is the lowest.

4.2 Scenario Design

We set three scenarios of tariff reduction (see Table 3), which also reduces tariff wedge. The tariff reduction levels in each scenario are based on the tiered formula outlined in the draft modalities for agriculture proposed by the chairman of agricultural negotiations after Hong-Kong WTO Ministerial.

In scenario 1, tariff rates for upstream products will be reduced by 40%, and for downstream products 60%. In scenario 2, tariff rate reduction for upstream products is 30%, and for downstream products 50%. Although the tariff wedge in scenarios 1 and 2 are the same (20%), reductions in scenario 1 are 10% more than those in scenario 2. The purpose is to identify the effect of 10% more tariff reduction, for both upstream and downstream products, on Taiwan’s agriculture and overall economy.

In scenario 3, tariff rates of upstream products are reduced by 30% and downstream products 60%. Comparing scenarios 3 and 1, upstream products have 10% more tariff reduction, while downstream products remain with the same reduction rate. We could see the effect of tariff wedge reduction by reducing only tariff on upstream products by comparing the results of scenarios 3 and 1. Analogously we could identify the effect of tariff wedge reduction by reducing only tariff on downstream products by compare the results of scenarios 3 and 2.

5. Simulations Results

5.1 Impact on the Macroeconomy

Table 4 lists the effects of three scenarios on the macroeconomy of Taiwan. The three scenarios all have positive impact on employment, real GDP, total imports and exports and CPI falls. The results conform with the theoretic inference in section 2. Comparing the three sets of simulation results in terms of magnitude of impact, scenario 1 affects macroeconomic variables most while scenario 2 has least impact. This is because the tariff reductions in scenario 1 for both upstream and downstream products are the biggest. In scenario 1, more imports of upstream products, cheaper than before, enter domestic market, which reduces production costs of downstream product producer.

The tariff reduction for downstream products in scenario 1 affects CPI most, as the tariff reduction for upstream and downstream products are the biggest among the three scenarios. Analogously, the impact of scenario 3 on macroeconomic variables are bigger than that of scenario 2.

The magnitude of impact in scenario 1 outweighs that in scenario 2, as the reduction in tariff rates for both upstream and downstream products are 10% more. Scenario 3, which reduces more on the tariff from downstream products, has bigger effect, than scenario 2, on the macroeconomic variables as listed in Table 4. Noteworthy is that the impact of bigger tariff reduction for both upstream and downstream products (comparing scenarios 1 and 2) is bigger than that of reduction for only downstream products (comparing scenarios 2 and 3). The impact of scenario 3, compared with that of scenario 1, on macroeconomic variables is slightly smaller.

5.2 Impact on Domestic Production and Employment

Table 5 lists the effects of the three scenarios on agricultural and related processed food production and employment. The results show that all the three scenarios of tariff reduction have negative impact on employment and production. Scenario 2 has relatively smaller negative impact. Scenario 1, compared with scenario 3, gives bigger negative impact on production and employment of upstream products as tariff reduction for upstream products in scenario 1 is bigger. Nevertheless, the negative impact of scenario 1 on downstream products is smaller compared to that of scenario 3. This is because the bigger tariff reduction for upstream products in scenario 1 helps reduce the input costs of downstream product producer.

Among all sectors, upstream products like sugar cane (row 3), other special-purpose crops (row 4), and pig (row 8) are affected most in production and employment. Downstream products like flour (row 12), refined sugar (row 14), dairy products (row 19), frozen foods (row 17), canned foods (row 16), and tobacco (row 24)

are affected substantially. The magnitude of negative impact on production and employment of 10% more tariff reduction for both upstream and downstream products in scenario 1 is bigger than that in scenario 2. The same occurs to the 10% more tariff reduction for downstream products in scenario 3 than that in scenario 2. Comparing sectoral impact of scenarios 3 and 1—the same rate of tariff reduction for downstream products but 10% less tariff reduction for upstream products, most upstream products receive less negative impact while the negative impact on downstream products is bigger.

