Comparison of the Effects of Trade Liberalization under Different Market Structures

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Abstract

Using a static world CGE model, this paper compares welfare and output effects of trade liberalization of a perfectly competitive model and eight imperfectly competitive models in a unified framework. Our main finding is that welfare effects are generally robust to the model choice whereas output effects in some sectors drastically vary according to the model choice. Although there are a large number of CGE studies that try to analyze effects of trade liberalization on output, our analysis demonstrates that results derived from a specific model can be misleading.

1 Introduction

CGE models in trade policy analysis were initially based on perfect competition with constant returns to scale technology (CRTS). However, with the development of the new trade theory, many studies have adopted imperfectly competitive CGE models with increasing returns to scale technology (IRTS). Taking into account various types of imperfect competition and economies of scale, such studies quantitatively examine effects of trade liberalization initiated by GATT/WTO and FTAs, and provide useful information for policy making. However, they have one significant shortcoming: their choice of model is rather arbitrary.

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When the perfectly competitive model is used for CGE analysis, the structure of the model is fairly standardized. However, if we attempt to incorporate imperfect competition and economies of scale into CGE models, a number of alternative models arise and, as a result, a wide variety of models is used in research. These models differ in aspects such as, for example, the type of economies of scale, form of competition, market segmentation, and the assumptions on entry and exit. Since results of simulation can be altered according to assumptions about the model structure, it is desirable to use the most realistic model. However, there does not yet exist consensus on the existence of a realistic model. Thus, the second best solution is to show how results are altered according to the model choice.

Willenbockel (2004) is a study along this line. He endeavored to use a unified framework to examine how results from trade liberalization are altered by the assumptions about the model structure. Comparing welfare and output effects from a wide variety of models, he derived the following results. Welfare and output effects are generally remarkably robust to the choice of model. In addition, for a given demand nesting structure, the simulated responses to a trade policy shock are far more sensitive to the specification of substitution elasticity than to the choice of firm conduct specification. From these results, he concluded that it is more important to give careful consideration to the numerical specification choices at the calibration stage than to the choice of model.

His conclusion has been derived by examining a large variety of imperfectly competitive models and by conducting various sensitivity analyses of alternative calibration methods and parameter values. However, it is not appropriate to apply his results directly to a large scale CGE analysis actually used to evaluate trade policy. The reasons for this are as follows. First, models used in his analysis are extremely simplified. His CGE models incorporate only three regions, two goods, and one factor, and consider neither intermediate inputs nor investment. Second, his simulation is based on the imaginary data which does not reflect real economies. Finally, as a policy scenario, he considers the rise in tariff rate on one good in a region, which is the policy rarely analyzed in the realistic CGE analysis. Compared to the standard CGE analysis used for trade policy analysis, his analysis is very rudimentary in every aspect and we can say that he provides only a numerical example. This makes it difficult to apply his results to a large scale CGE analysis actually used to evaluate trade policy.

The purpose of this paper is to provide a comprehensive comparison of different imperfectly competitive models in a more realistic setting. The characteristics of our analysis are as follows. First, we use a more elaborate model. Our model is a world trade model with 13 sectors and 13 regions and incorporates not only final demand but also intermediate inputs. Compared to the model in Willenbockel, our model can capture real economies more closely in both structure and scale. Second, we use the GTAP data which are the standard dataset for multi-region CGE models. Third, we consider the more realistic trade policy than Willenbockel's, that is, we consider a multilateral liberalization and an FTA. These features mean that we compare various models under the similar setting to the standard CGE analysis.

Examining welfare and output effects from various models, we derived the following insights. First, welfare effects are generally robust to the choice of model. This means that Willenbockel's result on welfare effects is applicable also to the large scale realistic CGE analysis. Second, output effects in most sectors are not so different across models but they drastically vary in some sectors. In addition, we show that difference in welfare and output effects across models tends to be expanded when the values of elasticity of substitution and CDR are large and the value of the number of firms is small. These results imply that Willenbockel's result does not necessarily hold for output effects and that we should be cautious about the model choice in examining output effects in a large scale CGE analysis. Although there are a large number of studies that try to analyze effects of trade liberalization on output, our analysis demonstrates that results derived from a specific model are likely to be quite misleading. Dixon and Parmenter (1996) argued that the allocation effect analysis by CGE model successfully provides quite useful information but welfare analysis by CGE model is unsatisfactory. From their argument, we receive the impression that allocation analysis of CGE model is more reliable than welfare analysis. However, our analysis shows that welfare effect is less vulnerable to the model specification than output effect (allocation effect) and thus more reliable. This can be useful information for interpreting results from CGE analysis.

2 Model

In this section, we describe the structure of the model used in the simulations.[1] The model is a multisector and multiregion static general equilibrium model. In order to examine how the model specification affects the results of trade liberalization, we consider not only a model with CRTS technology and perfect competition (the perfectly competitive model) but also eight models with IRTS technology and imperfect compe-

[1]The models used in this paper are the same as those in Takeda (2006).

Table 1:

tition (the imperfectly competitive models). In the following, we only present the brief explanation of the models. For the details of the models, see the supplementary paper available from the author (Takeda, 2007).

2.1 The perfectly competitive model

As the perfectly competitive model, we use the simplified version of the GTAP standard model (Hertel, 1997).[2] Using intermediate inputs and four primary factors (capital, skilled labor, unskilled labor, and land), firms produce goods under CRTS technology to maximize profits. All markets of goods and factors are assumed to be perfectly competitive and thus all producers are price takers. The production function is a two-stage CES function. The input structure is as follows. First, primary factors are aggregated into a primary factor composite through a CES function with elasticity of σ_i^{PF}, and then primary factor composite and intermediate inputs are used to produce goods using a Leontief technology.

To represent the demand side, we assume a representative household for each region. As we do not consider government explicitly, final demand is the sum of private demand and government expenditure. Final demand is derived from the optimizing behavior of this representative household. The utility function for the household is a Cobb-Douglas function of consumption goods. The household income consists of factor income and tax revenues. Endowment of primary factors is assumed to be constant.

