Market Size, Market Structure, and Welfare Improving Regional Economic Integration: The Computable General Equilibrium Modelling Approach

Pachara Lochindaratn[†*]

1 May 2007

Abstract

This paper measures the linkages between a policy shock, in the form of a subset of countries creating a customs union, and the welfare effects on each region in the world economy, using the CGE modelling approach. It seeks to estimate the extent to which the results are sensitive to regional market sizes and sectoral market structures. Further, under various market structure specifications, it investigates common external tariff policy alternatives for the union, especially those that ensure a necessarily welfare-improving outcome for all regions by eliminating the entailed trade diversion effect. The model is modified such that the common external tariff rates are adjusted to keep border prices at the pre-grouping levels, so that bilateral trade volumes between member and non-member regions remain unchanged after the union shock. Using the standard EV evaluation method to measure the decomposed welfare effects of regional economic integration, there are three main findings in this paper. First, the welfare gains of a union member are robustly proportionate to the market size of the other members, a consequence of the use of the Armington assumption where products are differentiated across regions of origin. Secondly, regions with different market structures adjust to such policy changes in significantly dissimilar ways. These results confirm that increasing returns to scale in imperfectly competitive industries enhance firm productivity and promote positive economic effects in the member regions. These outcomes emphasise the importance of identifying the sectoral market structures of each region before evaluating a regional trade integration policy. The final finding is drawn from the study of welfare-improving regional economic integration: in the absence of the trade diversion effect, changes in the welfare of the union members are smaller when trade creation and trade diversion effects are in place, but the world economy now can gain more, since non-member regions do not experience the non-negligible welfare losses entailed by such trade diversion effects.

Keywords: General Equilibrium, customs union, market size, imperfect competition, tariff endogenisation

JEL Codes: C68, D41, D43, D58, F1

[†] School of Economics, University of Nottingham, University Park, Nottingham, NG7 2RD, United Kingdom. Tel: +44 115 8466131. Fax: +44 115 9514159. E-mail: lexpl1@nottingham.ac.uk

[*] The author is grateful for helpful comments on an earlier draft of this paper by Geoffrey Reed and Wyn Morgan.

1 Introduction

The recent revival of such interest in economic integration is propelled by the proliferation of regional Customs Unions (CUs) and Free Trade Areas (FTAs) in the world trading system after the United States turned in the early 1980s to embracing Preferential Trading Arrangements (PTAs) in the midst of lacklustre trade negotiations under the General Agreement on Tariffs and Trade (GATT) negotiations. More recently, new WTO rules have required the replacing of Preferential Trade Agreements between high and low income economies with (Regional) Economic Partnership Agreements, which are likely to promote further trade diversion. However, it remains the case that in general the welfare effects of preferential trading agreements remain inconclusive. To shed light on this topic, this paper seeks to quantify the economic outcomes of a particular form of preferential trading arrangement: the CU. Compared to other types of regional economic integration, the results of the CU formation should be easier to interpret, since union members impose common external tariffs. Adopting the Computable General Equilibrium (CGE) technique to analyse a 'hypothetical' world economy, this study is aimed at pinpointing the real causes of regional welfare changes, while maintaining modelling simplicity.

The theory of regional economic integration has long been debated since Jacob Viner (1950) first examined the economics of customs unions. Viner (1950) undermined the presumption that discriminatory tariff cuttings were necessarily welfare improving, and proposed that trade diversion be distinguished from trade creation when analysing the welfare effects of CUs. Assuming constant costs and perfectly inelastic demands[1], Viner focused on shifts in volumes of trade and production among regions after a CU was formed. The welfare-augmenting trade creation shifted trade and production from a higher-cost member country to a lower-cost member country, while the potentially welfare-decreasing trade diversion shifted them from a lower-cost non-member region to a higher-cost member region.[2] In this context, a CU was associated with trade creation in some sectors and trade diversion in others. However, cross-sector economic effects were ruled out due to the nature of a partial equilibrium framework.

Influenced by Viner's work, many trade theorists of the period developed the formal analysis of the issues. Among others, Meade (1955) was the first to provide a complete general-equilibrium analysis of preferential trading in *The Theory of Customs Unions*. Meade showed that, when trade creation and trade diversion were present under the assumption of flexible terms of trade, the world welfare outcomes depended on parameters such as pre-union tariffs and cross-product complementarity.

Lipsey (1957) argued that although the concepts of trade creation and trade diversion introduced by Viner were 'fundamental' for understanding how a customs union might change the pattern of world trade and production, the argument that trade diversion was always welfare-decreasing was no longer valid when allowing for the positive consumption effects induced by lower prices of imported goods in union member countries. Thus, a trade-diverting customs union could be beneficial to its members, and might result in a higher level of world welfare. Johnson (1960) then elaborated on Lipsey's point by explicitly defining the

[1] The perfectly inelastic demand assumption essentially ruled out the consumption effects of CU formations.
[2] Where demand is not perfectly elastic, trade diversion may be welfare-increasing. This point is illustrated later by Lipsey (1957).

consumption effect – which facilitated higher trade flows for member countries and consequently increased world welfare – as another source of trade creation, thus providing a more direct link between the definitions and the welfare effects of CUs.

Mundell (1964) systematically studied the effects of changes in the terms of trade between CU members and between the union and the rest of the world. He relaxed the consumption substitutability assumption in the Meade model and derived an important implication that the higher were the pre-CU tariffs of other partner countries, the larger were the gains to the country that joined the preferential tariff-cutting scheme. Mundell's work was very important in that it was the last piece of the puzzle that completed the basic analytical framework for the customs union problem. Subsequently, the production effect, consumer effect, and capital-inflow effect are regarded, by default, as the core elements of welfare changes due to CU formation.

Forming a PTA among small regions was once considered as an alternative development strategy for developing countries. Cooper and Massell (1965), Johnson (1965), and Bhagwati (1968) independently developed the idea that if the "South" were to continue to maintain protection against the industrialised North, then they might facilitate their economic growth by liberalising trade among themselves. Although such South-South economic integration turned out to be unsuccessful in most cases (which is attributable to the substituting nature of their economic structures), in theory, such groupings might work if there are scale economies to be exploited. If PTA members specialise in different industries in order to exploit the scale economies, then developing countries might be able to achieve the desired levels of industrialisation at lower costs. However, when considering the position of a developing country with a relatively small scale of production, the question as to how the economic size of a CU member compared to that of her partner country affects the welfare outcomes of a CU formation could be more explicitly examined using the CGE approach. This problem will be handled in section 3 after the model design is briefly explained in section 2.

How the welfare outcome of CU formation would be affected when allowing for imperfect competition is less explored in the classic customs union literature. Corden (1972) attempted to isolate the welfare effects of the economies of scale in a three-country, multi-good general equilibrium framework, but general equilibrium complications demanded that there were simultaneous adjustments in demands across sectors and also exchange rates across countries, so that it remained difficult to satisfactorily pinpoint the natural link between the economies of scale and the welfare outcomes of CUs. Nonetheless, a central element of Corden's analysis is that a reduction in the number of firms within the CU is necessary if we are to be sure that the CU's welfare is increased. If the number of firms in the CU stays the same then it is possible that CU welfare falls. In addition, imports from non-member regions might cease because they were replaced by domestic production, thus causing the trade-suppressing effect akin to trade diversion, even though domestic producers, not partner country's producers, are the dearer source that replace a cheaper source outside the CU grouping. Bliss (1994) then narrowed down the analysis and built a symmetric three-country model, where each country has one producer, all with the same production costs for the same homogeneous good, and identical demand functions, with the firms playing a Cournot game before and after CU formation.. He shows that a customs union between two of those countries necessarily results in union members gaining and non-members losing. However, the world at large will enjoy a higher level of economic welfare, provided that no producers are eliminated from the market. Corden and Bliss hence provided some useful insights into the issue of CU formation when imperfect competition is involved. Nonetheless, little has been said about how a union member may adjust to the preferential trading given different types of imperfect competition in different sectors, an issue to which this paper will return in section 4.

The last issue considered in this paper is in response to concerns about the welfare-reducing aspect of CU formation. In their renowned essay, Kemp and Wan (1976) confined themselves to the Vinerian framework and proposed that any subset of countries could form a customs union that allowed member countries to achieve higher welfare levels without lowering that of others. The Pareto-improving solution could be found by endogenously determining the common external tariffs so as not to alter trade flows between CU members and the rest of the world, provided that lump sum income transfers among union members are feasible. Thus, section 5 focuses on how to achieve a Pareto-improving outcome given different forms of imperfect competition, and section 6 tests the robustness of the model to key parametric variations. Then, section 7 concludes.

2 General Model Design

The model is a static, four-region, three-sector, three-factor general equilibrium model, of which production and final demand structure is developed from the single-region EcoMod model (2006). This CGE model consists of 1) five agents: producers, a household, a government, a bank, and the rest of the world; and 2) two markets: primary factor markets and commodity markets, with an Armington aggregation to differentiate domestic outputs from imports in each region. Note that the model is kept simple, since after all, the goal of this paper is to identify how the economies adjust to the CU shock, *ceteris paribus*.

Assume that the world economy comprises four regions:[3]

reg = {reg1, reg2, reg3, reg4}.

All regions are completely symmetric in their factor abundances, producer technologies, and consumer tastes. In each region, firms are engaged in three production sectors. Among the three commodities, two are tradable (*sec1, sec2*) and supplied to the private sector; and the other one is non-traded and only supplied to the government as a public good (*sec3*). The production costs are minimised subject to the nested Constant Elasticity of Substitution (CES) production function explained later in this section. Therefore, the set of all commodities is:

sec = {secT, secTN}, where:

secT = {sec1, sec2} and *secTN = {sec3}.*

In each sector, intermediate inputs and three primary inputs: capital (*K*), labour (*L*), and land (*H*), are used to produce the final good. Although three of them are commonly used in all sectors, capital and labour are

[3] At least four regions are required when analysing the CU effects on regions with different market sizes in section 3.

mobile across production sectors but immobile across regions; and land is assumed to be sector-specific. To be precise, the set of all factors of production is:

$$fac = \{facM, facS\}, \text{ where:}$$

$$facM = \{K, L\} \text{ and } facS = \{H\}.$$

In terms of value flows between agents through markets, firms in each sector purchase factors of production from the household and then pay *ad-valorem* factor taxes to the government. Consumers, on the other hand, consist of a household and a government. The household owns all primary factors. It supplies these factors for firms to produce value added, and receives rental payments in return. The household then spends on buying commodities and paying income direct taxes. The rest of household's income is saved in the regional bank. The government collects taxes and tariffs, spends on transfers to the household, consumes the non-traded good, and then similarly saves the rest of its revenues in the bank. Both household and government maximise their Cobb-Douglas (CD) utility functions, thus a constant expenditure share is allocated to each final demand commodity. Similarly to the household and government behaviours, the bank receives savings from the household, the government, and the rest of the world, and then allocates a constant share to each commodity in the form of investment. The macroeconomic closure rule always holds that the foreign savings transferred from the rest of the world is actually the difference between total values of imports and exports for each region.

Next, we discuss market clearance in the CGE model. As in standard CGE settings, there are two types of markets in the model: the commodity markets (domestic and international) and the factor markets. Under perfect competition, price flexibility ensures that supplies equate demands, thus all markets are cleared, except for the labour market where the market clearing condition is relaxed to allow for unemployment.

For tradable commodities, the commodity markets are supplied by imported and domestically-produced commodities; and then demanded by production sectors as intermediate inputs, the household as final products and the bank as investment goods. Commodity markets contribute to government revenues by paying *ad-valorem* commodity taxes and import tariffs. For simplicity of the analysis, the possibility of trade deflection (re-exportation) is excluded from the model. As such, only domestically-produced commodities will be exported. For the non-traded commodity, the stylised model specifies that the market is supplied by a domestic sector (*sec3*) and solely demanded by the government as an aggregate public good. No taxes are imposed to any purchase in this market.

There also exists an international market for each tradable commodity. In this market, exports and imports are traded bilaterally among regions, and total values of exports and imports traded in the global market of each commodity will always be identical.

The household supplies primary factor markets with its fixed endowments, and production sectors demand them to produce value added to final goods. In the capital market, the model calibrates return rates to capital inputs so that all endowments are employed in each region. In the labour market, wage is still determined by labour demand, but not at the level that ensures full employment. It occurs simultaneously that real wage is also correlated with the unemployment rate, thus the relationship specified by the

Blanchflower and Oswald (1995)'s wage curve definition demands that any change in the unemployment rate is associated with the change in real wage.

In comparison to the above two primary factors, the land market is unique such that it is not mobile across sectors. This property of land implies that each production sector will demand a fixed amount of land input; hence the model allows the rental rate of land to be varied by sector.

2.1 Production

Each production sector *sec* in region *reg* demands factor inputs ($F_{sec}^{fac,reg}$) and intermediate goods from sectors *secc* ($IO_{secc,sec}^{reg}$) to produce a final product (QZ_{sec}^{reg}). The demand structure is a nested CES tree illustrated in Figure 1.

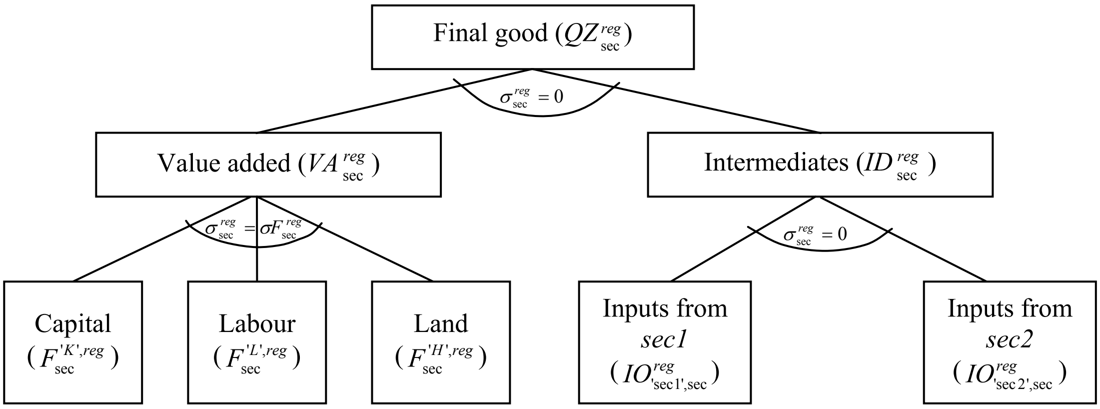

Figure 1: Structure of production demand

The substitution elasticities at each nest are denoted with the parameter prefixed 'σ_{sec}^{reg}'. At the top level of the demand structure, substitution with zero elasticity (i.e. Leontief technology) is made between Value Added (VA_{sec}^{reg}) and Intermediate (ID_{sec}^{reg}) aggregate goods. The Value Added aggregate under the CES technology is made up of demands for capital, labour, and land; while the Intermediate aggregate nest under the Leontief technology requires fixed shares ($\overline{io}_{secc,sec}^{reg}$) of intermediate inputs from non-public goods (*sec1* and *sec2*). It is straightforward to express intermediate input demand as:

$$IO_{secc,sec}^{reg} = \overline{io}_{secc,sec}^{reg} \cdot QZ_{sec}^{reg} . \tag{1}$$

As for the Value Added aggregate, the CES production function is adopted so as to allow for flexible substitution at a given elasticity between primary factor inputs:

$$QZ_{sec}^{reg} = \overline{aF}_{sec}^{reg} \cdot \left[\sum_{fac} \overline{\gamma F}_{sec}^{fac,reg} \cdot \left(F_{sec}^{fac,reg} \right)^{\overline{\rho F}_{sec}^{reg}} \right]^{1/\overline{\rho F}_{sec}^{reg}} , \tag{2}$$

Where the value of parameter $\overline{aF}_{sec}^{reg}$ implies how efficient sector *sec* is in using primary inputs to produce the final product; $\overline{\gamma F}_{sec}^{fac,reg}$ is the share parameter that sums up to one ($\sum_{fac} \overline{\gamma F}_{sec}^{fac,reg} = 1$); and $\overline{\rho F}_{sec}^{reg}$ is the substitution elasticity parameter of the value-added production function. Assuming that firms minimise primary factor costs while maintaining their output levels, the demand function for factor inputs is derived as:

$$F_{\sec}^{fac,reg} = \frac{\left(\dfrac{\overline{\gamma F}_{\sec}^{fac,reg}}{(1+\overline{tf}_{\sec}^{fac,reg}) \cdot PF_{\sec}^{fac,reg}} \right)^{\overline{\sigma F}_{\sec}^{reg}}}{\overline{aF}_{\sec}^{reg} \cdot \left\{ \sum_{fac} (\overline{\gamma F}_{\sec}^{fac,reg})^{\overline{\sigma F}_{\sec}^{reg}} \cdot \left[(1+\overline{tf}_{\sec}^{fac,reg}) \cdot PF_{\sec}^{fac,reg} \right]^{1-\overline{\sigma F}_{\sec}^{reg}} \right\}^{\overline{\sigma F}_{\sec}^{reg} / (\overline{\sigma F}_{\sec}^{reg}-1)}} \cdot QZ_{\sec}^{reg}, \tag{3}$$

where $\overline{\sigma F}_{\sec}^{reg}$ represents 1/(1-$\overline{\rho F}_{\sec}^{reg}$) for simplicity; $\overline{tf}_{\sec}^{fac,reg}$ is the *ad-valorem* factor tax rate imposed on producers; $PF_{\sec}^{fac,reg}$ is the rate of return to factor *fac* in region *reg*, which is universal across sectors within the same region for mobile factors (capital and labour).