5.3 Impact on Agricultural Imports and Exports

Table 6 lists the effects of the three scenarios on imports and exports of the agricultural and related processed food sectors. All the three scenarios have bigger (in terms of magnitude) impact on imports and exports of downstream products than on those of upstream products. Sectoral imports are increased in all three scenarios, except 'other common crops' (row 2), 'pig' (row 8) in the upstream product category and 'animal feeds' (row 15) in the downstream product category. Exports are all increased in all three scenarios. Big increase in imports are 'Other horticultural crops' (row 7) and 'fruits' (row 5) in the upstream product category, and 'processed rice' (row 13), 'flour' (row 12), 'sugar' (row 14), 'canned foods' (row 16), 'non-alcohol drinks' (row 22), 'other foods' (row 21), and 'frozen foods' (row 17) in the downstream product category. Exports see big increases in 'other special-purpose crops' (row 4), 'other livestock' (row 9), and 'other common crops' (row 2) in the upstream product category, and 'flour' (row 12), 'tobacco' (row 24) and 'alcohol' (row 23) in the downstream product category.

By increasing 10% more of tariff reduction for both upstream and downstream products (i.e., comparing scenario 1 with scenario 2), the magnitude of impact, negative or positive, on imports and exports of the products is bigger. The same situation occurs in the case of increasing 10% more of tariff reduction for only downstream products

(i.e., comparing scenario 3 and scenario 2). On the other hand, imports of upstream products in scenario 3 increases less than those in scenario 1, but imports of downstream products increase more. For exports, the increase of upstream and downstream products is smaller in scenario 3.

5.4 Impact on Market Prices and Consumption

Table 7 lists the effects of the three scenarios on market prices of and demand for agricultural products and related processed foods. Except for ‘paddy rice’ (row 1), ‘sugar cane’ (row 3) and ‘pig’ (row 8), market prices of most upstream and downstream products fall and the magnitude for downstream products is bigger than that for upstream products. Market prices of ‘other special-purpose crops’ (row 4) and ‘fruits’ (row 5) fall more than others in the upstream product category. Market prices of ‘flour’ (row 12), ‘frozen foods’ (row 17) and ‘tobacco’ (row 24) fall substantially among the downstream products. Demands for these products are increased except for ‘paddy rice’ (row 1), ‘sugar cane’ (row 3) and ‘pig’ (row 8). ‘Other livestock’ (row 9) in the upstream product category, and ‘flour’ (row 12), ‘tobacco’ (row 24), ‘dairy products’ (row 10) and ‘refined sugar’ (row 14) in the downstream product category see more increase in demand than other products.

By comparing scenarios 1 and 2 (i.e., 10% more tariff reduction for all products), we can see that the increase in demands for and the price fall of both upstream and downstream products are bigger in magnitude. The same occurs to the change from scenario 2 to scenario 3 (i.e., 10% more tariff reduction for downstream products while upstream products remain with the same tariff reduction). Price fall and demand increase for all upstream and downstream products are smaller in magnitude in scenario 3 than in scenario 1 (i.e., tariff reduction for upstream products is 10% less while downstream products have the same tariff reduction).

6. Concluding Remarks

Tariff escalation is commonly seen in developed and developing countries to protect its food processing sectors in hope of increasing value-added of the processed products. Yet this could hinder industrialization of developing and less developed countries. As such, tariff escalation has become an important issue in WTO negotiations. In this paper we study the tariff escalation in agricultural and related processed food products. We also simulate for three scenarios with the TAIGEM-WTO computable general equilibrium model the economy-wide impact of reducing tariff wedge between agricultural and related processed food products.

The statistics shows that tariff escalation occurs in three fifths of the Taiwan's agricultural products, and the average tariff wedge between the upstream and downstream products is around 11%. Tariff de-escalation happens to a quarter of the agricultural products, and the average tariff wedge between upstream and downstream products is -127%.