As with other CGE analysis, we use the Armington assumption to explain cross-hauling in trade (Armington, 1969). We aggregate domestic and imported goods through a two-stage CES function displayed in Figure 1 where σ_i^A represents the elasticity of substitution (EOS, hereafter) between domestic and imported goods (Armington elasticity) and σ_i^M is EOS between imports from different regions.

[2]Our model differs from the GTAP model in four main aspects. First, savings and investment are determined endogenously in the GTAP model, while they are exogenously constant at the benchmark level in our model. Second, the regional welfare (utility) in the GTAP model is determined through a Cobb-Douglas function of private demand, government expenditure, and savings, while we aggregate private demand and government expenditure into a single final demand and assume that utility is derived only from this final demand. Third, the GTAP model aggregates consumption through a CDE function, while our model aggregates it through a Cobb-Douglas function. Finally, the GTAP model assumes that the aggregation of domestic and imported goods (Armington aggregation) is conducted separately according to their uses, while our model assumes that Armington aggregation is conducted as a whole irrespective of their uses.

Figure 1:

Table 2:

2.2 Imperfectly competitive models

Next, we explain the imperfectly competitive models. In imperfectly competitive models, there are economies of scale and thus firms behave as price makers. However, even in the imperfectly competitive models, sectors AFF and MIN are assumed to be perfectly competitive sectors with CRTS technology. The assumption that AFF is a perfectly competitive sector is common in many CGE studies. The assumption that MIN is perfectly competitive is for a computational reason.[3]

Table 2 lists the models examined in the simulation. Model PC is a perfectly competitive model explained in the previous section. Model CD is a benchmark model of all imperfectly competitive models. Alternative imperfectly competitive models are derived from model CD by changing the assumptions. So, we first explain the structure of model CD in detail. In model CD, we make the following assumptions.

A1: Economies of scale arise from the existence of fixed costs.

A2: Varieties of different firms in a sector are assumed to be differentiated and aggregated using a CES function. Following this assumption, the variety aggregation stage is added to Armington structure (see Figure 1).

A3: Each firm behaves in a Cournot fashion, that is, each firm determines its output, taking the output of all other firms as fixed.

A4: Markets in different regions are segmented. Thus, firms can independently control output and prices in different regions.

A5: Free entry and exit are possible. This implies that the number of firms is endogenously determined so that the zero profit conditions are satisfied.

A1 is applied to all imperfectly competitive models, while A2-A5 are modified according to the different models. Model LGMC is the large group monopolistic competition model frequently used in theoretical analysis. In this model, it is assumed that each firm recognizes the number of firms as sufficiently large. As a result, model LGMC has

[3] When MIN is assumed to be imperfectly competitive, the model becomes significantly unstable and cannot be solved. To make the model stable, MIN is assumed to be perfectly competitive even in the imperfectly competitive model.

the following two features: (1) markup rate is kept constant (equal to the inverse of the elasticity of substitution), and (2) scale of each firm (total output of each firm) is kept constant. As these features seem to be somewhat unrealistic, the validity of this model may be questionable. However, this model is frequently used not only in theoretical analysis but also in CGE studies, and thus we decided to consider also this model.[4]

Model CH changes the assumption of product variety. It assumes that product varieties of different firms are perfect substitutes (homogeneous). In model CF, the assumption on entry is modified. It assumes that the number of firms is fixed at the benchmark level. Note that in our model, each firm produces one variety and thus the assumption of a fixed number of firms implies the fixed number of varieties.

Model QCV changes the assumption on conjectural variation. Model CD assumes Cournot conjecture, that is, each firm determines its output, taking the output of all other firms as fixed. On the other hand, in model QCV, each firm determines its output, taking the output of all other firms as variable. Although this non-Cournot conjecture model may rarely be used in theoretical analysis due to its complexity, it is often used in CGE analysis.[5] The Cournot competition model is the representative model in the imperfect competition models and is used in both theoretical and empirical analysis. However, this does not necessarily guarantee the actual validity of the Cournot competition model. Thus, it is of great importance to show how the assumptions on conjectural variation affect results.

Model BD is a Bertrand competition version of model CD, that is, it assumes that a firm's strategic variable is price and that each firm determines its prices, taking the prices of all other firms as fixed. As with the Cournot model, the Bertrand model is one of the most popular imperfectly competitive models and is used frequently in both theoretical and empirical works. However, because it is difficult to evaluate which model is the more realistic, we decided to consider the Bertrand model as well as the Cournot model.

Although all models listed so far assume segmented markets, there is another frequently used model: the integrated market model. In the integrated market model, where arbitrage trade across different regions is possible, firms cannot independently set output for markets in different regions and only control total output. Moreover, they cannot set different prices for different regions. Studies such as Markusen and

[4]For example, the following papers employ model LGMC: Francois et al. (1996), Francois and Roland-Holst (1997), and Francois et al. (2005).

[5]For example, the following studies adopt a non-Cournot conjectural variation models: Burniaux and Waelbroeck (1992), Melo and Tarr (1992, Chap.7), Harrison et al. (1996, 1997), Francois and Roland-Holst (1997), and Santis (2002a,b).

Venables (1988) show that the effects on trade policy can vary significantly, depending on whether the market is segmented or integrated. Thus, we attempt to consider integrated market models. Model IC is the integrated market version of model CD and model IB is the integrated market version of model BD.