Given the functions of intermediate and factor demands in Equations (1) and (3), the perfect competition assumption requires that firms will equate their total revenues with total costs (zero profit condition):

$$PZ_{\sec}^{reg} \cdot QZ_{\sec}^{reg} = \sum_{fac} \left(1+\overline{tf}_{\sec}^{fac,reg}\right) \cdot PF_{\sec}^{fac,reg} \cdot F_{\sec}^{fac,reg} + \sum_{\sec c} PA_{\sec c}^{reg} \cdot IO_{\sec c,\sec}^{reg}, \tag{4}$$

where $PZ_{\sec}^{reg}$ is the producer price, and $PA_{\sec c}^{reg}$ is the price of a composite commodity *secc*.

2.2 Household and Government

In this model, the household consumes tradable commodities *sec1* and *sec2* (*secT*), and the government consumes the only non-traded good *sec3* (*secTN*). The household and government similarly maximise their CD utility functions, subject to their budget constraints. Given the derived CD consumption demand functions, a broader picture of household and government income flows is explained below.

2.2.1 Household

The household demand function is derived as:

$$\left(1+\overline{tc}_{\sec T}^{reg}\right) \cdot PA_{\sec T}^{reg} \cdot C_{\sec T}^{reg} = \overline{\alpha HH}_{\sec T}^{reg} \cdot CBUD^{reg}, \tag{5}$$

where $CBUD^{reg}$ is the consumption budget of household, spent on final goods ($C_{\sec T}^{reg}$); $\overline{\alpha HH}_{\sec T}^{reg}$ is the constant expenditure share of commodity *secT* consumption for household that sums up to one ($\sum_{\sec T} \overline{\alpha HH}_{\sec T}^{reg} = 1$); and the commodity tax rate is denoted by $\overline{tc}_{\sec T}^{reg}$. Thus, the real consumption budget level ($CBUD^{reg} / PA_{\sec T}^{reg}$) is the key determinant of the consumption quantity of a final good *secT*. The consumption budget, on the other hand, depends on the following income balance equation which states that the household allocates its income to consumption, savings (SHH^{reg}), and income tax payment (TRY^{reg}):

$$INC^{reg} = CBUD^{reg} + SHH^{reg} + TRY^{reg}, \tag{6}$$

where the income tax payment is proportional to the total household income, given a fixed income tax rate ($\overline{ty}^{reg}$):

$$TRY^{reg} = \overline{ty}^{reg} \cdot INC^{reg}; \tag{7}$$

and the household saving is a fixed proportion (denoted by $\overline{mps}^{reg}$) of the total household income, net of income tax payment:

$$SHH^{reg} = \overline{mps}^{reg} \cdot (INC^{reg} - TRY^{reg}). \tag{8}$$

As for income sources, the household receives transfers ($TRNF^{reg}$) from the government besides factor incomes from production sectors:

$$INC^{reg} = \sum_{sec} \sum_{fac} PF_{sec}^{fac,reg} \cdot F_{sec}^{fac,reg} + TRNF^{reg}. \tag{9}$$

Total transfers from the government to the household, in turn, consist of unemployment benefits and other transfers:

$$TRNF^{reg} = \overline{trep}^{reg} \cdot PF^{'L',reg} \cdot UNEMP^{reg} + \overline{TRO}^{reg} \cdot CPI^{reg}, \tag{10}$$

In this equation, the government pays unemployment benefits to the household as a fixed proportion, labelled as the replacement rate ($\overline{trep}^{reg}$) of the lost household income due to unemployment ($PF^{'L',reg} \cdot UNEMP^{reg}$);[4] and also transfers other lump-sum benefits which is fixed in real terms ($\overline{TRO}^{reg}$), e.g. income subsidies. To maintain the homogeneity of the equation, other transfers are made nominal by the multiplication of the Laspeyres consumer price index (CPI^{reg}), which is defined in the presence of endogenous taxes as:

$$CPI^{reg} = \frac{\sum_{secT} (1 + \overline{tc}_{secT}^{reg}) \cdot PA_{secT}^{reg} \cdot C0_{secT}^{reg}}{\sum_{secT} (1 + \overline{tc}_{secT}^{reg}) \cdot PA0_{secT}^{reg} \cdot C0_{secT}^{reg}}, \tag{11}$$

where 0 is appended to denote the value of a variable at the base year.

Figure 2 summarises the income flows of the representative household.

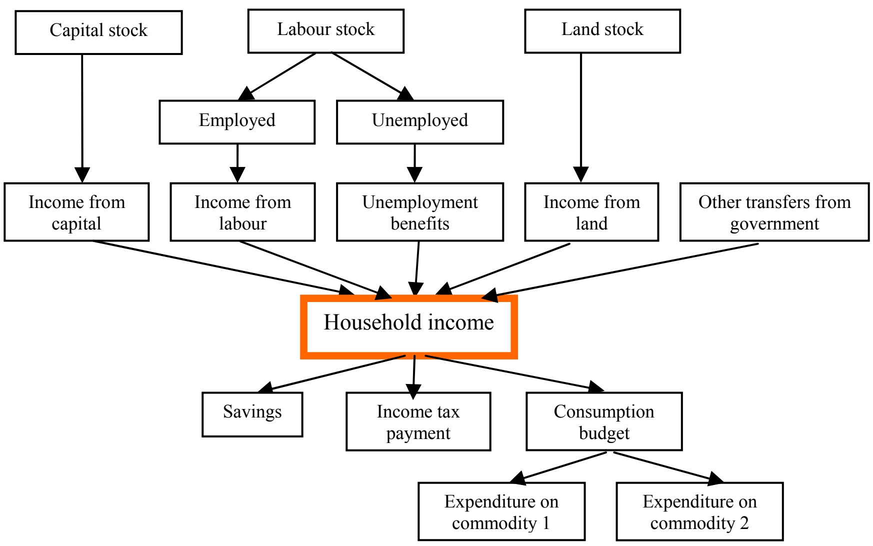

Figure 2: Household income flows

[4] Note that the dimension *sec* of the labour wage $PF_{sec}^{'L',reg}$ can be abbreviated in this equation, since for the factor labour, wages are universal across sectors within a region, due to its mobility assumption.

2.2.2 Government

Similarly, the government spends on the non-traded public good (*sec3*), based on this demand function:

$$PA_{secTN}^{reg} \cdot CG_{secTN}^{reg} = \overline{\alpha CG}_{secTN}^{reg} \cdot CGBUD^{reg}, \tag{12}$$

where $CGBUD^{reg}$ is the government budget spent on *secTN* (CG_{secTN}^{reg}); and $\overline{\alpha CG}_{secTN}^{reg}$ is the expenditure share of commodity *secTN* consumption for government that sums up to one ($\sum_{secTN} \overline{\alpha CG}_{secTN}^{reg} = 1$). Thus, the real consumption budget level ($CGBUD^{reg} / PA_{secTN}^{reg}$) is the key determinant of the consumption quantity of a final good *secTN*. The consumption budget, on the other hand, depends on the following government's income balance equation which states that the government allocates its total tax revenues ($TREV^{reg}$) to consumption budget, savings ($\overline{SG}^{reg}$), and total transfers to the household:

$$TREV^{reg} = CGBUD^{reg} + \overline{SG}^{reg} \cdot CPI^{reg} + TRNF^{reg}. \tag{13}$$

Note that government savings $\overline{SG}^{reg}$ is fixed in real terms, though its nominal value ($\overline{SG}^{reg} \cdot CPI^{reg}$) can be varied after a policy shock.

As for the sources of tax revenues, the government receives tax payments in forms of household income taxes (TRY^{reg}); commodity taxes (TRC^{reg}); factor usage taxes (TRF^{reg}); and import tariffs (TRM^{reg}):

$$TREV^{reg} = TRY^{reg} + TRC^{reg} + TRF^{reg} + TRM^{reg}. \tag{14}$$

As household income taxes are already defined in Equation (7), the rest is defined as following:

$$TRC^{reg} = \sum_{secT} \overline{tc}_{secT}^{reg} \cdot C_{secT}^{reg} \cdot PA_{secT}^{reg}; \tag{15}$$

$$TRF^{reg} = \sum_{sec} \sum_{fac} \overline{tf}_{sec}^{fac,reg} \cdot F_{sec}^{fac,reg} \cdot PF_{sec}^{fac,reg}; \text{ and} \tag{16}$$

$$TRM^{reg} = \sum_{secT} \sum_{regg \neq reg} \overline{tm}_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg}. \tag{17}$$

Note that in Equation (17), bilateral imports to region *reg* from region *regg* is denoted by $QBM_{secT}^{reg,regg}$, and tariff revenues from these imported goods are converted to the local currency by multiplying its matching world prices ($PWE_{secT}^{regg,reg}$) with the exchange rate (EXC^{reg}). Figure 3 thus summarises the income flows of the government in a region:

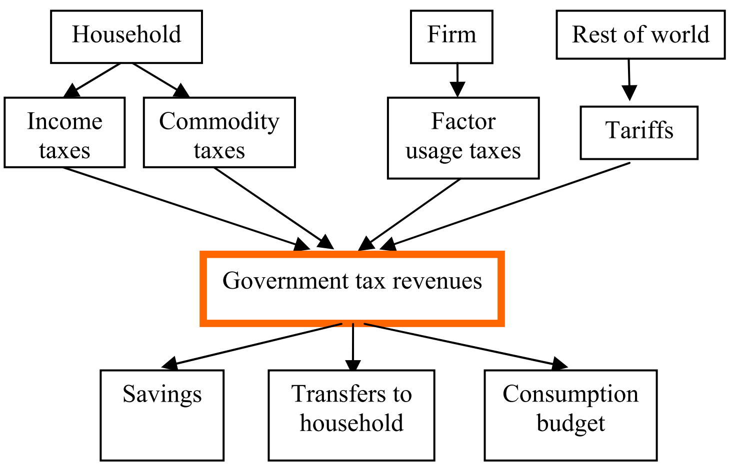

Figure 3: Government income flows

2.3 Bank

The investment bank – which is an arbitrary agent – is set up to explain how outputs from production sectors are demanded for investment within a region. As this model attempts to isolate the non-traded public sector (*sec3*) from the world in order to examine how a CU shock could affect such an isolated sector through domestic price adjustment, again, investment is not allocated to *sec3*, which is the non-traded sector that specifically produces to meet the government's final demand. Thus, the investment demand function is expressed as:

$$PA_{\sec T}^{reg} \cdot I_{\sec T}^{reg} = \overline{\alpha I}_{\sec T}^{reg} \cdot S^{reg}, \quad (18)$$

where S^{reg} is the total savings in region *reg* that will be allocated to investment demands in sector *secT* ($I_{\sec T}^{reg}$); and $\overline{\alpha I}_{\sec T}^{reg}$ is the investment share of sector *secT* that sums up to one ($\sum_{\sec T}\overline{\alpha I}_{\sec T}^{reg} = 1$). The bank then collects savings from household, government, and the rest of the world (the income balance condition):

$$S^{reg} = SHH^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot CPI^{reg}, \quad (19)$$

and subsequently allocates them to investment in production sectors as demanded. Note that foreign savings ($\overline{SF}^{reg}$) are fixed in real terms and denominated in local currency.

2.4 Rest of World

The balance of payments is essentially the zero-profit condition required to maintain the macroeconomic balance of a region. Evaluated in world currency, it defines the nominal foreign savings to be equal to the total values of imports less that of exports:

$$\sum_{\sec T}\sum_{regg \neq reg} QBM_{\sec T}^{reg,regg} \cdot PWE_{\sec T}^{regg,reg} = \left(\sum_{\sec T}\sum_{regg \neq reg} QBE_{\sec T}^{reg,regg} \cdot PWE_{\sec T}^{reg,regg}\right) + \frac{\overline{SF}^{reg} \cdot CPI^{reg}}{EXC^{reg}}, \quad (20)$$

where $QBE_{\sec T}^{reg,regg}$ denotes bilateral exports of commodity *secT* from region *reg* to region *regg*. Note that in this model all regions are under the flexible exchange regime, thus they adjust their exchange rates with respect to the world currency in order to stabilise the real foreign savings. As all regions are symmetric in this model[5], trade balances are set to be neutral.[6] Hence, we have total exports equal total imports and the foreign savings, which is in the second term on the right hand side, are fixed to zeroes at the benchmark year. This also implies that the sum of savings collected from the household and government will be equal to total domestic investment demands, as hinted in Equations (18) and (19).

2.5 Domestic Commodity Markets

This section explains market structures of commodities produced in a region. The value flow of each commodity depends on its tradability. While tradable goods are supplied to domestic and foreign markets,

---

[5] Even if I assume products to be differentiated by country of origin, all regions can be symmetric in the sense that the Armington demand functions and their associated elasticities are universal and that products are all equivalently differentiated from each other.
[6] As the sum of regional trade balances in the world economy is always zero, if regional trade balances are not zero, there will be some regions with trade deficits, and some with trade surplus. Therefore, trade balances are set as zero so that we do not have asymmetry with this regard.

non-traded goods are only produced for the domestic market. Figure 4 below illustrates such flows for both cases in this model.

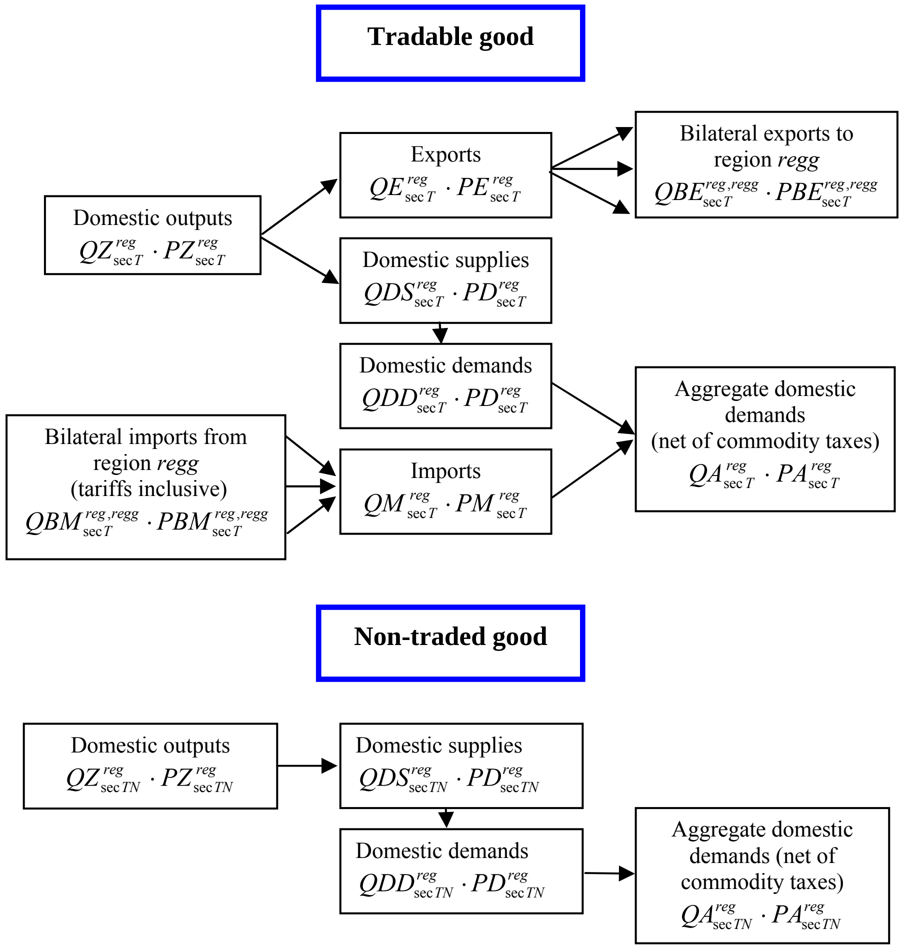

Figure 4: Value flows of commodities in region *reg*

For tradable goods, PE^{reg}_{secT} is the aggregate export price parallel to the aggregate export quantity (QE^{reg}_{secT}); $PBE^{reg,regg}_{secT}$ represents the bilateral export price parallel to the bilateral export quantity ($QBE^{reg,regg}_{secT}$); PM^{reg}_{secT} is the aggregate import price parallel to the aggregate import quantity (QM^{reg}_{secT}); and $PBM^{reg,regg}_{secT}$ represents the bilateral import price parallel to the bilateral import quantity ($QBM^{reg,regg}_{secT}$). As observed in Figure 4, re-exportation is not allowed in this model.