We set up three scenarios of tariff reduction: (1) 40% reduction in tariff for upstream products and 60% reduction for downstream products; (2) 30% reduction for upstream product and 50% reduction for downstream products; (3) 30% reduction for upstream products and 60% reduction for downstream products. All the three scenarios have positive impact on employment, real GDP, total imports and exports, while CPI falls. Employment and production of all agricultural sectors fall. Imports, exports and domestic consumption of most agricultural products increase. Market prices of upstream and downstream products fall.

By comparing results of the three scenarios, aggregate employment, real GDP, aggregate imports and exports increase in the scenario that simultaneously increases the reduction in tariff for upstream and downstream products, and in the scenario that only increase the reduction in tariff for downstream products. The magnitude of increase in aggregate employment, real GDP, aggregate imports and exports is less in the scenario

that reduces only the tariff for upstream products.

Employment and output of all upstream and downstream sectors are negatively affected in the scenario that simultaneously increases the tariff reduction for upstream and downstream products and in the scenario that increases tariff reduction for downstream products. The magnitudes of impact on imports, exports, prices and consumption are bigger. On the other hand, employment and output of most upstream sectors would reduce less if tariff reduction only occurs for upstream products. The magnitudes of increase in imports, exports and consumption, and price fall are smaller. However, the negative impact on employment and output of downstream sectors is bigger. The magnitudes of increase in imports, exports, and demand and price fall will shrink.

Based on the simulation results, reduction in tariff wedge helps increase social welfare of Taiwan. However, some agricultural sectors would be negatively affected. Among the three scenarios for the CGE simulations, the scenario that reduces only the tariff reduction for upstream products is better for agricultural sectors than the other scenarios, which give negative impact of bigger magnitude on output and employment of agricultural sectors.

References

Corden, W.M., 1966, “The Structure of a Tariff System and the Effective Protection Rate,” *Journal of Policy Economy*, 74:221-237.

Dixon, P.B., B.R. Parmenter, J. Sutton and D.P. Vincent, 1982, *ORANI: A Multisectoral Model of the Australian Economy,* North-Holland.

Elamin, N. and H. Khaira, 2004, “Tariff Escalation in Agriculture Commodity Markets,” *Commodity Market Review 2003-2004*, FAO, 101-120.

Greenaway, D. and G. Reed, 1996, “The Rationality of Positive Tariff Escalation: A Weighted Net Social Benefit Approach,” Discussion paper, presented in the 1996 Western Economic Association Annual Conference, San Francisco.

Harrison, W.J. and K.R. Pearson, 1996, “Computing Solutions for Large General Equilibrium Models Using GEMPACK,” *Computational Economics*, 9: 83-127.

Klein, L.R. and H. Rubin, 1948, “A Constant-Utility Index of the Cost of Living,” *Review of Economic Studies*, 15:84-87.

Li, P.-C., S.-H. Hsu, C.-H. Huang and H.-H. Lin, 2003, "Baseline Forecasting for Greenhouse Gas Reductions in Taiwan: A Dynamic CGE Analysis," in: C.C. Chang, R. Mendelson, and D.G. Shaw (eds.), *Global Warming and the Asian Pacific*, Edward Elgar Publishing Ltd, 35-59.

Lindland, J, 1997, “The Impact of the Uruguay Round on Tariff Escalation in Agricultural Products,” *Food Policy*, 22:487-500.

Weng, Y.-H. and Liu, P.-C., 1998, Tariff Structure and Import Policy, Taiwan Economic Review, 26, p.1-18.

Wu, S.-C. and Hwang, H., 2002, Economic Analysis of the Theory for Tariff Escalation. Economic Papers, 30, p.409-441.