3 Benchmark data and parameters

In this section, we describe the benchmark data and parameters for the simulation. As the benchmark data, we use GTAP version 6, whose benchmark year is 2001.[6] We aggregate the original GTAP data according to the sector and region classification in Table 1. Although the main content of liberalization is the removal of barriers to trade for goods, removal of barriers to services trade has developed into an important issue. However, we cannot analyze the effects of removal of services barriers using GTAP 6 data because it does not include services barriers. Thus, to analyze services barriers, it is necessary to create data for services barriers from other sources. For example, Brown et al. (2002) and Francois et al. (2005) have estimated services trade barriers. Although it is desirable to estimate services trade barriers from the actual data as these studies do, it is a quite difficult task. So we simply assume that tariffs of 30% are imposed on services trade at the benchmark equilibrium. This seems somewhat ad-hoc, but average tariff rates for services trade estimated in Brown et al. (2002, Table 4) are close to 30%. So, our assumption of 30% tariffs on services trade is not so unrealistic. In the simulation of liberalization conducted later, we consider removal of these services tariffs as well as removal of tariffs on goods trade.

Values of elasticity parameters are determined exogenously. We use GTAP 6 values for elasticity of substitution among primary factors (σ_i^{PF}). As to Armington elasticity (σ_i^A), we basically use GTAP 6 values. However, for sector FBT, TWA, OMF, and ELE, we use values derived by multiplying the original GTAP values by 0.8 for computational reasons.[7] As to elasticity of substitution among imports from different regions (σ_i^M), we assume $\sigma_i^M = 2 \times \sigma_i^A$, following the GTAP model. In addition to the two elasticities above, imperfectly competitive models include elasticity of substitution of varieties (σ_i^D and σ_i^F). For these two parameters, we assume $\sigma_i^D = \sigma_i^F = 2 \times \sigma_i^M$, following Harrison et al. (1996). The values of σ_i^{PF} and σ_i^A are reported in Table 1.

Imperfectly competitive models include parameters and variables that do not ap-

[6]For the details regarding the GTAP data, see the GTAP web site `http://www.gtap.agecon.purdue.edu/`.

[7]We use slightly smaller values because when using the original values we encountered computational difficulty in solving the model.

pear in the perfectly competitive model, such as fixed cost, the number of firms, markup rates, and elasticity of substitution of varieties. In addition to these parameters and variables, model QCV includes conjectural variation parameters. Among these parameters, elasticity parameters are determined exogenously as explained in the previous section. To conduct the simulation, it is necessary to determine the values of other parameters and variables. As results of the simulation are likely to be influenced by the approach for determining parameters and variables, it is desirable to choose the proper approach. However, there exists no standard method and different studies use different methods.[8] Here, we choose the approach we think the most appropriate for comparing various imperfectly competitive models in a comprehensive framework. The approach used for model CD is as follows: (1) first, we determine the benchmark number of firms exogenously, and (2) then, markup rates and fixed cost are calibrated so that the zero profit condition is satisfied at the benchmark equilibrium.

As the value for the benchmark number of firms in Step 1, we assume 20 for all regions and sectors.[9] Models CH, CF, IC, BD, and IB adopt the same approach for calibration as model CD. On the other hand, in model LGMC, markup rates become constant and it is not possible to apply the aforementioned approach. So, we use the approach where the number of firms is exogenously determined and the fixed cost is calibrated. The model QCV also cannot use the approach of model CD, because it includes conjectural variation parameters. In this case, following the approach of Harrison et al. (1996), we calibrate conjectural variation parameters and markup rates, given the number of firms and CDR.[10] As the value of the benchmark CDR, we assume 0.15 for all IRTS sectors.

4 Scenarios of trade liberalization

To compare various models, we consider two liberalization scenarios; (S1) global trade liberalization, and (S2) an FTA of ASEAN+3. S1 is the liberalization of the world as a whole. In this scenario, all regions in the world remove their tariffs. This is a benchmark scenario analyzed in many CGE studies and provides an upper bound of the world welfare effect of trade liberalization. On the other hand, S2 is an FTA of ASEAN+3 whose participants are the ASEAN regions plus China, Korea, and Japan.[11] We consider

[8]For example, Smith and Venables (1988), Harrison et al. (1996), Francois and Roland-Holst (1997), Grether and Müller (2000), Bchir et al. (2002), and Santis (2002b) adopt different methods for determining parameters and variables.

[9]In Section 5, we conduct the sensitivity analysis on the benchmark number of firms.

[10]CDR (cost disadvantage ratio) is defined as $(AC - MC)/AC$.

[11]Participants are IDN, MYS, PHL, SGP, THA, VNM, XSE, and CJK.

Table 3:

Table 4:

this scenario because we want to analyze an FTA as well as multilateral liberalization and because ASEAN+3 FTA is likely to be realized in the near future and have a strong impact in Asia.

Liberalization usually includes not only removal of trade barriers but also other components such as agreements on investment, labor movement, customs procedures, and rules of origin. In evaluating a particular trade liberalization process, these additional components may be important. However, our main aim is to demonstrate how the effects of liberalization can vary, depending on model structures, and not to evaluate a particular liberalization process. Thus, we decided to restrict the analysis to the removal of tariffs and export subsidies and not to consider other policies related to liberalization. Therefore, we only take into account a subset of policies included in actual liberalization. This means that the effects in our simulation are likely to be underestimated compared to those in actual liberalization.

5 Results of the simulation

In this section, we present results of the simulation. The simulation uses GAMS (General Algebraic Modeling System).[12] Although trade liberalization brings about various effects, we focus on effects on welfare and sectoral outputs following Willenbockel (2004). All other results of the simulation are available from the author upon request. In the following, we measure welfare and output effects by percentage change from benchmark values as most CGE analyses including Willenbockel's do.

First, let us examine welfare effects. Table 3 reports percentage change in welfare under S1 and S2. Column AVG and STD indicate average and standard deviation of welfare change and column M-M indicates the difference between maximum and minimum values of welfare change. The larger the size of M-M (or STD) is, the bigger the difference in welfare effects across models is. With respect to S1, the following results are observed. The size of welfare effects is generally small. In most regions, average of welfare increases is less than one percent. Due to the small size of welfare effects, their difference across models is also small. Except for MYS whose M-M exceeds four points, all regions have M-M of less than two points. It follows that the size of wel-

[12] All GAMS programs for the simulation are available from the author upon request.