For both types of goods, PD^{reg}_{sec} denotes the price of domestically-produced commodity supplied to the domestic market (QDS^{reg}_{sec}) that equals the level demanded for domestic consumption (QDD^{reg}_{sec}); and lastly, aggregate demands are denoted by QA^{reg}_{sec} parallel to the domestic price PA^{reg}_{sec} previously introduced.

Now, to elaborate on the market structures of in Figure 4, sections 2.5.1 and 2.5.2 explain the relationships between the above quantities and prices with respect to tradability.

2.5.1 Tradable Commodity Markets

For tradable goods, the supply flows can be summarised as following:

$$PZ_{\sec T}^{reg} \cdot QZ_{\sec T}^{reg} = PD_{\sec T}^{reg} \cdot QDS_{\sec T}^{reg} + PE_{\sec T}^{reg} \cdot QE_{\sec T}^{reg} . \tag{21}$$

This equation specifies in this model that nominal values of domestically-produced commodities are equal to the sum of those supplied to domestic markets and exported ones. Further, aggregate exports are the sum of bilateral export supplied to other regions *regg*:

$$PE_{\sec T}^{reg} \cdot QE_{\sec T}^{reg} = \sum_{regg \neq reg} PBE_{\sec T}^{reg,regg} \cdot QBE_{\sec T}^{reg,regg} . \tag{22}$$

Also, domestically-produced commodities supplied to the domestic market should be equal to the quantities demanded:

$$QDS_{\sec T}^{\text{reg}} = QDD_{\sec T}^{\text{reg}} . \tag{23}$$

Now, let us consider the demand side of the economy. In the upper level, the nominal demand for the domestic composite good ($QA_{\sec T}^{reg}$) equals the sum of nominal demands for domestically-produced goods ($QDD_{\sec T}^{reg}$) and aggregate imports ($QM_{\sec T}^{reg}$):

$$PA_{\sec T}^{reg} \cdot QA_{\sec T}^{reg} = PD_{\sec T}^{reg} \cdot QDD_{\sec T}^{reg} + PM_{\sec T}^{reg} \cdot QM_{\sec T}^{reg} . \tag{24}$$

Then, in the lower level of a sectoral demand structure, the model specifies that the values of aggregate imports should equal the sum of demands for bilateral imports from other regions *regg* in nominal terms:

$$PM_{\sec T}^{reg} \cdot QM_{\sec T}^{reg} = \sum_{regg \neq reg} PBM_{\sec T}^{reg,regg} \cdot QBM_{\sec T}^{reg,regg} . \tag{25}$$

Under perfect competition, the market clearance condition holds, and prices of composite goods ($PA_{\sec}^{reg}$) are determined by equating $QA_{\sec T}^{reg}$ with domestic demands from the household, bank, and firms:

$$\text{C}_{\text{secT}}^{\text{reg}} + I_{\text{secT}}^{\text{reg}} + \sum_{\text{sec}} IO_{\text{secT,sec}}^{\text{reg}} = QA_{\text{secT}}^{\text{reg}} . \tag{26}$$

If in a tradable sector *secT*, all prices listed above are identical, we can say that exports, domestically-oriented products, and imports are homogeneous and not differentiated from each other, which is the case for the 'supply' side of the economy. However, on the 'demand' side, it is clearly observed in empirical data that two-way trade exists, thus imperfect substitutability between commodities produced in different countries exists in reality and should be incorporated into the model. With product differentiation, $PA_{\sec T}^{reg}$, $PD_{\sec T}^{reg}$, $PM_{\sec T}^{reg}$, and $PBM_{\sec T}^{reg,regg}$ in Equations (24) and (25) will be allowed to deviate from each other, hence the sum of the domestically-produced quantity ($QDD_{\sec T}^{reg}$) and the imported one ($QM_{\sec T}^{reg}$) will no longer equal the aggregate demand ($QA_{\sec T}^{reg}$); and the sum of bilateral imports ($QBM_{\sec T}^{reg,regg}$) may not equal the aggregate import demand ($QM_{\sec T}^{reg}$). Accordingly, different Armington demand functions for $QDD_{\sec T}^{reg}$, $QM_{\sec T}^{reg}$, and $QBM_{\sec T}^{reg,regg}$ need to be derived.

The Armington good is composited by minimising costs:

$$PM_{\sec T}^{reg} \cdot QM_{\sec T}^{reg} + PD_{\sec T}^{reg} \cdot QDD_{\sec T}^{reg} , \tag{27}$$

subject to the CES Armington function:

$$QA_{\sec T}^{reg} = \overline{aA}_{\sec T}^{reg} \cdot \left[\overline{\gamma AM}_{\sec T}^{reg} \cdot QM_{\sec T}^{reg\ \overline{\rho A}_{\sec T}^{reg}} + \overline{\gamma AD}_{\sec T}^{reg} \cdot QDD_{\sec T}^{reg\ \overline{\rho A}_{\sec T}^{reg}} \right]^{\frac{1}{\overline{\rho A}_{\sec T}^{reg}}}, \tag{28}$$

where $\overline{aA}_{\sec T}^{reg}$ is the efficiency parameter, $\overline{\gamma AM}_{\sec T}^{reg}$ and $\overline{\gamma AD}_{\sec T}^{reg}$ are the share parameters $\left(\overline{\gamma AM}_{\sec T}^{reg} + \overline{\gamma AD}_{\sec T}^{reg} = 1\right)$, and $\overline{\rho A}_{\sec T}^{reg}$ is the elasticity parameter for Armington composite good production. When $\overline{\sigma A}_{\sec T}^{reg} = 1/(1 - \overline{\rho A}_{\sec T}^{reg})$, Equations (24), (27), and (28) are solved, and the upper-level Armington demand functions are:

$$QDD_{\sec T}^{reg} = (\overline{aA}_{\sec T}^{reg})^{\overline{\sigma A}_{\sec T}^{reg}-1} \cdot (\overline{\gamma AD}_{\sec T}^{reg})^{\overline{\sigma A}_{\sec T}^{reg}} \cdot \left(\frac{PA_{\sec T}^{reg}}{PD_{\sec T}^{reg}} \right)^{\overline{\sigma A}_{\sec T}^{reg}} \cdot QA_{\sec T}^{reg}\text{; and} \tag{29}$$

$$QM_{\sec T}^{reg} = (\overline{aA}_{\sec T}^{reg})^{\overline{\sigma A}_{\sec T}^{reg}-1} \cdot (\overline{\gamma AM}_{\sec T}^{reg})^{\overline{\sigma A}_{\sec T}^{reg}} \cdot \left(\frac{PA_{\sec T}^{reg}}{PM_{\sec T}^{reg}} \right)^{\overline{\sigma A}_{\sec T}^{reg}} \cdot QA_{\sec T}^{reg}. \tag{30}$$

Thus, demands for domestically-produced and imported commodities are determined by the Armington aggregate demand ($QA_{\sec T}^{reg}$), and their relative prices to the Armington price ($PA_{\sec T}^{reg}$).

In the lower-level of the Armington demand structure, bilateral imports from different regions are also differentiated from each other. Therefore, the Armington demand function for aggregate imports can similarly be composited by minimising costs:

$$\sum_{regg \neq reg} PBM_{\sec T}^{reg,regg} \cdot QBM_{\sec T}^{reg,regg}, \tag{31}$$

subject to the CES Armington function:

$$QM_{\sec T}^{reg} = \overline{aBM}_{\sec T}^{reg} \cdot \left[\sum_{regg \neq reg} \overline{\gamma BM}_{\sec T}^{reg,regg} \cdot QBM_{\sec T}^{reg,regg\ \overline{\rho BM}_{\sec T}^{reg}} \right]^{\frac{1}{\overline{\rho BM}_{\sec T}^{reg}}}, \tag{32}$$

where $\overline{aBM}_{\sec T}^{reg,regg}$ is the efficiency parameter, $\overline{\gamma BM}_{\sec T}^{reg,regg}$ is the share parameter ($\sum_{reg \neq regg} \overline{\gamma BM}_{\sec T}^{reg,regg} = 1$), and $\overline{\rho BM}_{\sec T}^{reg}$ is an elasticity parameter for the Armington aggregate import. When $\overline{\sigma BM}_{\sec T}^{reg} = 1/(1 - \overline{\rho BM}_{\sec T}^{reg})$, the Armington demand function for bilaterally-imported goods is:

$$QBM_{\sec T}^{reg,regg} = (\overline{aBM}_{\sec T}^{reg})^{\overline{\sigma BM}_{\sec T}^{reg}-1} \cdot (\overline{\gamma BM}_{\sec T}^{reg,regg})^{\overline{\sigma BM}_{\sec T}^{reg}} \cdot \left(\frac{PM_{\sec T}^{reg}}{PBM_{\sec T}^{reg,regg}} \right)^{\overline{\sigma BM}_{\sec T}^{reg}} \cdot QM_{\sec T}^{reg}. \tag{33}$$

2.5.2 Non-Traded Commodity Markets

For non-traded goods, the commodity flow is fairly simple. The nominal value of a non-traded commodity should be identical all through the supply chain, hence we get:

$$QZ_{\sec TN}^{reg} \cdot PZ_{\sec TN}^{reg} = QDS_{\sec TN}^{reg} \cdot PD_{\sec TN}^{reg} = QDD_{\sec TN}^{reg} \cdot PD_{\sec TN}^{reg} = QA_{\sec TN}^{reg} \cdot PA_{\sec TN}^{reg}. \tag{34}$$

That is to say, product differentiation does not apply to the non-traded commodity, and their quantities and prices are universal by sector and region:

$$QZ_{\sec TN}^{reg} = QDS_{\sec TN}^{reg} = QDD_{\sec TN}^{reg} = QA_{\sec TN}^{reg}\text{; and} \tag{35}$$

$$PZ_{\sec TN}^{reg} = PD_{\sec TN}^{reg} = PA_{\sec TN}^{reg}. \tag{36}$$

Under perfect competition, the market clearance condition holds such that domestic prices are determined by equating domestic supplies with final demands from the government:

$$CG^{reg}_{secTN} = QA^{reg}_{secTN} \, . \tag{37}$$

2.6 International Commodity Market

Consider the market clearing condition in an international commodity market. The bilateral import demand of commodity *secT* by region *reg* from region *regg* should be identical to the matching export supplies from region *regg* to region *reg*. Hence, the summation of sectoral export values traded in the international market must be equal to that of the imported. This property ensures that the world price ($PWE^{reg,regg}_{secT}$) is flexibly adjusted so that the international market is always cleared under perfect competition. As for the relationship between the world price and border prices, the border price of an exported good is converted into the world currency as:

$$PBE^{reg,regg}_{secT} = PWE^{reg,regg}_{secT} \cdot EXC^{reg} \, . \tag{38}$$

Similarly, the world price is converted into the border price of an imported commodity, inclusive of tariffs, as:

$$PBM^{reg,regg}_{secT} = (1 + \overline{tm^{reg,regg}_{secT}}) \cdot PWE^{regg,reg}_{secT} \cdot EXC^{reg} \, . \tag{39}$$

2.7 Factor Markets

In the factor markets, primary endowments should be equal to the summation of primary inputs demanded by production sectors, thus ensuring full employment. However, as mentioned at the beginning of section 2, this property only holds in the capital market. The market clearing condition does not apply to the land market, since land is sector specific, and primary factor inputs are inherently fixed by sector. As for the labour market, the summation of factor demands equals labour endowment less the unemployed labour. Thus, this model assumes that the labour market has an excess capacity of labour endowment that can be supplied to production sectors when a policy shock is imposed to the economy. Labour wages are still flexible, but they do not ensure that the labour market will clear, since the unemployment rate is associated with real wage, according to Blanchflower and Oswald (1995). To endogenise unemployment, the wage curve is defined such that its elasticity (ω^{reg}) is approximately [-0.1] across regions. Therefore, we derive:

$$\left(\frac{PF^{"L",reg}}{CPI^{reg}} \Big/ \frac{PF0^{"L",reg}}{CPI0^{reg}} \right) - 1 = \omega^{reg} \cdot \left[(UNEMP^{reg} / UNEMP0^{reg}) - 1 \right] \cdot \tag{40}$$

3 CU Simulation #1: Would Market Size Matter?

Section 3 considers CU formation in the perfectly-competitive world economy with four regions, symmetric in their factor abundances, production technologies, and consumer tastes, but different in their economic sizes. Two regions (*reg1* and *reg2*) are regarded as ‘small’ and the others (*reg3* and *reg4*) are referred to as ‘big’ in relative terms. Thus, the terms do not refer to these regions with respect to their influences on world prices, and a CU initiated by a small region may face retaliation from non-member regions.

As a small region, *reg1* considers liberalising trade with another region in order to facilitate its economic growth. First, this section explores the welfare effects of *reg1* forming a CU with another small region (*reg2*), and when the rest of the world (*reg3* and *reg4*) retaliates by forming another CU in response. Then, the second option for *reg1* is also investigated, where it forms a CU with another big region (*reg3*), and when that triggers another CU formation between the rest of the world (*reg2* and *reg4*).

3.1 Data Description

As mentioned above, benchmark data are symmetric across regions, although the data in small regions (*reg1* and *reg2*) are ten times less than those in big regions (*reg3* and *reg4*). As all prices are initially set to ones, the model is Walrasian in spirit and prices only matter in terms of their relative changes. Table 1 shows intermediate and factor inputs demanded by production sectors:

Table 1: Intermediate and Factor Inputs to Production Sectors in Four Regions

Production Inputs	*reg1* and *reg2*			*reg3* and *reg4*		
	sec1	*sec2*	*sec3*	*sec1*	*sec2*	*sec3*
sec1 (IO_1)	6	6	6	60	60	60
sec2 (IO_2)	6	6	6	60	60	60
sec3 (IO_3)	0	0	0	0	0	0
Labour (F_L)	5	5	5	50	50	50
Capital (F_K)	5	5	5	50	50	50
land (F_H)	4	4	4	40	40	40

Capital and land endowments thus equal the summation of primary inputs to production sectors; however, the labour endowment is the summation of those supplied to production sectors and the unemployed labour, which is 1 in small regions and 10 in large ones. Total government transfers to the household are 2 in small regions and 20 in large ones. The replacement rate is 0.5 in all regions, thus according to Equation (10), 25% of the transfers is in the form of unemployment benefits.

Substitution elasticities are identical in all sectors and regions. The substitution elasticity between the three factor inputs is 0.8; while that of the Armington production function is 2 for the upper level, and 4 for the lower level.

Next, consumption and investment demands by commodity are reported in Table 2. The government only consumes commodity *sec3*, leaving the rest to household consumption and investment.

Table 2: Consumption and Investment Demands in Four Regions

Commodity Demands	*reg1* and *reg2*			*reg3* and *reg4*		
	sec1	*sec2*	*sec1*	*sec2*	*sec1*	*sec2*
Household (*C*)	15	15	0	150	150	0
Government (*CG*)	0	0	26	0	0	260
Investment (*I*)	2	2	0	20	20	0

Household savings are 1 in small regions and 10 in big ones; while government savings are 3 in small regions and 30 in big ones. Their savings are passed on to the regional banks to purchase investment commodities in Table 2. Since the symmetry requires that the balance of payments is zero for all regions, foreign savings are zeroes, and household plus government savings equals the summation of investment demands in each region.

Since products are differentiated at border due to the Armington demand function, the cross-hauling of trade is common for tradable commodities (*sec1* and *sec2*) in Table 3, where imports are read on the rows and exports are read on the columns. To maintain the symmetry, the model finds identical two-way trade data between any pair of regions. Due to their economic sizes, small regions can only trade small volumes with the rest of the world. Big regions, on the other hand, can trade big volumes with each other.