Table 1. Tariff wedges between agricultural and related processed products

Unit: %

	Products (1)	Tariff: upstream (2)	Tariff: downstream (3)	Tariff wedge (4)＝(3)－(2)
	Meats Product			
(1)	meat of bovine animals：carcasses － boneless	7.24	7.57	0.33
(2)	meat of bovine animals： boneless－ preparations	7.57	20.00	12.43
(3)	meat of swine：carcasses－hams	12.50	15.00	2.50
(4)	meat of fowls： cut in pieces－ preparations	20.00	20.00	0.00
	Milk Product			
(5)	milk－Butter	20.00	5.00	-15.00
	Vegetables & Fruit			
(6)	Tomato－Tomato jam	10.00	12.50	2.50
(7)	Olive－Virgin olive oil	10.00	0.00	-10.00
(8)	Coconut－Copra	120.00	0.00	-120.00
(9)	Copra－Crude coconut oil	0.00	0.00	0.00
(10)	Pineapples－ Preparations pineapples	173.00	15.00	-158.00
(11)	Orange－Orange juice	20.00	30.00	10.00
(12)	Fresh apples－Apple juice	20.00	30.00	10.00
	Rice Product			
(13)	Durum wheat－Wheat flour	6.50	20.00	13.50
(14)	Wheat flour－Spaghetti	20.00	21.00	1.00
(15)	Barley－Malt	1.00	7.50	6.50
(16)	Malt－Beer	7.50	0.00	-7.50
(17)	Oats－Oatmeal	2.00	17.00	15.00
(18)	Corn－ Meal of Corn	0.00	10.00	10.00
(19)	Paddy rice － Brown rice	783.97	326.83	-457.14
(20)	Brown rice －Milled rice	326.83	343.31	16.48
	Special Crops Product			
(21)	Soya beans－Soya bean oil	0.00	5.00	5.00
(22)	Peanut, in shell－Peanut, shelled	102.55	158.76	56.21
(23)	Peanut, shelled－ Peanut butter	158.76	25.00	-133.76
(24)	Sugar cane － cane sugar	10.00	143.00	133.00
(25)	cane sugar － Refined sugar	143.00	143.00	0.00
(26)	Refined sugar － Sugar confectionery	143.00	27.50	-115.50
(27)	Coffee, not roasted － Coffee, roasted	0.00	0.00	0.00
(28)	Cocoa beans － Cocoa powder	0.00	0.00	0.00
(29)	Cocoa powder － Chocolate	0.00	10.00	10.00
(30)	not boneless tobacco － Cigarette	13.00	27.00	14.00

Table 2. Bound rates for agricultural products in the TAIGEM-WTO data base

Unit: %

number	Name of Sector	induistry	Average Bound rate
1	Paddy Rice	**upstream** products	199.47
2	Other coarse grain crops	**upstream** products	2.52
3	Sugarcane	**upstream** products	8.00
4	Other Special Crops	**upstream** products	13.38
5	Fruits	**upstream** products	36.15
6	Vegetables	**upstream** products	30.44
7	Other Horticultural	**upstream** products	29.01
8	Hogs	**upstream** products	4.17
9	Other Poultry & Livestock	**upstream** products	12.15
18	Slaughtering & By-products	downstream products	10.80
19	Edible Oil & Fat By-Products	downstream products	14.54
20	Flour	downstream products	90.54
21	Rice	downstream products	392.91
22	Sugar	downstream products	79.15
23	Animal Feeds	downstream products	1.09
24	Canned Foods	downstream products	22.10
25	Frozen Foods	downstream products	24.53
27	Other Seasonings	downstream products	15.06
28	Dairy Products	downstream products	20.98
29	Suger confectionery & Bakery Products	downstream products	18.59
30	Other Foods	downstream products	26.78
31	Non-Alcoholic Beverages	downstream products	19.90
32	Alcoholic Beverages	downstream products	13.70
33	Tobacco	downstream products	16.85

Table 3. Simulation Scenarios

Scenarios	Processing stage	Reduction
Scenario 1	Upstream product	40%
	Downstream product	60%
Scenario 2	Upstream product	30%
	Downstream product	50%
Scenario 3	Upstream product	30%
	Downstream product	60%