Table 5:

Table 6:

fare effects from trade liberalization is not so affected by the model specification. This coincides with the result in Willenbockel (2004). In the case of S2, the size of welfare effects becomes much smaller and thus their difference across models is highly reduced compared to S1. According to these results, the conclusion of Willenbockel that welfare effects are generally remarkably robust to the choice of model is applicable also to our simulation which uses the more elaborate and realistic models, data, and scenarios.

Next, let us consider output effects (percentage change in sectoral outputs). Since the number of regions is 13 and each region has 13 sectors, the total number of sectors is 169 = 13 × 13. Thus, we have 169 output effects in total for each scenario. However, due to the limitation of space, it is difficult to report all output effects. So, we only report output effects of 20 sectors whose M-M values are large. For the values of output effects in other sectors, see the supplementary paper. Table 4 reports output effects of 20 sectors for S1 and S2. As to output effects, the following results are derived. First, as welfare effects, the difference in output effects across models is generally small. The number of sectors whose M-M exceeds 10 points is only 26.[13] It follows that the result of Willenbockel holds for output effects in most sectors. However, some sectors exhibit the large difference in output effects according to model type. Table 4 shows these sectors. For example, the value of M-M in sector OMF of SGP reaches 387 points. In addition, the values of M-M are dozens of points also in other sectors. In the case of S2, the difference across models becomes smaller, but the values of M-M in many sectors still exceed ten points. This indicates that Willenbockel's result cannot be applied to some sectors and that we should give attention to the choice of model in analyzing output effects.

To test robustness of the above results, we try to conduct three types of sensitivity tests: (SA1) value of elasticity of substitution, (SA2) the value of benchmark number of firms, and (SA3) the calibration method. In SA1, we increase values of Armington elasticity σ_i^A by 50% (this is denoted by case EOS).[14] In SA2, we change the benchmark number of firms. The base case assumes that the benchmark number of firms is 20. Here, we consider two other cases where the benchmark number of firms is 10 or 100 (denoted by Case n10 and n100 respectively). In SA3, we change the calibration method. In the base case, we calibrate CDR (fixed cost), given the benchmark number of firms.

[13]You can confirm this by the supplementary paper that reports all output effects.

[14]Since $\sigma_i^M = 2 \times \sigma_i^A$ and $\sigma_i^D = \sigma_i^F = 2 \times \sigma_i^M$, the values of σ_i^M, σ_i^D, and σ_i^F are also increased by 50%.

Here, changing the role of CDR and the number of firms, we calibrate the benchmark number of firms, given the benchmark value of CDR. As the exogenous value of CDR, we assume 0.15 or 0.2 (denoted by Case CDR15 and CDR20 respectively). In sensitivity analysis, we consider only scenario S1.

Welfare and output effects in sensitivity analysis are reported in Table 5 and 6 respectively. Blank cells in the tables indicate that the model cannot be solved in that case. First let us see welfare effects. The table shows that difference across models tends to be expanded in Case EOS, n10, and CDR20. This implies that welfare effects are likely to be strongly affected by the model choice when we assume the large value of EOS and CDR and the small value of the number of firms. However, even in such cases, the value of M-M in many regions is less than one point. Thus, the previous result that welfare effect is generally robust to the model choice is still valid in these cases. Next, let us see output effects by Table 6. To save space, Table 6 only provides 10 sectors whose M-M has the large value. The table shows that, compared to the base case, the difference across models tend to be expanded except for Case n100. In particular, in Case EOS, the maximum value of M-M reaches 1,586 points. This reinforces the previous result that output effects are likely to be strongly affected by the model choice. As these results show, quantitative results are significantly changed in some cases, but the following result are still valid in most cases: welfare effects are generally robust to the model choice whereas output effects in some sectors are strongly affected by the model choice. Thus, we can conclude that our results achieve robustness to some extent.

Finally, let us examine Willenbockel's proposition that the simulated responses to a trade policy shock are far more sensitive to the specification of substitution elasticity than to the choice of firm conduct specification. Case EOS in sensitivity analysis shows that the size of liberalization effects, in particular, output effects is drastically altered when values of EOS are changed. So, his proposition seems valid also in our simulation although it does not mean the model choice is of no significance as we showed in the previous paragraphs.

6 Concluding remarks

As a useful tool for policy evaluation, CGE analysis has been widely used in trade policy analysis. However, a wide variety of models is used in different studies and there does not yet exist consensus on which model is the most realistic model. Against this tide, Willenbockel (2004) attempted to show how assumptions on model structure influence the effects of trade policy. By comparing a wide variety of models, he derived the result that welfare and output effects are generally remarkably robust to the choice of model. Although his analysis provides useful information for policy analysis, the models, data, and scenarios used in his analysis are extremely simplified and thus it is difficult to apply his results to the realistic CGE analysis actually used for trade policy analysis.

To overcome this shortcoming, we attempted to compare various models in a more realistic setting and derived the following result. First, welfare effects are generally robust to the choice of model. This means that Willenbockel's result on welfare effects is applicable also to the large scale realistic CGE analysis. Second, output effects in most sectors are not so different across models but they drastically vary in some sectors. Thus, with respect to output effects, Willenbockel's result does not necessarily hold. This implies that we should be cautious about the model choice when we examine output effects in a large scale CGE analysis. Although there are a large number of studies that try to analyze effects of trade liberalization on output, our analysis demonstrates that results derived from a specific model are likely to be misleading.

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Table 1: Region and Sector list.

Region	Description	Sector	Description	σ^{A}_{i}	σ^{PF}_{i}
CJK	China, Japan, and Korea	AFF	Agriculture, forestry and fishery	2.42	0.23
IDN	Indonesia	MIN	Mining	5.75	0.20
MYS	Malaysia	FBT	Food, Beverages and Tabacco	1.99	1.12
PHL	Philippines	TWA	Textiles, Wearing Apparel, and Leather products	3.02	1.26
SGP	Singapore	WPP	Wood and Paper products	3.10	1.26
THA	Thailand	CHM	Chemical products	2.92	1.26
VNM	Vietnam	MET	Metal products	3.56	1.26
XSE	Rest of Southeast Asia	MVT	Motor vehicles and transport equipment	3.15	1.26
XAS	Rest of Asia	ELE	Electronic equipment	3.52	1.26
NAF	NAFTA	OME	Machinery and equipment nec	4.05	1.26
XCS	Central and Southern America	OMF	Manufactures nec	3.00	1.26
EUR	European countries and the former Soviet Union	TAT	Trade and transport	1.90	1.68
ROW	Rest of the world	OSE	Other services	1.95	1.28

Values of elasticity of substitution are taken from GTAP data (version 6).