Table 3: Bilateral Trade Flows of Tradable Goods

QBM	*reg1*	*reg2*	*reg3*	*reg4*	Total
reg1		2	2	2	6
reg2	2		2	2	6
reg3	2	2		56	60
reg4	2	2	56		60
Total	6	6	60	60	

Lastly, tax revenues are introduced to the production and consumption of non-public goods (*sec1* and *sec2*). Factor usage taxes are 1 in small regions and 10 in big ones, while commodity tax revenues are 3 in small regions and 30 in big ones. Income taxes are 13 in small regions, and 130 in big ones. Tariff revenues, on the other hand, are summarised in Tables 4, where each cell represents the import tariff payments by the exporting region in the column to the importing one in the row:

Table 4: Bilateral Tariffs Imposed On Tradable Goods

Bilateral Tariff	*reg1*	*reg2*	*reg3*	*reg4*	Total
reg1		1	1	1	3
reg2	1		1	1	3
reg3	1	1		28	30
reg4	1	1	28		30

3.2 Welfare Decomposition: The Equivalent Variation Approach

This paper uses the Equivalent Variation (EV) method in analysing the welfare effects of CU formations. It measures the income change induced by regional trade liberalisation, given the price at the benchmark year. In conjunction with the work of Varian (1992), the EV can be shown as:

$$EV^{reg} = \frac{Y^{reg}}{WPI_{1,0}^{reg}} - Y0^{reg}, \tag{41}$$

where regional incomes at the benchmark year and after the CU formation are denoted by $Y0^{reg}$ and Y^{reg}, respectively; and the simulated regional income is deflated by $WPI_{1,0}^{reg} = WPI^{reg} / WPI0^{reg}$, where regional welfare price indices at the benchmark year and after the CU formation are denoted by $WPI0^{reg}$ and WPI^{reg}. Next, let us focus on the definition of the regional welfare price index. Consistent with Blake (1998), the index is the geometric average of price indices perceived by the household, government, and bank, weighted by their budget shares in the CD form:

$$WPI^{reg} = \left(GPI^{reg}\right)^{\overline{\alpha GPI}^{reg}} \cdot \left(HPI^{reg}\right)^{\overline{\alpha HPI}^{reg}} \cdot \left(SPI^{reg}\right)^{\overline{\alpha SPI}^{reg}}, \tag{42}$$

where GPI^{reg}, HPI^{reg}, and SPI^{reg} denote consumer price indices of the government, household, and bank; and $\overline{\alpha GPI}^{reg}$, $\overline{\alpha HPI}^{reg}$, and $\overline{\alpha SPI}^{reg}$ denote budget shares of the government, household, and bank in the regional income.

These price indices are further defined as the geometric average of aggregate prices, weighted by their respective expenditure shares of the CD utility function:

$$GPI^{reg} = \prod_{\sec} (PA_{\sec}^{reg})^{\overline{\alpha CG_{\sec}^{reg}}} ; \tag{43}$$

$$HPI^{reg} = \prod_{\sec} \left(PA_{\sec}^{reg} \cdot (1 + \overline{tc}_{\sec}^{reg}) \right)^{\overline{\alpha HH_{\sec}^{reg}}} ; \tag{44}$$

$$SPI^{reg} = \prod_{\sec} (PA_{\sec}^{reg})^{\overline{\alpha I_{\sec}^{reg}}} . \tag{45}$$

The budget shares of the government, household, and bank are in the benchmark year, and should sum up to one ($\overline{\alpha GPI}^{reg} + \overline{\alpha HPI}^{reg} + \overline{\alpha SPI}^{reg} = 1$), therefore the CD property holds, i.e.:

$$\overline{\alpha GPI}^{reg} = CGBUD0^{reg} / Y0^{reg} ; \tag{46}$$

$$\overline{\alpha HPI}^{reg} = CBUD0^{reg} / Y0^{reg} \text{; and} \tag{47}$$

$$\overline{\alpha SPI}^{reg} = S0^{reg} / Y0^{reg} \text{, where} \tag{48}$$

$$CGBUD0^{reg} + CBUD0^{reg} + S0^{reg} = Y0^{reg} . \tag{49}$$

From the EV definition in Equation (41), the EV can be decomposed into the real income effect and the consumer surplus effect. The real income effect is the nominal change in regional income deflated by $WPI_{1,0}^{reg}$; and the consumer surplus effect shows the effect of rising prices on welfare:

$$EV^{reg} = \underbrace{\frac{Y^{reg} - Y0^{reg}}{WPI_{1,0}^{reg}}}_{\text{real income effect}} + \underbrace{\left(\frac{1}{WPI_{1,0}^{reg}} - 1 \right) \cdot Y0^{reg}}_{\text{consumer surplus effect}} \tag{50}$$

3.2.1 The Real Income Effect

The real income effect is decomposed into the production effect, tax-revenue effect, and capital-inflow effect. To derive these effects, the first term is decomposed as following:

$$\begin{aligned} \frac{Y^{reg} - Y0^{reg}}{WPI_{1,0}^{reg}} &= \frac{\left(CGBUD^{reg} + CBUD^{reg} + S^{reg} \right) - \left(CGBUD0^{reg} + CBUD0^{reg} + S0^{reg} \right)}{WPI_{1,0}^{reg}} \\ &= \underbrace{\left(\sum_{\sec} \sum_{fac} PF_{\sec}^{fac,reg} \cdot F_{\sec}^{fac,reg} - \sum_{\sec} \sum_{fac} PF0_{\sec}^{fac,reg} \cdot F0_{\sec}^{fac,reg} \right) / WPI_{1,0}^{reg}}_{\text{the production effect}} \\ &+ \underbrace{\left[(TREV^{reg} - TRY^{reg}) - (TREV0^{reg} - TRY0^{reg}) \right] / WPI_{1,0}^{reg}}_{\text{the tax-revenue effect}} \\ &+ \underbrace{(SF0^{reg} \cdot CPI^{reg} - SF0^{reg} \cdot CPI0^{reg}) / WPI_{1,0}^{reg}}_{\text{the capital-inflow effect}} . \end{aligned} \tag{51}$$

3.2.1.1 The Production Effect by Sector

The production effect is the change in the value-added after a shock, deflated by $WPI_{1,0}^{reg}$. Further, we can disaggregate the production effect by sector:

$$\left(\sum_{fac} PF_{\sec}^{fac,reg} \cdot F_{\sec}^{fac,reg} - \sum_{fac} PF0_{\sec}^{fac,reg} \cdot F0_{\sec}^{fac,reg} \right) / WPI_{1,0}^{reg} . \tag{52}$$

3.2.1.2 The Tax-revenue Effect by Type of Taxes and by Sector

Derived from Equation (14), the tax-revenue effect should comprise the welfare effects of changes in commodity taxes, factor usage taxes, import tariffs, and income taxes. Although, the change in income tax revenues is excluded, since they are paid by the household, so they do not really affect the regional income.

When the commodity tax revenue effect is defined as $(TRC^{reg} - TRC0^{reg}) / WPI_{1,0}^{reg}$, its effect by sector is decomposed as:

$$\left(\overline{tc}_{\sec T}^{reg}(C_{\sec T}^{reg} \cdot PA_{\sec T}^{reg} - C0_{\sec T}^{reg} \cdot PA0_{\sec T}^{reg})\right) / WPI_{1,0}^{reg} . \tag{53}$$

As for the factor usage tax revenue effect, similarly we have $(TRF^{reg} - TRF0^{reg}) / WPI_{1,0}^{reg}$, thus its effect by sector is:

$$\left(\sum_{fac} \overline{tf}_{\sec T}^{fac,reg}(F_{\sec T}^{fac,reg} \cdot PF_{\sec T}^{fac,reg} - F0_{\sec T}^{fac,reg} \cdot PF0_{\sec T}^{fac,reg})\right) / WPI_{1,0}^{reg} . \tag{54}$$

Since factor usage taxes are *ad-valorem*, the factor tax revenue effect is proportionate to the production effect in Equation (52).

Lastly, the import tariff revenue effect is: $(TRM^{reg} - TRM0^{reg}) / WPI_{1,0}^{reg}$, thus we know that its effect by sector is expressed as:

$$\left[\sum_{regg \neq reg} \overline{tm}_{\sec T}^{reg,regg} \cdot \begin{pmatrix} QBM_{\sec T}^{reg,regg} \cdot PWE_{\sec T}^{regg,reg} \cdot EXC^{reg} - \\ QBM0_{\sec T}^{reg,regg} \cdot PWE0_{\sec T}^{regg,reg} \cdot EXC0^{reg} \end{pmatrix}\right] / WPI_{1,0}^{reg} . \tag{55}$$

Note that no tax revenue effects are observed in the non-traded sector (*sec3*), as it is assumed to be a public sector, i.e. no tax/tariff imposition.

3.2.1.3 The Capital-Inflow Effect

The regional capital-inflow effect shown as the third term of Equation (51) is not further decomposed. Furthermore, since foreign savings are fixed to zeroes, the capital-inflow effect does not exist in this paper.

3.2.2 The Consumer Surplus Effect

The consumer surplus effect in the second term of Equation (50) can be decomposed into the effects on government, household, and investment bank. From Equation (49), we know that the consumer surplus effect is $(1/WPI_{1,0}^{reg} - 1) \cdot CGBUD0^{reg}$ for the government; $(1/WPI_{1,0}^{reg} - 1) \cdot CBUD0^{reg}$ for the household; and $(1/WPI_{1,0}^{reg} - 1) \cdot S0^{reg}$ for the investment bank. Hence, by definition, the relative benchmark budget constraints among these agents ($CGBUD0^{reg}$, $CBUD0^{reg}$, and $S0^{reg}$) determine the relative strengths of their consumer surplus effects.

3.3 Simulation Results

The motivation behind simulating a small region forming CUs with small and big regions is to pinpoint the welfare effects of CU formations with regions of different market sizes. The paper assumes that, even though the world economy is under perfect competition, and comparative advantage is ruled out since the model presumes symmetry in factor abundance among regions, a small region (*reg1*) may still substantially benefit from regional trade liberalisation, because under the Armington assumption, product differentiation between domestically-produced goods and imports from other regions implicitly yields monopolistic powers to commodities from different origins. Thus, even though regions are completely symmetric, regional market expansion with the Armington preference should yield positive gains to member regions.

The simulation results from the four CU scenarios are compared below in Tables 5 and 6.

Table 5: Percentage Changes in Macroeconomic Variables Given Four Types of CU Formations

Percentage change \ CU scenarios		*reg1+reg2*	*reg1+reg2 reg3+reg4*	*reg1+reg3*	*reg1+reg3 reg2+reg4*
Unemployed labour	*reg1*	-53.232	-29.824	-70.830	-60.630
	reg2	-53.232	-29.824	12.669	-60.630
	reg3	1.316	-99.925	-7.676	-2.470
	reg4	1.316	-99.925	5.162	-2.470
Real Gross Domestic Product (GDP)	*reg1*	1.295	0.823	1.672	1.472
	reg2	1.295	0.823	-0.265	1.472
	reg3	-0.027	2.419	0.183	0.076
	reg4	-0.027	2.419	-0.108	0.076
Aggregate imports (QM_{sec}^{reg})	*reg1* (*secT*[7])	32.007	20.517	42.060	36.781
	reg2 (*secT*)	32.007	20.517	-5.839	36.781
	reg3 (*secT*)	-0.614	64.263	4.215	1.174
	reg4 (*secT*)	-0.614	64.263	-2.398	1.174
Aggregate exports (QE_{sec}^{reg})	*reg1* (*secT*)	33.315	32.016	38.593	37.875
	reg2 (*secT*)	33.315	32.016	-2.485	37.875
	reg3 (*secT*)	-0.257	64.795	4.211	3.315
	reg4 (*secT*)	-0.257	64.795	-1.008	3.315

Table 6: The Terms-of-Trade (TOT) Index in Each Tradable Sector (*secT*) Given Four Types of CU Formations

TOT index \ CU scenarios	*reg1+reg2*	*reg1+reg2 reg3+reg4*	*reg1+reg3*	*reg1+reg3 reg2+reg4*
reg1 (*secT*)	1.185	1.123	1.239	1.211
reg2 (*secT*)	1.185	1.123	0.966	1.211
reg3 (*secT*)	0.996	1.360	1.025	1.011
reg4 (*secT*)	0.996	1.360	0.986	1.011

In Table 5, we observe within the same region similar types of adjustment in unemployment, real Gross Domestic Product (GDP), sectoral aggregate imports and exports, given the above-mentioned CU scenarios. For region *reg1*, these real variables respond most positively to the CU formation with a big region (*reg3*), and it is more likely that *reg1* will gain at a higher rate than *reg3*, because relative to total trade flows, a small member trades more with a big member than the big member does with the small one, due to the constraint in factor endowment thus production capacity of each region.

Even if the rest of the world forms another CU in response, *reg1* would still find the '*reg1+reg3'* CU more beneficial than the regional economic integration with another small region (*reg2*). Not surprisingly, if *reg1* forms the '*reg1+reg2*' CU and faces retaliation from the rest of the world (the *'reg3+reg4*' CU), the welfare gains will be lowest among the four options. As for other regions, percentage changes in real variables turn negative as they are left outside regional groupings, and the losses get bigger as the size of the CU economy grows.

In Table 6, the terms-of-trade (TOT) index is calculated as the ratio of the Laspeyres price index of regional exports to that of imports:

[7] For simulation results reported in the table format, note that '*secT*' and '*secTN*' refer to the welfare effects of CU formations on 'individual' tradable and non-traded sectors, respectively.

$$TOT^{reg} = \left(\frac{\sum_{secT} \frac{PE^{reg}_{secT}}{PE0^{reg}_{secT}} \cdot QE0^{reg}_{secT}}{\sum_{secT} QE0^{reg}_{secT}} \bigg/ \frac{\sum_{secT} \frac{PM^{reg}_{secT}}{PM0^{reg}_{secT}} \cdot QM0^{reg}_{secT}}{\sum_{secT} QM0^{reg}_{secT}} \right). \qquad (56)$$

By definition, this index captures the terms-of-trade change for each region, which improves when $TOT^{reg} > 1$; neutral when $TOT^{reg} = 1$; and deteriorates when $0 < TOT^{reg} < 1$. Presumably, the terms of trade is one of the factors that causes welfare gains or losses after a CU formation, thus the TOT index should be consistent with the simulation results observed in Table 5. As predicted, in Table 6, the terms of trade improve with the economic size of the regional grouping, among which small members gain more than big ones; the terms-of-trade gains reduce as the CU faces retaliation from the rest of the world; and non-members find their terms of trade progressively worsened as the CU size grows.

Next, Tables 7-10 summarise the welfare effects of four types of CU formations as the decomposed EVs in world currency ($) as defined in section 3.2.

Table 7: The EVs as Region *reg1* Forms a CU With Another Small Region (*reg2*)

Decomposed EVs (in world currency: $)			*reg1* & *reg2* (small)	*reg3* & *reg4* (big)
Real income effect	Production effect	*secT*	1.545	-0.202
		secTN	0.907	-0.577
	Tax revenue effect	Commodity taxes (*secT*)	0.255	-0.063
		Factor taxes (*secT*)	0.332	-0.043
		Tariffs (*secT*)	-0.851	-0.107
Consumer surplus effect	Household		-0.497	0.183
	Government		-0.430	0.159
	Bank		-0.066	0.024
Regional EV			2.476	-1.040

Table 8: The EVs as The Rest of The World Forms a '*reg3+reg4*' CU in Response to The '*reg1+reg2*' Regional Economic Integration

Decomposed EVs (in world currency: $)			*reg1* & *reg2* (small)	*reg3* & *reg4* (big)
Real income effect	Production effect	*secT*	1.275	30.709
		secTN	-0.303	14.240
	Tax revenue effect	Commodity taxes (*secT*)	0.144	4.828
		Factor taxes (*secT*)	0.275	6.608
		Tariffs (*secT*)	-1.199	-18.586
Consumer surplus effect	Household		-0.144	-8.776
	Government		-0.125	-7.606
	Bank		-0.019	-1.170
Regional EV			0.396	43.804

Table 9: The EVs as Region *reg1* Forms a CU With a Big Region (*reg3*)

Decomposed EVs (in world currency: $)			*reg1* (small)	*reg2* (small)	*reg3* (big)	*reg4* (big)
Real income effect	Production effect	*secT*	1.887	-0.195	1.987	-0.793
		secTN	1.547	-0.554	1.750	-2.260
	Tax revenue effect	Commodity taxes (*secT*)	0.340	-0.060	0.367	-0.246
		Factor taxes (*secT*)	0.405	-0.042	0.427	-0.169
		Tariffs (*secT*)	-0.837	-0.103	-0.822	-0.421
Consumer surplus effect	Household		-0.712	0.177	-0.797	0.720
	Government		-0.617	0.154	-0.691	0.624
	Bank		-0.095	0.024	-0.106	0.096
Regional EV			3.712	-1.000	4.071	-4.079

Table 10: The EVs as The Rest of The World Forms a '*reg2+reg4*' CU in Response to The '*reg1+reg3*' Regional Economic Integration

Decomposed EVs (in world currency: $)			*reg1 & reg2* (small)	*reg3 & reg4* (big)
Real income effect	Production effect	*secT*	1.776	1.220
		secTN	1.026	-0.598
	Tax-revenue effect	Commodity taxes (*secT*)	0.291	0.118
		Factor taxes (*secT*)	0.380	0.263
		Tariffs (*secT*)	-0.977	-1.032
Consumer surplus effect	Household		-0.564	-0.063
	Government		-0.488	-0.055
	Bank		-0.075	-0.008
Regional EV			2.817	-0.126

Overall, regional EVs reported in the last rows are in line with the welfare changes in real variables and the TOT index examined. Hence, if regions only differ in terms of their economic sizes and are identical otherwise, the best option for a small region (*reg1*) is to form a CU with bigger economies, since the economic gains are plausibly substantial enough to cancel out potential retaliation from the rest of the world in form of a counteracting CU formation. A big region, on the other hand, may not find a regional grouping with small regions attractive in economic terms, as it incurs institutional adjustment costs with little gains expected. However, a CU between small and big regions may still be formed for political reasons.