Table 4. Impact on macroeconomic variables

Macroeconomic variables	Scenario 1	Scenario 2	Scenario 3
Aggregate employment	0.34	0.28	0.33
CPI	-0.85	-0.70	-0.83
Real GDP	0.22	0.18	0.21
Aggregate imports	0.55	0.46	0.54
Aggregate exports	0.94	0.78	0.92

Table 5. Impact on output and employment of agricultural sectors

	Sectors		Percentage change in output			Percentage change in employment		
			Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
upstream products	(1)	Paddy Rice	-0.42	-0.36	-0.44	-0.55	-0.47	-0.57
	(2)	Other coarse grain crops	-0.68	-0.54	-0.6	-0.93	-0.74	-0.82
	(3)	Sugarcane	-11.38	-9.49	-11.41	-14.16	-11.81	-14.19
	(4)	Other Special Crops	-2.13	-1.71	-1.93	-2.78	-2.23	-2.51
	(5)	Fruits	-1.44	-1.08	-1.08	-1.69	-1.27	-1.27
	(6)	Vegetables	-0.62	-0.48	-0.52	-0.81	-0.64	-0.69
	(7)	Other Horticultural	-1.05	-0.78	-0.76	-1.31	-0.97	-0.95
	(8)	Hogs	-0.93	-0.78	-0.95	-2.83	-2.38	-2.88
	(9)	Other Poultry & Livestock	-0.69	-0.57	-0.69	-1.39	-1.16	-1.39
downstream products	(10)	Slaughtering & By-products	-0.21	-0.18	-0.23	-0.43	-0.36	-0.45
	(11)	Edible Oil & Fat By- Products	-1.33	-1.13	-1.39	-3.47	-2.95	-3.64
	(12)	Flour	-12.18	-10.18	-12.27	-21.7	-18.14	-21.86
	(13)	Rice	-0.45	-0.38	-0.46	-1.03	-0.87	-1.06
	(14)	Sugar	-11.62	-9.7	-11.65	-7.28	-6.07	-7.3
	(15)	Animal Feeds	-0.4	-0.34	-0.43	-0.81	-0.69	-0.85
	(16)	Canned Foods	-3.23	-2.7	-3.26	-4.7	-3.93	-4.74
	(17)	Frozen Foods	-3.73	-3.12	-3.76	-6.49	-5.43	-6.55
	(18)	Other Seasonings	-1.43	-1.2	-1.46	-2.08	-1.75	-2.13
	(19)	Dairy Products	-4.07	-3.4	-4.09	-5.95	-4.97	-5.98
	(20)	Suger confectionery & Bakery Products	-1.11	-0.93	-1.13	-1.61	-1.35	-1.64
	(21)	Other Foods	-2.52	-2.11	-2.56	-3.19	-2.67	-3.24
	(22)	Non-Alcoholic Beverages	-0.54	-0.45	-0.54	-1.08	-0.9	-1.09
	(23)	Alcoholic Beverages	-1.7	-1.42	-1.71	-3.9	-3.26	-3.92
	(24)	Tobacco	-2.79	-2.33	-2.8	-6.57	-5.49	-6.6