* Values of FBT, TWA, ELE, and OMF are derived by multiplying original values by 0.8.

Table 2: Model type.

Mode name	Description
PC	Perfectly competitive model.
CD	Cournot model.
LGMC	Large group monopolistic competition model.
CH	Cournot model with homogeneous varieties.
CF	Cournot model with fixed number of firms.
QCV	Quantity competition model with non-Cournot conjectural variation.
BD	Bertrand model.
IC	Integrated market Cournot model.
IB	Integrated market Bertrand model.

Table 3: Welfare effects (percentage change in welfare).

Scenario	Region	PC	CD	LGMC	CH	CF	QCV	BD	IC	IB	AVG	STD	M-M
S1	CJK	0.8	0.8	0.9	0.8	0.8	0.9	0.9	1.0	0.9	0.9	0.1	0.2
	IDN	1.7	2.5	2.5	1.8	2.6	2.5	2.5	2.5	2.4	2.3	0.3	0.9
	MYS	12.1	15.9	16.4	12.3	15.8	14.8	16.4	16.2	16.1	15.1	1.7	4.3
	PHL	0.8	0.9	0.9	0.8	0.7	0.8	0.9	0.9	0.9	0.8	0.1	0.2
	SGP	7.0	8.8	8.7	7.2	7.2	8.5	8.7	8.5	8.7	8.1	0.8	1.8
	THA	3.9	3.8	4.3	3.7	3.8	3.5	4.3	4.1	4.2	4.0	0.3	0.8
	VNM	1.5	2.8	3.1	1.3	2.2	2.6	3.1	2.8	3.0	2.5	0.7	1.8
	XSE	0.2	-0.1	0.0	0.1	-0.4	-0.1	0.0	0.1	0.0	0.0	0.2	0.6
	XAS	0.5	0.6	0.8	0.5	0.4	0.6	0.8	0.8	0.8	0.6	0.2	0.4
	NAF	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.3	0.2	0.2	0.0	0.2
	XCS	0.8	0.4	0.6	0.7	0.3	0.4	0.6	0.7	0.6	0.6	0.2	0.5
	EUR	0.8	0.7	0.7	0.8	0.6	0.7	0.7	0.8	0.7	0.7	0.1	0.2
	ROW	0.4	0.3	0.5	0.3	0.2	0.2	0.5	0.6	0.5	0.4	0.2	0.4
	World	0.6	0.5	0.6	0.6	0.4	0.5	0.6	0.7	0.6	0.6	0.1	0.2
S2	CJK	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.0	0.1
	IDN	1.0	1.1	1.2	1.0	1.1	1.1	1.2	1.2	1.2	1.1	0.1	0.2
	MYS	7.3	9.1	9.6	7.1	8.7	9.1	9.6	9.5	9.5	8.8	1.0	2.6
	PHL	0.7	0.7	0.8	0.6	0.5	0.7	0.8	0.8	0.8	0.7	0.1	0.2
	SGP	3.7	4.3	4.0	3.8	4.3	4.3	4.1	3.9	4.0	4.0	0.2	0.6
	THA	3.3	3.5	3.9	3.2	3.3	3.2	3.9	3.8	3.8	3.5	0.3	0.8
	VNM	1.4	2.2	2.8	1.1	1.4	2.0	2.8	2.7	2.7	2.1	0.7	1.6
	XSE	0.1	-0.2	-0.1	0.0	-0.4	-0.2	-0.1	0.0	-0.1	-0.1	0.1	0.5
	XAS	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	0.0	0.0
	NAF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	XCS	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0
	EUR	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.0
	ROW	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	0.0
	World	0.1	0.0	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0

Table 4: Output effects (percentage change in sectoral output).