Next, the welfare effects of CU formations are decomposed and analysed. Note that in all scenarios, the production effects are the biggest sources of welfare changes, since higher trade volumes facilitate production booms in tradable sectors. Adjustments to the CU shock between small regions are explained in section 3.3.1; however, similar mechanisms can be observed in other types of CU formations, with exceptions later noted in sections 3.3.2-3.3.4.

3.3.1 The Welfare Effects of a CU Formation Between Small Regions (*reg1+reg2*)

(1) CU Members

Among CU members, as bilateral tariffs are abolished, the corresponding import prices should decrease, thus trade volumes among CU members increase by 140.3%. In CU member regions, as a secondary effect of the regional grouping, prices of imports from non-member regions are now higher than those from member regions, causing imports from non-members to drop by 15.7%.[8] Simultaneously, CU consumers substitute domestically-produced commodities with imports from other CU members, causing the 5.954% fall in sales of domestic products oriented to domestic markets. Overall, demands for Armington composite goods in CU members increase by 4.1% because of the expansion in private sectors due to the enlarged regional economic size. After the CU shock, bilateral exports between CU members increase by 140.3%. Taking the 20.2% drop in exports to non-members into account, aggregate export supplies still increase by 33.3%, hence domestic productions actually expand as a whole.

Now, let us focus on the welfare effects on factor demands in tradable sectors of CU members. Due to higher demands from other CU members, rates of return to primary factors unambiguously increase. Although, with unemployment in the labour market, the percentage changes of labour wages after an external shock will be smaller than those of the capital's rental rates, because the labour market is more flexible in the way that unemployed labour can enter the market when production sectors expand, thus providing cheaper costs per production unit, in comparison to the capital supply. As a result, capital rental rates rise by 10.0% and labour wages increase by 5.3%. Combined with higher factor input demands, the production effects for CU members equal \$1.545, which is the biggest source of EV, as mentioned previously. In particular, the production effects are strengthened, due to the magnification effect of the Stolper-Samuelson theorem that enables factor price changes to be higher than that of final good prices.

As for the production effects on the non-traded sector (*sec3*), factors of production are bid away as tradable sectors expand, causing its production to fall, and its price to rise due excess demands. Consequently, nominal returns to primary factors increase, though not as much as in the case of tradable ones.[9]

From Equations (52) and (54), the factor tax revenue effect is a fixed proportion of the production effect in the same sector. The tariff revenue effect is unambiguously negative, since CU members has eliminated import tariffs within the grouping, and tariff revenues received from non-members are also lower as imports are diverted from non-members to member countries. The commodity tax revenue effect, on the other hand, depends on private consumption and investment. Since returns to primary factors accrued to the household increase significantly, household incomes increase by 8.66%, thus we observe positive commodity tax revenue effects as household consumptions increase. Higher household incomes also raise household savings, and that increases regional investments on commodities and commodity tax payments to the government. Therefore, the commodity tax revenue effects in private sectors show positive signs.

Now we turn to the consumer surplus effects in CU member regions. From section 3.2.2, the key variable is the change in the regional welfare price index ($WPI_{1,0}^{reg}$) which depends on changes in Armington composite prices. As Armington prices rise, $WPI_{1,0}^{reg} > 1$, the consumer surplus effects on the household, government,

[8] The extent to which bilateral import demands increase with prices depends on the elasticity of substitution ($\overline{\sigma BM_{secT}^{reg}}$), as can be observed in Equation (33).
[9] Note that the production effects on *sec3* remain ambiguous in general. Once the fall in its production exceeds the rise in its price, the production effect may turn negative, which we observe in later scenarios.

and investment bank in CU regions are negative, and their respective values are proportionate to the initial budget constraints.

(2) Non-Members

The abolishment of import tariffs between CU members increases total trade demands in the world commodity market, thus shifting world prices of exports from CU regions by 5.9%. Since supply prices are not differentiated by their exporting destinations, non-members also face higher export prices which results in lower import demands from CU regions. Non-members then adjust to the changes in relative world prices by trading more between themselves. However, the negative effects of such CU formation reduce aggregate imports of non-members by 0.6%.[10] This, in turn, expands domestic production by 0.1% to meet domestic demands. Regarding non-members' exports, the decrease in exports to CU members lowers aggregate exports by 0.3%. Therefore, the CU formation is likely to cause non-members negative real GDP growth rates, as in Table 5.

Inevitably, declining import demands from CU members push down supply prices in non-member regions, which imply lower rates of return to primary factors. As a result, the production effects on tradable sectors are negative. The tariff revenue effects also drop, as aggregate import demands decline with the CU formation. As the economies of non-member regions head for recession, the household and bank consume less, and the commodity tax-revenue effects turn negative. Therefore, the government receives lower tax revenues, which leads to decreased demands for public goods. This, in turn, explains why we observe more negative values of the production effects of public sectors (*sec3*), in relation to those in private sectors (*sec1* and *sec2*).

Naturally, economic contraction reduces their regional welfare price indices, and in turn yields positive consumer surplus effects in non-member regions. As a consequence, the regional EVs in non-member regions are negative, though not remarkably, since the ratios of trade with (small) CU members to total consumptions in (big) non-member regions are diminutive.

3.3.2 The Welfare Effects of CU Formations Between Small Regions (*reg1+reg2*) in the Presence of Another CU Between Big Regions (*reg3+reg4*)

(1) CU Formation Between Small regions (reg1 and reg2)

The economic effects on small CU economies in the presence of another CU formed between big regions are compared with that in section 3.3.1. In general, small regions benefit less from CU formation as they face retaliation from the rest of the world. In this scenario, bilateral imports between small CU nations increase by 171.4%, much higher than in section 3.3.1, since small regions now face higher trade barriers from the rest of the world. Thus, aggregate imports rise only by 20.5%, compared to the 32.0% increase in section 3.3.1; and aggregate exports expand only by 7.9%, since big regions now divert imports from small regions to their CU counterparts. As a result, the real income and consumer surplus effects in Table 8 are weaker than that in Table 7, except for the tariff revenue effects that yield stronger negative values, as the decrease in tariff revenues are not only caused by tariff abolition between small regions, but also

[10] Note that the difference in economic sizes is the reason behind such a small percentage change in non-member countries.

exacerbated by big regions forming their own preferential trading arrangement, causing trade volumes between small and big regions to drop by 41.6%. Also, the production effects on the non-traded sector (*secTN*) become negative, as the falling commodity and thus factor demands in the non-traded sector outweighs the moderate increase in their corresponding prices, due to the dwindling total tax revenues after the shock and also the increasing prices of mobile factors. The recession in the non-traded sector also causes the rental rates of land to drop by 3.2%, thus the adverse effects on this sector are conceivable in the presence of counteracting CU formations.

(2) CU Formation Between Big regions (reg3 and reg4)

The simulation outcomes for these regions are comparable to those reported in section 3.3.1 for CU members, with the magnitude being accentuated due to the ten-time bigger market sizes. Also, in this scenario, the welfare outcomes for big regions are not interrupted by the presence of the CU between small regions, because supposedly, bilateral trade with these regions are relatively small compared to their GDP sizes.

3.3.3 The Welfare Effects of a CU Formation Between Small and Big Regions (*reg1*+*reg3*)

(1) CU Members

In Tables 5 and 6, the percentage changes in key variables perceived by the small region (*reg1*) are roughly ten times higher than those observed in the big region (*reg3*), as its economic size and capacity to trade are 10% of the bigger one. Thus, generally speaking, the results indicate that, for CU members, the proportional changes in variables are inversely proportionate to the initial sizes of their economies. Given the definition of the decomposed money metric measures of utility in section 3.2 and the changes in variables mentioned above, between the two CU members, the magnitude of each of the decomposed EV shares proximity, and the general direction of changes is consistent with the outcomes in section 3.3.1, as shown in Table 9. Specifically, since the rising in the welfare price index of the small region is stronger than that in the big region, the CU simulation yields slightly lower EVs on the small region.

(2) Non-Members

For the small and big regions outside the grouping, the proposed change casts analogous welfare effects on their economies, and the mechanism resembles that is explained in section 3.3.1. Similar to the case of member regions, the magnitudes of the decomposed EVs on non-members are proportionate to their economic sizes, though the differences in the decomposed EVs across non-member regions are greater than those expected in CU member regions. Such gaps are also captured in the third column of Table 5, where the proportional changes in macroeconomic variables of the small non-member region (*reg2*) only double those of the big non-member region (*reg4*), while their market sizes are different by ten times. Therefore, we may conclude that *reg2* and *reg4* are certainly worse off due to trade diversion caused by the CU formation between *reg1* and *reg3*, but in relative terms, *reg2* loses less than *reg4* because the consequential higher trade barriers against these non-members bring about higher trade between *reg2* and *reg4*, and the losses for *reg2* are smaller in comparison to *reg4*, since *reg2* now has better access to the big market in *reg4*, but *reg4* has to re-direct its trade from the big CU member to a smaller one in *reg2*.

3.3.4 The Welfare Effects of CU Formations Between Regions of Different Sizes (‘*reg1+reg2*’ and ‘*reg3+reg4*’ CUs)

(1) Small Regions

The regional EVs for small regions in Table 10 are smaller than that reported in Table 9. In brief, the emergence of another CU in the world economy certainly tones down the welfare gains for small members, since it reduces bilateral imports by small members from countries outside the grouping, thus the positive CU effects on prices and quantities of small regions are diminished by the counteraction.

(2) Big Regions

In Table 10, the regional EVs for big regions noticeably show negative signs, supposedly due to strong trade diversion effects: given certain substitution elasticities between imports from CU members and non-members, bilateral imports from the big non-member are substantially compensated by those from the small grouping counterpart. In this scenario, the welfare effects on big economies become negative, since they cannot expect equivalently strong trade creation effects from regionally liberalising trade with the region 10% of their sizes. It is also observed in section 3.3.3 that, a preferential trading arrangement between small and big regions with no retaliation from the rest of the world yields trade-diverting effects on the big CU member, such that we find the big member (*reg3*) not gaining much more than the small member (*reg1*) in terms of EVs.

The decomposed EVs reported in Table 10 for big members illustrate the sources of such negative regional EVs. In this table, big members do not only record moderate values of decomposed EVs, but they also lose a significant amount of import tariff revenues that accordingly reduces demands for the public good and causes contraction in this sector. As a result, the production effect in sector *secTN* strongly turns negative, as does the money metric measures of utility in big member regions. However, the simulation results in the fourth column of Tables 5 and 6 indicate that in real terms, big regions still slightly benefit from the regional groupings, as real variables respond positively to the shock.

4 CU Simulation #2: How Does Market Structure Alter The Outcomes?

Section 4 examines the way different types of market structures alter the CGE simulation results on the verge of regional economic integration. In the first scenario, this section analyses the CU formation between *reg1* and *reg2*, assuming perfect competition. Then, the second scenario allows for Cournot oligopoly in homogeneous commodity markets without barriers to entry/exit the industries; and the third one assumes Cournot oligopoly with entry/exit barriers. In the fourth and fifth scenarios, this paper studies the outcomes of the regional grouping as the above Cournot oligopoly assumption is replaced by monopolistic competition with horizontal product differentiation between firms within the same sector.

4.1 Imperfect Competition and CGE Modelling

Under the constant returns to scale assumption, markets are perfectly competitive, and commodity prices are adjusted to be identical to average costs. Since marginal costs do not vary with the scale of production, average costs are also equal to marginal costs. On the other hand, increasing returns to scale are associated with imperfectly competitive markets. When production incurs fixed costs, as average costs are the summation of fixed and variable costs per unit of production; and marginal costs only refer to variable costs per unit, imperfectly competitive sectors with fixed costs tend to have average costs higher than marginal ones, and that means every additional cost per unit of production should reduce the average costs, and there we have the internal economies of scale, which implies imperfect competition as firms always have the incentive to expand their production scales. Imperfect competition tends to incur welfare losses, since firms are capable of setting market prices above marginal costs. However, after trade liberalisation, competition from abroad will lower domestic prices and reduce domestic market powers of imperfectly competitive firms (Brander, 1981).

Following Willenbockel (2004), imperfect competition is incorporated into the model described in section 2 to investigate how commodity markets operate under the internal economies of scale. In a world economy comprised four regions, only one tradable private sector (*sec1*) remains under perfect competition, henceforth denoted by *pc*. The other sectors, on the other hand, become under imperfect competition, denoted by *ic*. Precisely, the set of commodities is:

sec = {pc, ic}, where:

pc = {sec1} and *ic = {sec2, sec3}*.

Imperfectly competitive sectors are populated by NOF_{ic}^{reg} firms producing homogeneous commodities. Without entry barriers, the number of firms adjusts to ensure sectoral zero profit conditions. When fixed factor inputs for each 'firm' are denoted by $\overline{ff}_{ic}^{fac,reg}$, fixed factor inputs for each 'sector' solely depend on the number of firms, and as a trade policy change triggers firms to enter (exit) the industry, sectoral fixed factor costs increase (drop), thus causing inefficiency (efficiency) as the increasing returns to scale is less (more) exploited under the proposed change. When denoting sectoral variable factor inputs by $FV_{ic}^{fac,reg}$, total factor inputs read:

$$F_{ic}^{fac,reg} = FV_{ic}^{fac,reg} + NOF_{ic}^{reg} \cdot \overline{ff}_{ic}^{fac,reg}. \quad (57)$$

Sectoral variable factor demands ($FV_{ic}^{fac,reg}$) are in turn determined by factor prices and output levels, thus the CES production function in Equation (3) is replaced by:

$$FV_{ic}^{fac,reg} = \frac{\left(\dfrac{\overline{\gamma F}_{ic}^{fac,reg}}{(1+\overline{tf}_{ic}^{fac,reg}) \cdot PF_{ic}^{fac,reg}} \right)^{\overline{\sigma F}_{ic}^{reg}}}{\overline{aF}_{ic}^{reg} \left\{ \sum_{fac} (\overline{\gamma F}_{ic}^{fac,reg})^{\overline{\sigma F}_{ic}^{reg}} \left[(1+\overline{tf}_{ic}^{fac,reg}) \cdot PF_{ic}^{fac,reg} \right]^{1-\overline{\sigma F}_{ic}^{reg}} \right\}^{\frac{\overline{\sigma F}_{ic}^{reg}}{\overline{\sigma F}_{ic}^{reg}-1}}} \cdot QZ_{ic}^{reg}. \quad (58)$$

4.1.1 Cournot Oligopolistic Sectors with Homogeneous Products

1) Profit Maximisation Under Cournot Oligopoly

Total profits of firms are expressed as:

$$\Pi = PZ \cdot qz - MC \cdot qz, \quad (59)$$

where PZ represents sectoral commodity prices; qz denotes output levels of firms; and MC stands for marginal costs. [11] Firms maximise profits with respect to output quantities, thus they produce where $\partial \Pi / \partial qz = 0$. In other words, marginal revenues read:

$$MR = \frac{\partial (PZ \cdot qz)}{\partial qz} = MC,$$

$$\therefore MR = PZ + \frac{\partial PZ}{\partial qz} \cdot qz = PZ\left(1 + \frac{\partial PZ}{\partial qz} \cdot \frac{qz}{PZ}\right) = PZ\left(1 + \frac{\partial PZ}{\partial QZ} \cdot \frac{\partial QZ}{\partial qz} \cdot \frac{qz}{PZ}\right).$$

Since Cournot oligopoly assumes no retaliation among domestic rivals in the same sector, any change in output levels of firms do not alter those of other firms in the same industry, i.e. $\partial QZ/\partial qz = 1$. Thus, marginal revenues are rephrased as:

$$MR = PZ\left(1 + \frac{\partial PZ}{\partial QZ} \cdot \frac{QZ}{PZ} \cdot \frac{qz}{QZ}\right). \tag{60}$$

As each firm produces the same output level, we know that $qz/QZ = 1/NOF$, therefore:

$$MR = PZ\left(1 - \frac{1}{EDM} \cdot \frac{1}{NOF}\right) = MC, \tag{61}$$

where EDM denotes the elasticity of demand perceived by firms:

$$EDM = -\left(\frac{\partial QZ}{QZ} \Big/ \frac{\partial PZ}{PZ}\right). \tag{62}$$

When the symbol '^' represents the proportional change of a variable, EDM can also be expressed as $EDM = -\hat{Q}Z / \hat{P}Z$. Since the mark-ups of firms equal sectoral commodity prices (PZ) less marginal costs (MC), they increase with the prices and are inversely proportionate to the elasticity of demand and number of firms:

$$MUP = PZ - MC = \frac{PZ}{EDM \cdot NOF}. \tag{63}$$

Hence, the mark-up pricing equation below is added to the model explained in section 2 to ensure that $MR = MC$, thus firms maximise profits under Cournot oligopoly:

$$PZ_{ic}^{reg} \cdot \left(1 - \frac{1}{EDM_{ic}^{reg} \cdot NOF_{ic}^{reg}}\right) = \begin{pmatrix} \sum_{fac} (1 + tf_{ic}^{fac,reg}) \cdot PF_{ic}^{fac,reg} \cdot FV_{ic}^{fac,reg} \\ + \sum_{sec} PA_{sec}^{reg} \cdot IO_{sec,ic}^{reg}. \end{pmatrix} / QZ_{ic}^{reg}, \tag{64}$$

and Equation (64) can be simplified as:

$$PZ - MUP = VC/QZ, \tag{65}$$

where VC denotes sectoral variable costs. Now, this section returns to the general property of imperfect competition. For the whole industry, the free entry assumption ensures that the zero-profit condition in Equation (4) still holds: total revenues equal total costs, or $TR = TC$. When sectoral fixed costs are denoted by FC, Equation (4) can also be expressed as:

$$QZ \cdot PZ = FC + VC. \tag{66}$$

Divide this equation by sectoral outputs to derive average costs (AC):

[11] For brevity, subscripts (*ic*) and superscripts (*reg*) are abbreviated here, but will be appended again later when referring to certain equations in the model.