Table 6. Impact on imports and exports of agricultural products

	Sectors		percentage change in imports			percentage change in exports		
			Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
upstream products	(1)	Paddy Rice	0.87	0.71	0.82	4.83	3.96	4.64
	(2)	Other coarse grain crops	-2.53	-2.12	-2.59	5.78	4.69	5.41
	(3)	Sugarcane	0	0	0	0	0	0
	(4)	Other Special Crops	1.53	1.17	1.21	6.7	5.45	6.29
	(5)	Fruits	8.23	6.11	6	3.96	3.2	3.65
	(6)	Vegetables	7.39	5.47	5.33	5.04	4.07	4.67
	(7)	Other Horticultural	8.31	6.16	6.01	5.16	4.1	4.57
	(8)	Hogs	-4.97	-4.41	-5.77	0	0	0
	(9)	Other Poultry & Livestock	2.79	2.11	2.14	6.32	5.2	6.1
downstream products	(10)	Slaughtering & By-products	9.02	7.52	9.03	8.57	7.09	8.41
	(11)	Edible Oil & Fat By- Products	7.9	6.63	8.03	11.42	9.34	10.9
	(12)	Flour	35.62	29.72	35.74	25.43	21.02	24.92
	(13)	Rice	107	89.19	107.08	6.87	5.66	6.67
	(14)	Sugar	33.41	27.85	33.43	1.11	0.88	0.97
	(15)	Animal Feeds	-0.84	-0.7	-0.83	9.76	7.97	9.28
	(16)	Canned Foods	15.93	13.28	15.96	7.42	6.14	7.3
	(17)	Frozen Foods	14.89	12.42	14.92	10.14	8.42	10.05
	(18)	Other Seasonings	9.25	7.72	9.28	6.47	5.35	6.35
	(19)	Dairy Products	9.74	8.12	9.76	10.37	8.6	10.25
	(20)	Suger confectionery & Bakery Products	10.48	8.74	10.51	10.04	8.33	9.92
	(21)	Other Foods	15.19	12.68	15.24	9.9	8.19	9.72
	(22)	Non-Alcoholic Beverages	15.38	12.82	15.4	9.07	7.53	8.99
	(23)	Alcoholic Beverages	8.16	6.81	8.19	14.39	11.97	14.31
	(24)	Tobacco	7.66	6.39	7.68	22.55	18.76	22.46

Table 7. Impact on prices of and demands for agricultural products

	Sectors		Percentage change in market price			Percentage change in demand		
			Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
upstream products	(1)	Paddy Rice	0	0	0	-0.34	-0.28	-0.34
	(2)	Other coarse grain crops	-1.17	-0.95	-1.09	0.04	0.03	0.03
	(3)	Sugarcane	0	0	0	-0.43	-0.35	-0.42
	(4)	Other Special Crops	-1.58	-1.27	-1.43	0.08	0.06	0.07
	(5)	Fruits	-1.57	-1.22	-1.31	0.08	0.06	0.05
	(6)	Vegetables	-1.08	-0.86	-0.96	0.03	0.02	0.02
	(7)	Other Horticultural	-1.3	-1.02	-1.11	0.05	0.04	0.03
	(8)	Hogs	0	0	0	-0.43	-0.35	-0.42
	(9)	Other Poultry & Livestock	-1.3	-1.06	-1.24	0.24	0.19	0.21
downstream products	(10)	Slaughtering & By-products	-1.4	-1.16	-1.38	0.31	0.26	0.31
	(11)	Edible Oil & Fat By- Products	-2.36	-1.94	-2.29	0.72	0.59	0.69
	(12)	Flour	-8.42	-7	-8.37	3.48	2.9	3.46
	(13)	Rice	-1.47	-1.21	-1.43	0.31	0.26	0.3
	(14)	Sugar	-3.25	-2.7	-3.23	1.13	0.94	1.12
	(15)	Animal Feeds	-1.27	-1.04	-1.22	0.27	0.22	0.25
	(16)	Canned Foods	-3.15	-2.62	-3.13	1.08	0.9	1.08
	(17)	Frozen Foods	-5.16	-4.3	-5.15	2	1.66	2
	(18)	Other Seasonings	-2.41	-2	-2.39	0.74	0.62	0.74
	(19)	Dairy Products	-3.3	-2.74	-3.28	1.52	1.27	1.52
	(20)	Suger confectionery & Bakery Products	-2.59	-2.15	-2.57	0.83	0.69	0.82
	(21)	Other Foods	-3.18	-2.64	-3.15	1.09	0.91	1.09
	(22)	Non-Alcoholic Beverages	-1.62	-1.35	-1.61	0.47	0.39	0.47
	(23)	Alcoholic Beverages	-2.94	-2.45	-2.93	1.2	1	1.2
	(24)	Tobacco	-4.28	-3.56	-4.27	1.77	1.47	1.77