Scenario	Region	Sector	PC	CD	LGMC	CH	CF	QCV	BD	IC	IB	AVG	STD	M-M
S1	SGP	OMF	220	573	600	229	219	530	600	606	601	464	183	387
	VNM	TWA	126	246	238	130	121	237	239	238	239	202	57	125
	MYS	TWA	57	124	117	59	56	120	118	116	118	99	31	68
	MYS	FBT	63	122	121	67	61	112	121	120	120	101	28	61
	PHL	TWA	31	65	61	34	31	66	61	60	61	52	15	35
	IDN	TWA	31	61	56	35	31	63	56	55	56	49	13	32
	VNM	OME	4	-21	-20	3	3	-15	-20	-20	-20	-12	12	25
	VNM	ELE	-12	-33	-32	-13	-11	-32	-32	-32	-32	-26	10	22
	VNM	MET	-21	-41	-41	-22	-20	-40	-41	-41	-41	-34	10	21
	VNM	MVT	2	-18	-15	1	2	-18	-15	-16	-16	-10	9	21
	VNM	MIN	-15	-35	-35	-15	-15	-33	-35	-34	-35	-28	10	21
	SGP	FBT	29	41	40	30	27	42	40	40	40	37	6	14
	SGP	MVT	-19	-31	-33	-19	-19	-30	-33	-33	-33	-28	7	14
	SGP	OME	-1	-14	-15	-1	-1	-13	-15	-15	-15	-10	7	14
	SGP	MIN	-16	-28	-29	-17	-15	-25	-29	-29	-29	-24	6	14
	THA	OME	15	27	26	16	14	28	26	27	26	23	6	14
	MYS	WPP	21	33	35	22	22	33	35	35	34	30	6	13
	MYS	MVT	-10	-20	-18	-11	-7	-20	-19	-18	-18	-16	5	13
	CJK	TWA	26	35	35	28	24	35	35	37	35	32	5	13
	SGP	WPP	2	14	14	3	2	14	14	14	14	10	6	13
S2	VNM	TWA	45	83	86	45	42	76	86	87	86	71	20	45
	SGP	FBT	42	67	68	44	40	65	68	69	68	59	13	28
	PHL	MVT	22	38	39	24	23	36	39	39	38	33	7	17
	MYS	TWA	17	33	32	18	17	33	32	33	32	28	8	16
	VNM	OME	24	29	28	25	24	39	28	29	29	28	4	15
	VNM	MVT	-15	-27	-25	-15	-14	-28	-26	-26	-26	-22	6	14
	VNM	MIN	-3	-12	-13	-3	-4	-10	-13	-13	-13	-9	5	11
	MYS	FBT	16	26	26	17	16	25	26	26	26	23	5	10
	VNM	MET	-10	-18	-19	-10	-9	-16	-19	-19	-19	-16	5	10
	VNM	ELE	-5	-13	-14	-5	-4	-9	-14	-14	-14	-10	4	10
	MYS	MVT	-9	-16	-14	-9	-6	-16	-15	-14	-15	-13	4	10
	THA	OME	11	18	19	11	10	19	19	20	19	16	4	10
	MYS	OME	11	17	18	11	11	20	18	19	18	16	4	9
	MYS	WPP	17	25	26	18	17	25	26	26	26	23	4	9
	THA	ELE	8	15	14	8	7	16	14	14	14	12	3	9
	THA	TWA	-8	-14	-15	-9	-7	-14	-15	-15	-15	-12	3	7
	SGP	MVT	-11	-17	-18	-11	-10	-17	-18	-18	-18	-15	3	7
	THA	WPP	-8	-12	-13	-8	-8	-12	-13	-13	-13	-11	3	6
	THA	MVT	-10	-12	-13	-9	-7	-12	-13	-13	-13	-11	2	6
	THA	OMF	-5	-10	-11	-6	-6	-10	-11	-11	-11	-9	2	5

Table 5: Sensitivity analysis of welfare effects (percentage change in welfare)