$PZ = FC/QZ + VC/QZ = AC.$ (67)

Therefore, under imperfect competition with free entry and exit of firms, it is always true that $PZ = AC > MC = MR$. Moreover, from Equations (65) and (67), as sectoral profits are always zero, mark-ups will be just high enough to cover unit fixed costs, thus:

$FC/QZ = MUP.$ (68)

2) Perceived Elasticity of Demand Under Cournot Oligopoly

The expression for the perceived elasticity of demand (EDM_{ic}^{reg}) varies with its tradability, thus such elasticities are derived separately as following.

Non-Traded Sector

From Equations (35) and (37), domestic demands for non-traded goods should be equal to total outputs in each sector:

$$QZ_{\sec TN}^{reg} = CG_{\sec TN}^{reg}. \quad (69)$$

Take a natural logarithm of Equation (69) to find the expression for the perceived elasticity of demand:

$$\ln(QZ_{\sec TN}^{reg}) = \ln\left(\frac{\alpha CG_{\sec TN}^{\text{reg}} \cdot CGBUD^{reg}}{PA_{\sec TN}^{\text{reg}}}\right) = \ln(*) \cdot \quad (70)$$

Since $PA_{\sec TN}^{reg} = PZ_{\sec TN}^{reg}$, and firms perceive to have no influence on $CGBUD^{reg}$, total differentiation of Equation (70) yields:

$$\frac{d\ln(QZ_{\sec TN}^{reg})}{dQZ_{\sec TN}^{reg}} \cdot dQZ_{\sec TN}^{reg} = \frac{d\ln(*)}{dQZ_{\sec TN}^{reg}} \cdot dQZ_{\sec TN}^{reg} + \frac{d\ln(*)}{dPZ_{\sec TN}^{reg}} \cdot dPZ_{\sec TN}^{reg}, \text{ or}$$

$$\frac{dQZ_{\sec TN}^{reg}}{QZ_{\sec TN}^{reg}} = -\frac{CG_{\sec TN}^{reg}}{PZ_{\sec TN}^{reg} \cdot (*)} \cdot dPZ_{\sec TN}^{reg}. \text{ That implies:}$$

$$\hat{Q}Z_{\sec TN}^{reg} = -\frac{CG_{\sec TN}^{reg}}{QZ_{\sec TN}^{reg}} \cdot \hat{P}Z_{\sec TN}^{reg}. \quad (71)$$

Therefore, from Equation (62), the perceived elasticity of demand for non-traded sectors under Cournot oligopoly is:

$$EDM_{\sec TN}^{reg} = -\hat{Q}Z_{\sec TN}^{reg} \big/ \hat{P}Z_{\sec TN}^{reg} = CG_{\sec TN}^{reg} \big/ QZ_{\sec TN}^{reg}. \quad (72)$$

Tradable Sector

This paper further assumes that domestic firms in tradable sectors under Cournot oligopoly do not regard foreign firms as their business competitors. Thus, the perceived elasticity of demand neither takes into account reactions from 'domestic' or 'foreign' rival firms, as it also assumes no retaliation from domestic rivals in the same sector. In addition, from section 2.5.1, markets are internationally integrated such that the law of one price reigns globally, and firms charge universal supply prices across regional market segments. In other words, there is no discrimination between prices of domestic goods produced for the domestic market and for exports: $PZ_{\sec T}^{reg} = PD_{\sec T}^{reg} = PE_{\sec T}^{reg}$.

Given the above assumptions, the perceived elasticity of demand for tradable sectors is thus the weighted average of such elasticities within own and foreign markets:

$$EDM_{\sec T}^{reg} = \frac{QDD_{\sec T}^{reg}}{QZ_{\sec T}^{reg}} \cdot EDM_{\sec T}^{reg,reg} + \sum_{regg \neq reg} \frac{QBM_{\sec T}^{regg,reg}}{QZ_{\sec T}^{reg}} \cdot EDM_{\sec T}^{reg,regg} , \tag{73}$$

where $QDD_{\sec T}^{reg} + \sum_{regg \neq reg} QBM_{\sec T}^{regg,reg} = QZ_{\sec T}^{reg}$.

Accordingly, to find a solution for Equation (73), such perceived elasticities of demand within own and foreign markets are to be calculated, separately.

The former elasticity $\left(EDM_{\sec T}^{reg,reg}\right)$ is derived by log differentiating Equation (29):

$$Q\hat{D}D_{\sec T}^{reg} = \overline{\sigma A}_{\sec T}^{reg} \cdot \hat{P}A_{\sec T}^{reg} - \overline{\sigma A}_{\sec T}^{reg} \cdot \hat{P}D_{\sec T}^{reg} + \hat{Q}A_{\sec T}^{reg} . \tag{74}$$

Since this elasticity is defined as: $EDM_{\sec T}^{reg,reg} = -Q\hat{D}D_{\sec T}^{reg} / \hat{P}D_{\sec T}^{reg}$, Equation (74) can be rewritten as following:

$$EDM_{\sec T}^{reg,reg} = -\overline{\sigma A}_{\sec T}^{reg} \cdot \frac{\hat{P}A_{\sec T}^{reg}}{\hat{P}D_{\sec T}^{reg}} + \overline{\sigma A}_{\sec T}^{reg} - \frac{\hat{Q}A_{\sec T}^{reg}}{\hat{P}A_{\sec T}^{reg}} \cdot \frac{\hat{P}A_{\sec T}^{reg}}{\hat{P}D_{\sec T}^{reg}} . \tag{75}$$

Since $\hat{P}A_{\sec T}^{reg} / \hat{P}D_{\sec T}^{reg}$ reflects the share of the expenditure on domestically-produced goods ($QD_{\sec T}^{reg} \cdot PD_{\sec T}^{reg}$) in total Armington composite commodity group expenditure ($QA_{\sec T}^{reg} \cdot PA_{\sec T}^{reg}$), or:

$$\frac{\hat{P}A_{\sec T}^{reg}}{\hat{P}D_{\sec T}^{reg}} = \frac{PD_{\sec T}^{reg} \cdot QD_{\sec T}^{reg}}{PA_{\sec T}^{reg} \cdot QA_{\sec T}^{reg}} ; \tag{76}$$

and supposedly, $\hat{Q}A_{\sec T}^{reg} / \hat{P}A_{\sec T}^{reg} = -1$, as firms perceive themselves to have no influences on the aggregate group expenditure ($QA_{\sec T}^{reg} \cdot PA_{\sec T}^{reg}$) given any change in $PA_{\sec T}^{reg}$ due to the CD domestic demand property; Equation (75) can be rewritten as following:

$$\therefore EDM_{\sec T}^{reg,reg} = \overline{\sigma A}_{\sec T}^{reg} - \left(\overline{\sigma A}_{\sec T}^{reg} - 1\right) \cdot \frac{PD_{\sec T}^{reg} \cdot QD_{\sec T}^{reg}}{PA_{\sec T}^{reg} \cdot QA_{\sec T}^{reg}} . \tag{77}$$

Similarly, the latter perceived elasticity of demand for bilateral imports from region *reg* to region *regg* ($EDM_{\sec T}^{reg,regg}$) can be derived by log differentiating the following equation, in which Equation (30) is substituted into Equation (33):

$$QBM_{\sec T}^{regg,reg} = \left(\overline{aBM}_{\sec T}^{regg}\right)^{\overline{\sigma BM}_{\sec T}^{regg} - 1} * \left(\frac{\overline{\gamma BM}_{\sec T}^{regg,reg} \cdot PM_{\sec T}^{regg}}{PBM_{\sec T}^{regg,reg}}\right)^{\overline{\sigma BM}_{\sec T}^{regg}} * \left(\overline{aA}_{\sec T}^{regg}\right)^{\overline{\sigma A}_{\sec T}^{regg} - 1} * \left(\frac{\overline{\gamma AM}_{\sec T}^{regg} \cdot PA_{\sec T}^{regg}}{PM_{\sec T}^{regg}}\right)^{\overline{\sigma A}_{\sec T}^{regg}} * QA_{\sec T}^{regg} . \tag{78}$$

The log differentiation yields:

$$Q\hat{B}M_{\sec T}^{regg,reg} = \left(\overline{\sigma BM}_{\sec T}^{regg} - \overline{\sigma A}_{\sec T}^{regg}\right) \cdot \hat{P}M_{\sec T}^{regg} - \overline{\sigma BM}_{\sec T}^{regg} \cdot P\hat{B}M_{\sec T}^{regg,reg} + \overline{\sigma A}_{\sec T}^{regg} \cdot \hat{P}A_{\sec T}^{regg} + \hat{Q}A_{\sec T}^{regg} .$$

This equation can be rephrased as following:

$$
\begin{aligned}
EDM_{\sec T}^{reg,regg} &= -\frac{Q\hat{B}M_{\sec T}^{regg,reg}}{P\hat{B}M_{\sec T}^{regg,reg}} \\
&= \overline{\sigma BM}_{\sec T}^{regg} - \left(\overline{\sigma BM}_{\sec T}^{regg} - \overline{\sigma A}_{\sec T}^{regg}\right)\frac{\hat{P}M_{\sec T}^{regg}}{P\hat{B}M_{\sec T}^{regg,reg}} - \overline{\sigma A}_{\sec T}^{regg}\frac{\hat{P}A_{\sec T}^{regg}}{P\hat{B}M_{\sec T}^{regg,reg}} - \underbrace{\frac{\hat{Q}A_{\sec T}^{regg}}{\hat{P}A_{\sec T}^{regg}}}_{=-1}\frac{\hat{P}A_{\sec T}^{regg}}{P\hat{B}M_{\sec T}^{regg,reg}} \\
&= \overline{\sigma BM}_{\sec T}^{regg} - \left(\overline{\sigma BM}_{\sec T}^{regg} - \overline{\sigma A}_{\sec T}^{regg}\right)\frac{\hat{P}M_{\sec T}^{regg}}{P\hat{B}M_{\sec T}^{regg,reg}} - \left(\overline{\sigma A}_{\sec T}^{regg} - 1\right)\frac{\hat{P}A_{\sec T}^{regg}}{P\hat{B}M_{\sec T}^{regg,reg}}.
\end{aligned}
$$

Similar to Equation (76), $\hat{P}M_{\sec T}^{regg} / P\hat{B}M_{\sec T}^{regg,reg}$ and $\hat{P}A_{\sec T}^{regg} / P\hat{B}M_{\sec T}^{regg,reg}$ represent the shares of imports from region *reg* in total import values and composite commodity group expenditures of region *regg*, respectively. Therefore, the perceived elasticity of demand for Cournot oligopolistic commodity group *secT* in region *regg* is expressed as:

$$
\begin{aligned}
\therefore EDM_{\sec T}^{reg,regg} &= \overline{\sigma BM}_{\sec T}^{regg} - \left(\overline{\sigma BM}_{\sec T}^{regg} - \overline{\sigma A}_{\sec T}^{regg}\right)\frac{PBM_{\sec T}^{regg,reg} \cdot QBM_{\sec T}^{regg,reg}}{PM_{\sec T}^{regg} \cdot QM_{\sec T}^{regg}} \\
&\quad - \left(\overline{\sigma A}_{\sec T}^{regg} - 1\right)\frac{PBM_{\sec T}^{regg,reg} \cdot QBM_{\sec T}^{regg,reg}}{PA_{\sec T}^{regg} \cdot QM_{\sec T}^{regg}}.
\end{aligned}
\tag{79}
$$

Hence, the perceived demand elasticities in tradable sectors are derived by substituting Equation (77) and (79) into Equation (73):

$$
\begin{aligned}
\therefore EDM_{\sec T}^{reg} &= \frac{QDD_{\sec T}^{reg}}{QZ_{\sec T}^{reg}}\left(\overline{\sigma A}_{\sec T}^{reg} - \left(\overline{\sigma A}_{\sec T}^{reg} - 1\right)\frac{PD_{\sec T}^{reg} \cdot QD_{\sec T}^{reg}}{PA_{\sec T}^{reg} \cdot QA_{\sec T}^{reg}}\right) \\
&+ \sum_{regg \neq reg}\frac{QBM_{\sec T}^{regg,reg}}{QZ_{\sec T}^{reg}}\left(\begin{array}{l}\overline{\sigma BM}_{\sec T}^{regg} - \left(\overline{\sigma BM}_{\sec T}^{regg} - \overline{\sigma A}_{\sec T}^{regg}\right)\dfrac{PBM_{\sec T}^{regg,reg} \cdot QBM_{\sec T}^{regg,reg}}{PM_{\sec T}^{regg} \cdot QM_{\sec T}^{regg}} \\ - \left(\overline{\sigma A}_{\sec T}^{regg} - 1\right)\dfrac{PBM_{\sec T}^{regg,reg} \cdot QBM_{\sec T}^{regg,reg}}{PA_{\sec T}^{regg} \cdot QM_{\sec T}^{regg}}\end{array}\right).
\end{aligned}
\tag{80}
$$

4.1.2 Monopolistic Competition Sectors with Horizontal Heterogeneous Products

This section explains how to incorporate monopolistic competition with the Dixit-Stiglitz (1977)'s Love-Of-Variety preference. In monopolistically competitive sectors, consumers regard products in the same sector as perfectly substitutable, yet distinguishable. Since products from different firms are 'heterogeneous' by definition, they possess a certain kind of monopolistic power, similarly assumed by the Armington demand function.

1) Intra-Industry Product Differentiation: Love-Of-Variety Preference

Figure 5 illustrates the structure of the quantity group index of sector *sec2* in a region. Perfectly substitutable products are heterogeneous but can be grouped into sectors, thus, firms use similar production technologies across varieties within a sector.

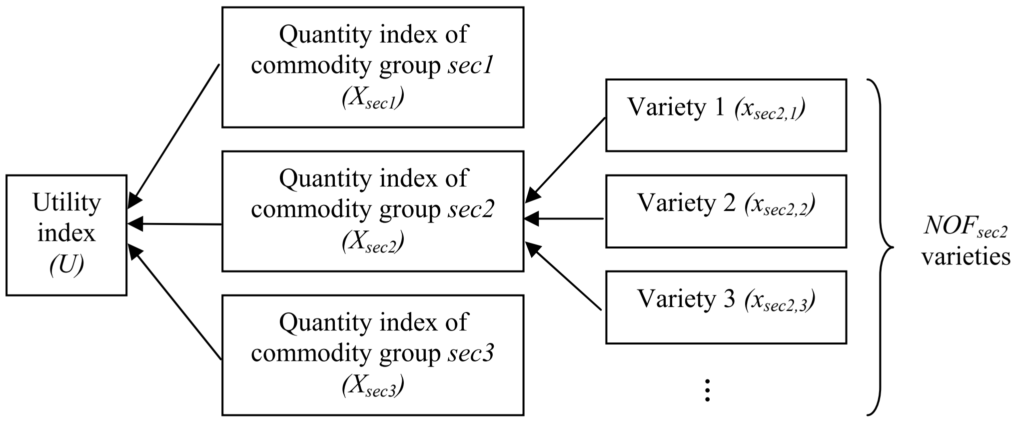

Figure 5: Structure of the commodity group index comprising outputs from individual firms in *sec2*

At the upper stage, consumers maximise their utility indices by allocating their consumption budgets across commodity groups (X_{sec}), of which values depend entirely on their corresponding price indices (P_{sec}), according to the CD demand property. At the lower stage, X_{sec} is a composite index of outputs from heterogeneous firms ($x_{sec,i}$) dual to the individual prices denoted by $p_{sec,i}$; and the number of firms in each group is denoted by NOF_{sec}, where $i = \{1, 2, ..., NOF_{sec}\}$ is a set of individual varieties in sector *sec.*

Green (1964) suggests that commodity groupings are strictly justified if:

(1) the by-product of X_{sec} and P_{sec} equals the summation of consumption expenditures on individual varieties; and also if:

(2) the 'two-stage' maximisation procedure is consistent, which means that the optimal individual commodity consumption determined by this procedure is identical to the amount which would have been purchased had the utility been maximised with respect to the individual prices without any grouping.