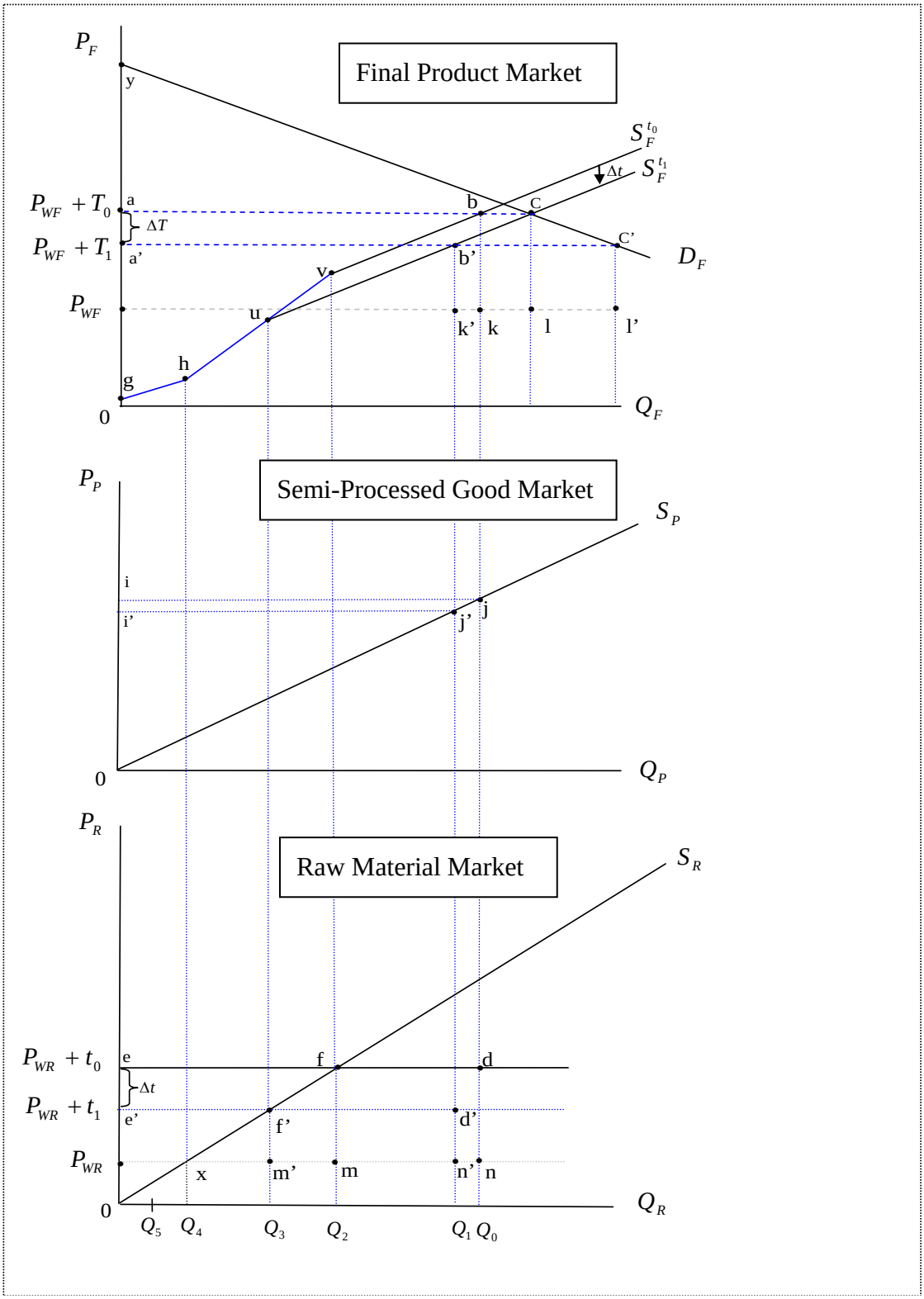

Figure 1. Demand and supply schedules of the three linked markets