Case	Region	PC	CD	LGMC	CH	CF	QCV	BD	IC	IB	AVG	STD	M-M
EOS	CJK	1.0	1.1	1.2	1.1	0.9	1.2	1.2	1.3	1.2	1.1	0.1	0.3
	IDN	1.9	2.5	2.4	2.1	2.7	2.6	2.4	2.4	2.4	2.4	0.2	0.8
	MYS	16.1	20.5	21.2	16.3	20.6	19.7	21.2	20.9	21.0	19.7	2.1	5.2
	PHL	1.2	1.0	1.1	1.1	0.8	0.9	1.1	1.0	1.1	1.0	0.1	0.4
	SGP	9.6	15.5	15.3	9.9	9.7	15.0	15.4	14.9	15.3	13.4	2.8	5.9
	THA	5.0	4.7	5.5	4.8	4.5	4.6	5.5	5.3	5.4	5.0	0.4	1.1
	VNM	3.3	4.7	5.1	3.0	3.6	4.3	5.1	4.8	5.0	4.3	0.8	2.1
	XSE	0.3	-0.1	0.1	0.2	-0.5	0.0	0.1	0.4	0.1	0.1	0.2	0.8
	XAS	1.0	1.1	1.4	1.0	0.7	1.3	1.4	1.5	1.3	1.2	0.3	0.8
	NAF	0.3	0.2	0.3	0.2	0.1	0.2	0.3	0.4	0.3	0.2	0.1	0.2
	XCS	1.1	0.6	0.9	0.9	0.5	0.7	0.9	1.0	0.9	0.8	0.2	0.6
	EUR	0.9	0.8	0.9	0.9	0.6	0.8	0.9	1.0	0.9	0.9	0.1	0.4
	ROW	0.6	0.5	0.9	0.5	0.3	0.6	0.9	1.0	0.8	0.7	0.2	0.6
	World	0.7	0.7	0.8	0.7	0.5	0.7	0.8	0.9	0.8	0.7	0.1	0.4
n10	CJK	0.8	0.8	0.9	0.8	0.6		0.9	1.1	0.9	0.9	0.1	0.5
	IDN	1.7	2.7	2.5	2.0	2.7		2.5	2.5	2.4	2.4	0.4	1.0
	MYS	12.1	16.0	16.4	12.6	15.8		16.3	16.3	16.1	15.2	1.8	4.3
	PHL	0.8	0.9	0.9	0.7	0.5		0.9	0.8	0.9	0.8	0.1	0.4
	SGP	7.0	8.9	8.7	7.3	7.3		8.7	8.0	8.7	8.1	0.8	1.9
	THA	3.9	3.5	4.3	3.6	3.1		4.3	4.0	4.2	3.9	0.4	1.2
	VNM	1.5	2.3	3.1	1.0	1.6		3.1	2.5	3.0	2.3	0.8	2.1
	XSE	0.2	-0.3	0.0	0.0	-0.8		0.0	0.3	0.0	-0.1	0.3	1.1
	XAS	0.5	0.5	0.8	0.4	0.1		0.8	1.0	0.8	0.6	0.3	0.8
	NAF	0.2	0.2	0.2	0.2	0.0		0.2	0.4	0.2	0.2	0.1	0.4
	XCS	0.8	0.3	0.6	0.6	0.0		0.6	0.9	0.6	0.5	0.3	0.8
	EUR	0.8	0.7	0.7	0.7	0.4		0.7	1.0	0.7	0.7	0.1	0.5
	ROW	0.4	0.1	0.5	0.2	-0.1		0.5	0.8	0.5	0.4	0.3	0.9
	World	0.6	0.5	0.6	0.5	0.3		0.6	0.8	0.6	0.6	0.1	0.5
n100	CJK	0.8	0.9	0.9	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.1	0.2
	IDN	1.7	2.4	2.5	1.7	2.5	2.5	2.5	2.4	2.4	2.3	0.3	0.8
	MYS	12.1	16.2	16.4	12.2	15.9	16.3	16.4	16.1	16.1	15.3	1.8	4.3
	PHL	0.8	0.9	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.1	0.2
	SGP	7.0	8.7	8.7	7.0	7.2	8.7	8.7	8.7	8.7	8.1	0.8	1.7
	THA	3.9	4.2	4.3	3.8	4.3	4.2	4.3	4.2	4.2	4.2	0.2	0.5
	VNM	1.5	3.1	3.1	1.5	2.7	3.0	3.1	3.0	3.0	2.7	0.7	1.6
	XSE	0.2	0.0	0.0	0.2	-0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.3
	XAS	0.5	0.7	0.8	0.5	0.7	0.8	0.8	0.8	0.8	0.7	0.1	0.3
	NAF	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.0
	XCS	0.8	0.6	0.6	0.8	0.6	0.6	0.6	0.6	0.6	0.6	0.1	0.2
	EUR	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7	0.7	0.7	0.0	0.1
	ROW	0.4	0.5	0.5	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.1	0.2
	World	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.0	0.1
CDR15	CJK	0.8	0.9	0.9	0.8	0.8	0.9	0.9	1.0	1.0	0.9	0.1	0.2
	IDN	1.7	2.5	2.5	2.1	2.5	2.5	2.4	2.6	2.3	2.3	0.3	0.9
	MYS	12.2	15.3	16.6	13.8	14.8	14.9	14.1	17.0	15.5	14.9	1.5	4.8
	PHL	0.7	0.9	0.9	1.0	0.8	0.9	0.9	1.0	0.9	0.9	0.1	0.3
	SGP	7.0	8.2	8.7	7.6	7.0	8.6	7.9	8.8	8.3	8.0	0.7	1.8
	THA	3.7	3.7	4.2	3.6	3.7	3.4	3.8	4.4	4.1	3.8	0.3	1.1
	VNM	1.5	3.2	3.1	2.2	3.1	2.5	3.1	3.4	3.2	2.8	0.6	1.9
	XSE	0.2	-0.1	0.0	0.0	-0.3	-0.1	-0.1	0.1	-0.1	0.0	0.1	0.4
	XAS	0.5	0.6	0.8	0.4	0.5	0.6	0.7	1.1	0.9	0.7	0.2	0.7
	NAF	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.0	0.1
	XCS	0.8	0.4	0.6	0.5	0.4	0.4	0.4	0.7	0.5	0.5	0.2	0.5
	EUR	0.8	0.7	0.7	0.7	0.6	0.7	0.7	0.8	0.7	0.7	0.1	0.2
	ROW	0.4	0.3	0.5	0.1	0.2	0.2	0.3	0.7	0.6	0.4	0.2	0.6
	World	0.6	0.5	0.6	0.5	0.5	0.5	0.5	0.7	0.6	0.6	0.1	0.2
CDR20	CJK	0.8	0.9	0.9	0.8	0.7	1.0		1.1		0.9	0.1	0.4
	IDN	1.7	2.6	2.5	2.4	2.6	2.6		2.2		2.4	0.3	1.0
	MYS	12.2	15.3	16.6	14.8	15.2	15.8		17.9		15.4	1.8	5.7
	PHL	0.7	0.9	0.9	1.1	0.7	0.9		0.9		0.9	0.1	0.3
	SGP	7.0	8.2	8.7	7.9	7.1	8.7		7.7		7.9	0.7	1.7
	THA	3.7	3.6	4.2	3.6	3.2	3.7		4.8		3.8	0.5	1.6
	VNM	1.5	4.2	3.1	3.1	3.3	2.6		3.5		3.0	0.8	2.7
	XSE	0.2	-0.2	0.0	-0.1	-0.5	-0.1		0.3		-0.1	0.3	0.8
	XAS	0.5	0.6	0.8	0.5	0.3	0.7		1.6		0.7	0.4	1.3
	NAF	0.2	0.2	0.2	0.2	0.1	0.2		0.3		0.2	0.1	0.2
	XCS	0.8	0.3	0.6	0.4	0.1	0.5		0.9		0.5	0.3	0.8
	EUR	0.8	0.7	0.7	0.7	0.5	0.7		0.9		0.7	0.1	0.5
	ROW	0.4	0.1	0.5	0.0	0.0	0.3		1.0		0.3	0.4	1.1
	World	0.6	0.5	0.6	0.5	0.4	0.6		0.8		0.6	0.1	0.4

Table 6: Sensitivity analysis of output effects (percentage change in sectoral output)