The first requirement can be phrased as:

$$P_{\sec} \cdot X_{\sec} = \sum_{i=1}^{NOF_{\sec}} p_{\sec,i} \cdot x_{\sec,i} \,. \tag{81}$$

Since these varieties are perfect substitutes, individual prices and quantities are universal within a sector, thus equation (81) can be re-written as:

$$P_{\sec} \cdot X_{\sec} = NOF_{\sec} \cdot p_{\sec} \cdot x_{\sec} \,. \tag{82}$$

As for the second requirement, the two-stage maximisation consistency is satisfied when either weak or strong separability holds. Weak separability[12] requires that if there are only two groups in the economy, the necessary and sufficient conditions for individual quantities and prices to be grouped in forms of X_{sec} and P_{sec}, respectively, are that the marginal rate of substitution between any pair of individual commodities in a group shall be independent of any quantities outside the group. Green (1964) proved that if there are more than two groups, weak separability is no longer sufficient for the grouping. The strong separability, on the other hand, satisfies the necessary and sufficient conditions for the two-stage maximisation consistency,

[12] The condition of the grouping is also termed as "functional separability" by Leontief (1947).

and thus justifying the grouping, even when the number of groups is higher than two. It only requires that each group output index X_{sec} is a function homogeneous of degree one in its individual outputs (x_{sec}). Thus, a θ% change in individual commodity consumption will result in an equivalent θ% change in commodity group index and the consumer's total expenditure, holding prices constant.

Dixit and Stiglitz (1977) then satisfy the above requirements by setting a homothetic utility function: $U = u(X_{sec1}, X_{sec2}, X_{sec3})$, of which the quantity index is expressed as the CES function of individual quantities:

$$X_{\sec} = \left[\sum_{i=1}^{NOF_{\sec}} \left(x_{\sec,i}\right)^{\frac{\overline{\sigma LV}_{\sec}-1}{\overline{\sigma LV}_{\sec}}}\right]^{\frac{\overline{\sigma LV}_{\sec}}{\overline{\sigma LV}_{\sec}-1}}, \tag{83}$$

where $\overline{\sigma LV}_{\sec}$ is the elasticity of substitution between varieties within a group[13]. Similar to how Equation (82) is derived, the function of perfectly substitutable individual varieties in Equation (83) can be rewritten as:

$$X_{\sec} = \left[NOF_{\sec} \cdot \left(x_{\sec}\right)^{\frac{\overline{\sigma LV}_{\sec}-1}{\overline{\sigma LV}_{\sec}}}\right]^{\frac{\overline{\sigma LV}_{\sec}}{\overline{\sigma LV}_{\sec}-1}} = \left(NOF_{\sec}\right)^{\frac{\overline{\sigma LV}_{\sec}}{\overline{\sigma LV}_{\sec}-1}} \cdot x_{\sec}. \tag{84}$$

Accordingly, the price index dual to X_{sec} can be derived as:

$$P_{\sec} = \left[\sum_{i=1}^{NOF_{\sec}} (p_{\sec,i})^{1-\overline{\sigma LV}_{\sec}}\right]^{\frac{1}{1-\overline{\sigma LV}_{\sec}}} = \left[NOF_{\sec} (p_{\sec})^{1-\overline{\sigma LV}_{\sec}}\right]^{\frac{1}{1-\overline{\sigma LV}_{\sec}}} = (NOF_{\sec})^{\frac{1}{1-\overline{\sigma LV}_{\sec}}} \cdot p_{\sec}. \tag{85}$$

Thus, Equations (84) and (85) satisfy Equation (82), and are homogeneous of degree one in their individual outputs and prices, respectively. Subsequently, we can derive the demand function for individual variety from these two equations:

$$x_{\sec} = \left(\frac{P_{\sec}}{p_{\sec}}\right)^{\overline{\sigma LV}_{\sec}} \cdot X_{\sec}. \tag{86}$$

2) Profit Maximisation of Heterogeneous Firms

As in the case of Cournot oligopoly with homogeneous products, under monopolistic competition, individual firms maximise profits with respect to their output levels, thus equating marginal revenues (MR_{sec}) to marginal costs (MC_{sec}):

$$\frac{\partial}{\partial x_{\sec}}\left(p_{\sec} \cdot x_{\sec} - MC_{\sec} \cdot x_{\sec}\right) = 0 \text{, that is to say:} \tag{87}$$

$$\frac{\partial}{\partial x_{\sec}}\left(p_{\sec} \cdot x_{\sec}\right) = MC_{\sec} = p_{\sec} + \frac{\partial p_{\sec}}{\partial x_{\sec}} x_{\sec} = p_{\sec}\left(1 + \frac{\partial p_{\sec}}{p_{\sec}} \Big/ \frac{\partial x_{\sec}}{x_{\sec}}\right). \tag{88}$$

Marginal revenues and marginal costs thus can be expressed as:

$$MR_{\sec} = MC_{\sec} = p_{\sec}\left(1 - \frac{1}{EDM_{\sec}}\right), \tag{89}$$

where $EDM_{\sec} = -\hat{x}_{\sec} / \hat{p}_{\sec}$ stands for the elasticity of demand for each variety.

3) Monopolistic Competition and Elasticity of Demand for Each Variety's Output

[13] As the function is homogeneous of degree one in its x_{sec}, we know that 0< 1-1/ $\overline{\sigma LV}_{\sec}$ <1. Therefore, $\overline{\sigma LV}_{\sec}$ >1.

Under monopolistic competition, the model assumes that the number of firms is large enough to prevent individual firms from influencing the group's price index (P_{sec}). From Equation (86), we derive the elasticity of demand for each variety as following:

$$EDM_{\sec} = -\frac{\partial x_{\sec}}{\partial p_{\sec}} \cdot \frac{p_{\sec}}{x_{\sec}} = -\frac{\partial \left(\frac{P_{\sec}^{\overline{\sigma LV}_{\sec}} \cdot X_{\sec}}{p_{\sec}^{\overline{\sigma LV}_{\sec}}} \right)}{\partial p_{\sec}} \cdot \frac{p_{\sec}}{x_{\sec}} = \left(\frac{P_{\sec}}{p_{\sec}} \right)^{\overline{\sigma LV}_{\sec}} \cdot \left(\frac{X_{\sec}}{x_{\sec}} \right) \cdot \overline{\sigma LV}_{\sec}. \tag{90}$$

From equations (84) and (85), the elasticity of demand under monopolistic competition with product differentiation reads:

$$EDM_{\sec} = \overline{\sigma LV}_{\sec}. \tag{91}$$

4) Model Application

This section then explains the modification of a perfectly competitive sector into a sector under monopolistic competition with heterogeneous products. Such modification mainly concerns with consumption demands, since consumers now prefer product variety. The market clearing condition for a monopolistically competitive sector is:

$$QA_{ic}^{reg} = NOF_{ic}^{reg} \cdot qa_{ic}^{reg} = NOF_{ic}^{reg} \cdot \left(qaFD_{ic}^{reg} + \sum_{\sec} qaIO_{ic,\sec}^{reg} \right), \tag{92}$$

where QA_{ic}^{reg} is the composite output demand; and qa_{ic}^{reg} represents the demand for the individual variety of commodity *ic*, which can be decomposed into final and intermediate demands, denoted by $qaFD_{ic}^{reg}$ and $qaIO_{ic,\sec}^{reg}$, respectively. From Equation (86), these individual demands can also be expressed as functions of group demands:

$$qaFD_{ic}^{reg} = \left(\frac{PA_{ic}^{reg}}{pa_{ic}^{reg}} \right)^{\overline{\sigma LV}_{ic}^{reg}} \cdot \left(C_{ic}^{reg} + I_{ic}^{reg} + CG_{ic}^{reg} \right), \text{ and} \tag{93}$$

$$qaIO_{ic,\sec}^{reg} = \left(\frac{PA_{ic}^{reg}}{pa_{ic}^{reg}} \right)^{\overline{\sigma LV}_{ic}^{reg}} \cdot \left(IO_{ic,\sec}^{reg} \right), \tag{94}$$

where PA_{ic}^{reg} is the group price index; and pa_{ic}^{reg} represents the price of the individual variety of commodity *ic*. From Equation (85), Equations (93) and (94) are rewritten as:

$$qaFD_{ic}^{reg} = \left(NOF_{ic}^{reg} \right)^{\frac{\overline{\sigma LV}_{ic}^{reg}}{1-\overline{\sigma LV}_{ic}^{reg}}} \cdot \left(C_{ic}^{reg} + I_{ic}^{reg} + CG_{ic}^{reg} \right), \text{ and} \tag{95}$$

$$qaIO_{ic,\sec}^{reg} = \left(NOF_{ic}^{reg} \right)^{\frac{\overline{\sigma LV}_{ic}^{reg}}{1-\overline{\sigma LV}_{ic}^{reg}}} \cdot \left(IO_{ic,\sec}^{reg} \right). \tag{96}$$

Substitute Equations (95) and (96) into Equation (92) to get:

$$QA_{ic}^{reg} = \underbrace{\left(NOF_{ic}^{reg} \right)^{\frac{1}{1-\overline{\sigma LV}_{ic}^{reg}}}}_{\text{scaling vector}} \cdot \left(C_{ic}^{reg} + I_{ic}^{reg} + CG_{ic}^{reg} + \sum_{\sec} IO_{ic,\sec}^{reg} \right). \tag{97}$$

Therefore, there is a scaling effect of the Love-Of-Variety preference on the group indices of final and intermediate demands, of which the magnitude depends on the size of the scaling vector in Equation (97).[14]

[14] Note that since the number of firms is positive and $\overline{\sigma LV}_{ic}^{reg} > 1$, the scaling vector is always positive.

Borrowing from Equation (85), the group price index (PA_{ic}^{reg}) can then be expressed as:

$$PA_{ic}^{reg} = \left(NOF_{ic}^{reg}\right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg} \,. \tag{98}$$

Again, the scaling effect of monopolistic competition is observed in this equation. Implicitly, the nominal values of final group demands are:

$$C_{ic}^{reg} \cdot PA_{ic}^{reg} = C_{ic}^{reg} \cdot \left(NOF_{ic}^{reg}\right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg} \,; \tag{99}$$

$$I_{ic}^{reg} \cdot PA_{ic}^{reg} = I_{ic}^{reg} \cdot \left(NOF_{ic}^{reg}\right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg} \text{ ; and} \tag{100}$$

$$CG_{ic}^{reg} \cdot PA_{ic}^{reg} = CG_{ic}^{reg} \cdot \left(NOF_{ic}^{reg}\right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg} \,. \tag{101}$$

Similarly, for intermediate inputs, the nominal values of intermediate group demands are:

$$IO_{ic,\sec}^{reg} \cdot PA_{ic}^{reg} = IO_{ic,\sec}^{reg} \cdot \left(NOF_{ic}^{reg}\right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg} \,. \tag{102}$$

Accordingly, given Equation (89), the mark-up pricing equation is then re-expressed as:

$$PZ_{ic}^{reg}\left(1-\frac{1}{EDM_{ic}^{reg}}\right) = \left(\begin{array}{l} \sum_{fac}\left(1+\overline{tf}_{ic}^{fac,reg}\right)\cdot PF_{ic}^{fac,reg} \cdot FV_{ic}^{fac,reg} \\ + \sum_{pc} PA_{pc}^{reg} \cdot IO_{pc,ic}^{reg} + \sum_{icc}\left(NOF_{icc}^{reg}\right)^{\frac{1}{1-\sigma LV_{icc}^{reg}}} \cdot pa_{icc}^{reg} \cdot IO_{icc,ic}^{reg} \end{array}\right) / \, QZ_{ic}^{reg} \,, \tag{103}$$

where the subscript *icc* stands for the set of monopolistic competition sectors alias to *ic*; and that the elasticity of demand for individual variety's output is fixed and equal to the elasticity of substitution between varieties, as shown in Equation (91).

4.1.3 Barriers to Entry and Exit the Imperfectly Competitive Industry

Under imperfect competition with the economies of scale, incumbent firms have a strong incentive to prevent potential rivals from entering the market, since market prices and then the profits of these firms tend to decrease as the number of firms increases. In addition, a high ratio of fixed to variable costs could naturally become an entry barrier to new entrants. As firm mobility is restricted, firms in imperfectly competitive sectors reap positive profits; hence this assumption reflects reality better than the previous assumption which allows for firm mobility.

To incorporate entry barriers, firms' profits are added to the representative household income. Thus, Equation (9) is altered to derive:

$$INC^{reg} = \left(\sum_{\sec}\sum_{fac} PF_{\sec}^{fac,reg} \cdot F_{\sec}^{fac,reg} + TRNF^{reg}\right) + \sum_{ic} PROFIT_{ic}^{reg} \,. \tag{104}$$

Subsequently, the zero-profit condition in Equation (4) is modified such that total revenues are equal to total costs plus sectoral profits:

$$PZ_{ic}^{reg} \cdot QZ_{ic}^{reg} = \left(\sum_{fac}(1+\overline{tf}_{ic}^{fac,reg})PF_{ic}^{fac,reg} \cdot F_{ic}^{fac,reg} + \sum_{\sec} PA_{\sec}^{reg} \cdot IO_{\sec,ic}^{reg}\right) + PROFIT_{ic}^{reg} \,. \tag{105}$$

Equation (105) can be simplified with scripts abbreviated as:

$$QZ \cdot PZ = (FC + VC) + PROFIT. \tag{106}$$

Divide Equation (106) by sectoral outputs (*QZ*) to find commodity prices (*PZ*) equal average costs plus unit profits:

PZ = (FC/QZ + VC/QZ) + PROFIT/QZ. (107)

From Equations (106) and (107), total revenues are higher than total costs, thus prices (i.e. average revenues) are higher than average costs. Nevertheless, marginal revenues are still equal to marginal costs (*PZ – MUP = VC/QZ*) as in Equation (65). Therefore, with entry/exit barriers, we know that: *PZ > AC > MC = MR*. Moreover, as profits become positive, a firm's mark-up comprise fixed costs and unit profits:

FC/QZ + PROFIT/QZ = MUP. (108)

Compared to Equation (68), the mark-up, which is the gap between the output price and marginal costs, is not only entailed by fixed costs, but also includes average profits per unit output.

4.2 CU Simulation Results

Before all, this section modifies the dataset used in the CU simulations with regions of different market sizes (as described in section 3.1), in order to capture the differences in CU simulation outcomes under different market structures. All regions become absolutely symmetric; hence the value flows in regions *reg1* and *reg2* equivalently increase by ten times, the bilateral trade volumes read the values of 20 and tariff revenues are now 10 across all trading partners, and elasticity parameters remain unchanged to maintain the characters and responsiveness to shocks of regional economies. As mentioned earlier, sector *sec1* will be left perfectly competitive as the others turn oligopolistic or monopolistically competitive, since the adjustments to a CU shock in sectors under different market structures can then be contrasted in a better manner.

The simulation results are reported in Tables 11-17. Table 11 reports the percentage changes in real GDP and aggregate imports and exports by sector; Table 12 reads percentage changes in output per firm under imperfect competition; and Tables 13-17 decompose regional EVs into real income and consumer surplus effects, as in Tables 7-10. Based on these results, welfare implications to the four economies are analysed by scenario.