Case	Region	Sector	PC	CD	LGMC	CH	CF	QCV	BD	IC	IB	AVG	STD	M-M
EOS	SGP	OMF	826	2,294	2,350	861	788	2,305	2,351	2,374	2,353	1,834	757	1,586
	VNM	TWA	197	375	356	204	189	362	357	355	358	306	82	186
	MYS	FBT	132	290	288	141	125	282	288	283	284	235	77	166
	MYS	TWA	95	240	211	101	95	245	212	207	213	180	63	149
	PHL	TWA	41	87	74	46	42	98	74	72	74	68	20	57
	IDN	TWA	40	84	70	48	43	95	70	68	70	66	19	55
	MYS	WPP	48	90	96	50	47	96	96	95	95	79	23	49
	SGP	OME	-14	-59	-61	-14	-13	-59	-61	-61	-61	-45	23	48
	SGP	TWA	-10	-43	-47	-10	-10	-41	-47	-48	-47	-34	18	38
	VNM	OME	5	-33	-30	4	3	-22	-30	-29	-30	-18	17	38
n10	SGP	OMF	220	564	600	239	219		600	618	604	458	193	399
	VNM	TWA	126	251	238	135	118		240	238	240	198	60	133
	MYS	TWA	57	129	117	62	56		119	111	119	96	32	73
	MYS	FBT	63	126	121	71	60		122	121	120	101	30	66
	VNM	MET	-21	-42	-41	-23	-19		-41	-42	-41	-34	11	42
	PHL	TWA	31	73	61	37	32		61	59	61	52	16	42
	IDN	TWA	31	70	56	39	32		56	54	56	49	14	39
	VNM	MIN	-15	-35	-35	-16	-15		-35	-34	-35	-27	10	35
	VNM	ELE	-12	-34	-32	-14	-10		-32	-32	-33	-25	11	34
	SGP	MVT	-19	-31	-33	-20	-19		-33	-34	-33	-28	7	34
n100	SGP	OMF	220	593	600	222	219	592	600	600	599	471	188	381
	VNM	TWA	126	240	238	126	123	239	238	238	238	201	57	117
	MYS	TWA	57	120	117	57	56	118	118	118	118	98	31	63
	MYS	FBT	63	121	121	64	61	121	121	119	119	101	29	60
	PHL	TWA	31	61	61	32	31	62	61	60	60	51	15	31
	IDN	TWA	31	56	56	32	31	58	56	56	56	48	13	27
	VNM	OME	4	-21	-20	4	3	-20	-20	-20	-20	-12	12	24
	VNM	ELE	-12	-32	-32	-12	-12	-33	-32	-32	-32	-26	10	21
	VNM	MIN	-15	-35	-35	-15	-16	-35	-35	-35	-35	-28	10	20
	VNM	MET	-21	-41	-41	-21	-21	-41	-41	-41	-41	-34	10	20
CDR15	SGP	OMF	220	564	593	302	221	524	692	753	797	518	222	578
	VNM	TWA	126	278	238	204	123	237	290	272	292	229	66	168
	MYS	TWA	57	147	116	97	58	119	174	153	173	122	45	117
	MYS	FBT	63	120	120	81	60	112	124	122	123	103	27	64
	PHL	TWA	31	76	61	54	33	66	93	81	94	65	23	63
	IDN	TWA	31	65	56	49	32	63	77	72	86	59	19	54
	VNM	MET	-21	-45	-40	-32	-18	-40	-59	-50	-66	-41	16	47
	VNM	OME	1	-26	-18	-10	2	-14	-34	-27	-38	-18	14	40
	VNM	MVT	2	-26	-15	-10	7	-19	-33	-18	-30	-16	13	39
	VNM	ELE	-11	-32	-29	-20	-9	-28	-39	-37	-46	-28	13	37
CDR20	SGP	OMF	220	624	593	348	224	569		1,063		520	295	843
	VNM	TWA	126	348	238	262	123	243		323		238	88	226
	MYS	TWA	57	234	116	134	60	123		226		136	71	177
	PHL	TWA	31	120	61	74	35	70		130		75	38	99
	IDN	TWA	31	84	56	62	33	67		116		64	30	85
	MYS	FBT	63	127	120	91	60	120		135		102	31	75
	SGP	MVT	-19	-35	-33	-28	-18	-32		-67		-33	16	67
	IDN	MET	-13	-28	-22	-20	-10	-24		-66		-26	19	66
	VNM	MET	-21	-55	-40	-40	-17	-41		-66		-40	17	66
	VNM	OME	1	-42	-18	-21	2	-16		-52		-21	20	55

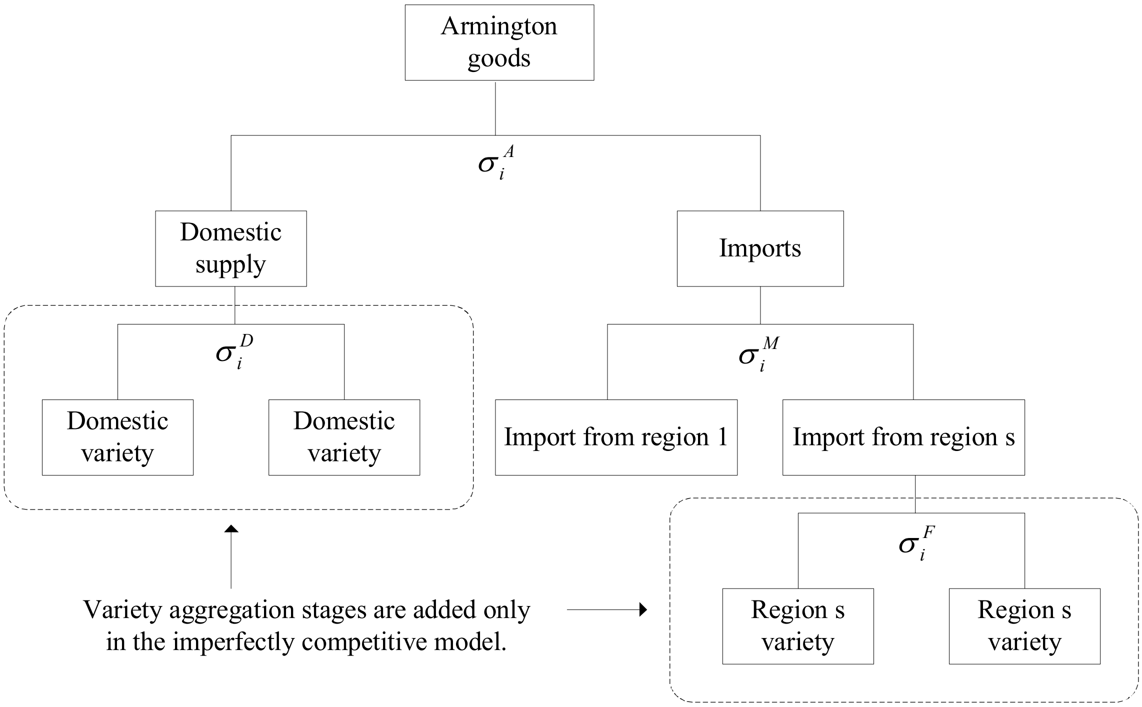

Figure 1: Armington structure.