Table 11: Percentage Changes in Macroeconomic Variables Under Different Market Structures

<table>
<tr><th colspan="3">Market structures / Percentage change</th><th>Perfect competition</th><th>Cournot oligopoly (free entry)</th><th>Cournot oligopoly (barred entry)</th><th>Monopolistic competition (free entry)</th><th>Monopolistic competition (barred entry)</th></tr>
<tr><td rowspan="2">real GDP</td><td colspan="2">CU member</td><td>1.808</td><td>3.497</td><td>2.474</td><td>3.518</td><td>2.359</td></tr>
<tr><td colspan="2">Non-member</td><td>-0.475</td><td>-1.335</td><td>-1.322</td><td>-1.083</td><td>-1.022</td></tr>
<tr><td rowspan="4">Aggregate exports (QE^{reg}_{sec})</td><td rowspan="2">CU member</td><td>sec1</td><td>47.525</td><td>46.845</td><td>44.578</td><td>47.162</td><td>45.886</td></tr>
<tr><td>sec2</td><td>47.525</td><td>52.402</td><td>51.260</td><td>52.052</td><td>50.141</td></tr>
<tr><td rowspan="2">Non-member</td><td>sec1</td><td>-4.443</td><td>-2.962</td><td>-2.607</td><td>-3.138</td><td>-3.234</td></tr>
<tr><td>sec2</td><td>-4.443</td><td>-6.819</td><td>-7.318</td><td>-6.496</td><td>-6.308</td></tr>
<tr><td rowspan="4">Aggregate imports (QM^{reg}_{sec})</td><td rowspan="2">CU member</td><td>sec1</td><td>46.187</td><td>48.086</td><td>46.765</td><td>47.923</td><td>46.786</td></tr>
<tr><td>sec2</td><td>46.187</td><td>47.436</td><td>45.928</td><td>47.623</td><td>46.192</td></tr>
<tr><td rowspan="2">Non-member</td><td>sec1</td><td>-10.276</td><td>-11.265</td><td>-11.632</td><td>-10.993</td><td>-11.111</td></tr>
<tr><td>sec2</td><td>-10.276</td><td>-9.630</td><td>-9.671</td><td>-9.794</td><td>-9.878</td></tr>
</table>

Table 12: Percentage Changes in Outputs Per Firm Under Imperfectly Competitive Market Structures

Market structures / Percentage change			Cournot oligopoly (free entry)	Cournot oligopoly (barred entry)	Monopolistic competition (free entry)	Monopolistic competition (barred entry)
Outputs per firm	CU members	Tradable	10.152	4.773	7.253	4.378
		Non-traded	3.195	0.160	5.725	-0.371
	non-members	Tradable	-1.675	-0.923	-1.702	-0.451
		Non-traded	-3.715	-3.907	-2.919	-3.430

It is commonly perceived in Tables 11 and 12 that CU members are better off in real terms, and such welfare gains will easily offset the losses accrued to non-members in order that the CU shock will improve the world welfare as a whole. For CU members, the real GDP growth is strengthened when assuming that sectors *sec2* and *sec3* are under imperfect competition; and such positive effects are weakened when imperfect competition is coupled with firm immobility. As for aggregate exports by sector, the imperfectly competitive sector (*sec2*) exploits the scale economies by expanding its production and thus increasing its export supply to the global market. That, in turn, bids away production resources from the sector under perfect competition (*sec1*), of which the aggregate export volume diminishes compared to the case where all sectors are under perfect competition. Consequently, aggregate imports of *sec1* under perfect competition increase further than that of the imperfectly competitive *sec2*, and also are higher than the percentage changes when the world economy is entirely under perfect competition. Furthermore, in Table 12, the percentage changes in outputs per firm of sectors under imperfect competition suggest that, for CU members, the oligopolistic market structure yields higher benefits than the monopolistically competitive one, as it enables member regions to exploit the scale economies in a superior way, and these results are consistent with the real GDP growth reported in Table 11.

For non-members, facing barred access to overseas markets causes further welfare losses as the increasing returns to scale press forward the detrimental effects on these economies. Therefore, in Tables 11 and 12, the magnitude of percentage changes in real variables of non-members is notably in accordance with the corresponding changes in the same variables in member regions, with the opposite sign.

Table 13: The EVs After Regions *reg1* and *reg2* Form a CU (Perfect Competition)

Decomposed EVs (in world currency: $)				CU members: *reg1* & *reg2*	Non-members: *reg3* & *reg4*
Real income effect	Production effect		*sec1*	22.216	-3.481
			sec2	22.216	-3.481
			sec3	11.631	-9.818
	Tax revenue effect	Commodity taxes	*sec1*	3.581	-1.076
			sec2	3.581	-1.076
		Factor taxes	*sec1*	4.779	-0.743
			sec2	4.779	-0.743
		Tariffs	*sec1*	-12.872	-1.844
			sec2	-12.872	-1.844
Consumer surplus effect	Household			-6.738	3.163
	Government			-5.840	2.741
	Saving-investment			-0.898	0.422
Regional EV				33.562	-17.781

Table 14: The EVs After Regions *reg1* and *reg2* Form a CU (Cournot Oligopoly without Barriers to Entry/Exit)

Decomposed EVs (in world currency: $)				CU members: *reg1* & *reg2*	Non-members: *reg3* & *reg4*
Real income effect	Production effect		*sec1*	25.285	-3.502
			sec2	23.572	-4.970
			sec3	12.478	-9.169
	Tax revenue effect	Commodity taxes	*sec1*	3.943	-1.145
			sec2	3.943	-1.145
		Factor taxes	*sec1*	5.439	-0.748
			sec2	5.102	-1.070
		Tariffs	*sec1*	-12.455	-2.053
			sec2	-13.230	-1.845
Consumer surplus effect	Household			-5.622	1.955
	Government			-4.872	1.695
	Saving-investment			-0.750	0.261
Regional EV				42.834	-21.736

Table 15: The EVs After Regions *reg1* and *reg2* Form a CU (Cournot Oligopoly with Barriers to Entry/Exit)

Decomposed EVs (in world currency: $)				CU members: *reg1* & *reg2*	Non-members: *reg3* & *reg4*
Real income effect	Production effect		*sec1*	23.633	-3.436
			sec2	27.223	-6.148
			sec3	18.552	-9.295
	Tax revenue effect	Commodity taxes	*sec1*	3.478	-1.155
			sec2	3.478	-1.155
		Factor taxes	*sec1*	5.077	-0.733
			sec2	5.899	-1.328
		Tariffs	*sec1*	-12.496	-2.114
			sec2	-13.430	-1.853
Consumer surplus effect	Household			-5.188	2.107
	Government			-4.497	1.826
	Saving-investment			-0.692	0.281
Regional EV				51.037	-23.002

Table 16: The EVs After Regions *reg1* and *reg2* Form a CU (Monopolistic Competition without Barriers to Entry/Exit)

Decomposed EVs (in world currency: $)				CU members: *reg1* & *reg2*	Non-members: *reg3* & *reg4*
Real income effect	Production effect		*sec1*	24.326	-3.174
			sec2	23.477	-4.335
			sec3	10.593	-9.145
	Tax revenue effect	Commodity taxes	*sec1*	3.756	-1.078
			sec2	3.756	-1.078
		Factor taxes	*sec1*	5.234	-0.678
			sec2	5.104	-0.930
		Tariffs	*sec1*	-12.628	-1.963
			sec2	-13.247	-1.806
Consumer surplus effect	Household			-4.237	2.114
	Government			-3.672	1.833
	Saving-investment			-0.565	0.282
Regional EV				41.896	-19.957

Table 17: The EVs After Regions *reg1* and *reg2* Form a CU (Monopolistic Competition with Barriers to Entry/Exit)

Decomposed EVs (in world currency: $)				CU members: *reg1* & *reg2*	Non-members: *reg3* & *reg4*
Real income effect	Production effect		*sec1*	23.303	-3.526
			sec2	24.228	-5.365
			sec3	16.170	-9.488
	Tax revenue effect	Commodity taxes	*sec1*	3.591	-1.129
			sec2	3.591	-1.129
		Factor taxes	*sec1*	5.010	-0.753
			sec2	5.260	-1.156
		Tariffs	*sec1*	-12.618	-2.022
			sec2	-13.211	-1.840
Consumer surplus effect	Household			-5.793	2.530
	Government			-5.021	2.192
	Saving-investment			-0.772	0.337
Regional EV				43.738	-21.348

4.2.1 Perfect Competition

In Table 13, the mechanism through which the preferential tariff cuttings alter percentage changes in real variables and regional EVs is extremely analogous to those reported in Tables 5-7 explicitly explained in section 3.3.1, as both are unvaryingly under perfect competition. The percentage changes in key variables show the same signs, and the difference in their EVs is only the matter of scale. Therefore, this section may abbreviate the detailed explanation of Table 13, but will compare such results with those derived under various forms of market imperfection below.

4.2.2 Cournot Oligopolistic Competition with Homogeneous Products in Sectors *sec2* and *sec3* (Free Entry/Exit)

(1) CU Members

For CU members, the proportional increase in bilateral imports within the grouping notably outweighs the decline in imports from non-members and demands for domestically-produced commodities. Hence, from Equation (80), the perceived demand elasticity for *sec2* then increases by 6.65%. Since now, a domestic price change will result in a more elastic adjustment in domestic consumption; the mark-up in *sec2* declines, as suggested in Equation (63) that these two variables are inversely proportionate to each other. The lower mark-up forces 4.0% of oligopolistic firms[15] to leave the competition, and that in turn reduces total fixed costs in *sec2*. Specifically, from Equation (68), the lower mark-up brings about instant profit losses in firms, because it is now exceeded by the unit fixed costs. Accordingly, under the free entry/exit assumption, less efficient firms will quit the competition, causing the unit fixed costs to drop until they equal the counterfactual mark-up again. Therefore, consistent with Horstmann and Markusen (1986), regional liberalisation will lead to an efficient exit of oligopolistic firms in *sec2*, where we find survived

[15] To avoid technical problems during the simulation process, the number of firms in this model is specified as continuous.

firms producing 10.2% more outputs and recording a higher growth in aggregate supply, in comparison to the perfectly competitive sector (*sec1*), due to the increasing returns to scale.

Even though the above improvement in productivity raises the rates of returns to primary factors, it also lowers real demands for unit factor inputs. As the latter dominates, in Table 14, the production effect and the corresponding factor-usage tax revenue effect on *sec2* are positive; yet they are still lower than the effects on *sec1*. On the other hand, since *sec2* incurs lower unit costs than *sec1*, it becomes more affordable and more demanded by consumers, resulting in higher commodity tax revenue effects.

As explained earlier, in the oligopolistic sector, bilateral exports among CU members are higher than that in the perfectly competitive one. Thus, member regions have to give up a bigger amount of tariffs imposed on oligopolistic imports as the CU is formed, and the tariff revenue effects of these two sectors are compared in Table 14.

As the tax revenue effects are improved overall, the demands for the public good *sec3* are higher by 0.7%. As *sec3* is also oligopolistic, the expansion entails moderate improvement in factor productivity, which again implies a slightly lower number of firms, higher outputs per firm, and lower unit primary input demands. However, the reduced real factor demands are outweighed by the higher rates of returns to mobile factors, which are driven up by the demands from tradable sectors, thus resulting in an augmented production effect in *sec3*. Overall, the regional EV reported in Table 14 is higher than that in Table 13, and such productivity improvement is attributable to the scale economies that significantly cast positive effects on the CU economies.

(2) Non-Members

The CU formation tends to drive up world prices of bilateral exports from members to non-members. Since the economies of scale in member regions enable the unit costs of *sec2* to be lower than that of *sec1*, the export price of the former also becomes cheaper in the world market. As a result, the aggregate imports of oligopolistic products by non-members are lower than those of the perfectly competitive one.

On the other hand, aggregate exports in non-member regions drop more in the Cournot sector. Allegedly, the production of an oligopolistic commodity in non-member regions is further hampered as producers in CU regions enjoy the increasing returns to scale by expanding their production scales. The drop in an aggregate export of the Cournot sector then causes its aggregate output to fall by 0.8%, while that of the perfectly competitive one rises by 0.4%. Thus, the contraction in *sec2* casts an undesirable effect on non-member economies, compared to the case of perfect competition.

Overall, when perfect competition is replaced with oligopoly, the trade diversion effect on non-members is more accentuated, thus in Table 14, we find further negative values of the decomposed EVs than those illustrated in Table 13.

4.2.3 Cournot Oligopolistic Competition with Homogeneous Products in Sectors *sec2* and *sec3* (Barred Entry/Exit)

It is obvious in Tables 14 and 15 that the firm mobility assumption does not alter the signs of the decomposed EVs. However, compared to the results in section 4.2.2, the barred entry assumption advances the *money metric* gains in CU regions while worsening those welfare losses in non-member regions. Such outcomes contradict the results in Table 11, where firm immobility yields lessened changes in *real* variables of CU members and non-members. Understandably, the contradiction arises as the model fixes a real variable (i.e., number of firms) while endogenising another nominal one (i.e., profits of firms), in order to restrict firm mobility. As a consequence, the world economy is less affected in real terms, though simultaneously more exposed to changes in money metric terms, since the firm entry/exit after the policy shock is transformed into the changes in profits accrued to the household income, thus making total fixed factor inputs in each sector exogenous. The welfare changes of CU members and non-members are discussed as following.

(1) CU Members

After the CU formation, the mark-up drops, and from Equation (108), profits tend to decline as the unit fixed factor costs are fixed in real terms. Also, without any firm quitting the competition, outputs per firm cannot grow as much as with barred entry[16]. Thus, the economies of scale are not fully exploited when firm mobility is restrictive, and the real effects are not as pronounced as under the free entry assumption. Nevertheless, in Table 15, we find the regional EVs of CU regions to be augmented, and the main sources of gains are in the production effects of oligopolistic sectors. Since total fixed factor demands in each sector do not adjust to the policy change, total factor demands, and thus their rental rates in oligopolistic sectors, become considerably higher after the counterfactual simulation. Henceforth, such heightened effects are expected with the barred entry assumption.

(2) Non-Members

The welfare effects on non-members are similar to those explained in section 4.2.2, though they become accentuated when firms are immobile across sectors. As the elasticity of demand of a Cournot sector in a non-member region declines as bilateral trade with member regions decreases, its mark-up rises. Since the number of firms does not increase, its profits become positive. Thus, the increase in firms' profits combined with the decrease in supply prices (due to lower demands from abroad) reduce marginal factor demands, which explains why we see further contraction as firm entry is barred, and the welfare losses in non-members are mainly found in the production effects of Cournot sectors.

4.2.4 Monopolistic Competition with Heterogeneous Products in Sectors *sec2* and *sec3* (Free Entry/Exit)

The welfare effects of a CU formation under monopolistic competition (Table 16) are moderate, in comparison to the previous results under perfect competition in Table 13, and Cournot oligopoly in Table 14. Since the elasticity of demand is fixed under monopolistic competition, firms are less endowed with the

[16] This refers to the results of percentage changes in outputs per firm in Table 12.

price-setting power compared to the oligopolistic case. However, they are not pure price takers, but they certainly gain some monopolistic power as consumers prefer product variety. It is noteworthy that since monopolistic competition and Cournot oligopoly similarly incur fixed costs during the production process, the welfare outcomes of the policy shock under monopolistic competition are closer to Cournot oligopoly than perfect competition, although the mark-up is alternatively specified, and the group price index is newly introduced.

Under monopolistic competition, the mark-up is independent of the number of firms, but still is a function of the fixed demand elasticity and individual supply price.

From Equation (85) the group price index is proportional to the scaling vector, which is a function of the number of firms and the substitution elasticity between product varieties. Knowing that the number of firms is positive, and the elasticity is higher than one, the scaling vector is positive and inversely proportionate to the number of firms. As the number of firms approaches one, the scaling vector also converges to one, meaning that under monopoly the group price index is equivalent to the individual price index. Under monopolistic competition, however, the number of firms is higher than one, implying the scaling vector to range in between zero and one. Thus, the relationship between the number of firms and the group price index is derived as following. If the number of firms is higher than one, the group price index is always lower than the individual price index; hence the sum of individual supplies is lower than total demands in each sector. As the number of firms approaches increases infinitely, the group price index falls relative to the individual one, raising total demands in each sector relative to the sum of individual supplies.

(1) CU Members

Under monopolistic competition, tariff reduction does not affect the demand elasticity, thus the mark-up rate remains unchanged. However, the granted access to a bigger market, the higher competition from abroad, and efficiency gains due to the drop in the number of firms, invariably reduce the unit fixed costs and raise the output per firm, though not as strongly as under oligopoly, as the demand elasticity is fixed. Henceforth, the production effect on the monopolistically competitive sector (*sec2*) is positive but lower than the results in the oligopolistic case.

As explained previously, the decline in the number of firms increases the scaling vector, which in turn raises the group price index by definition in Equation (98). Thus, final demands for commodity *sec2* adjust downward, as consumers maximise their CD utilities by allocating a fixed proportion of their budgets to each good's consumption. Coupled with the fixed elasticity of demand, it is generally perceived in CU economies that the consumption of the monopolistically competitive product does not expand as remarkably as under Cournot oligopoly.

As a consequence, all the decomposed tax revenue effects in Table 16 are lower than those in Table 14. Hence, the government receives lower revenues, and the demand for the public good (*sec3*) declines in comparison to the results from the oligopolistic case. This mechanism can be observed by contrasting the production effects of the public sector in Tables 14 and 16.

(2) Non-Members

For non-member regions, the changes in real economic flows barely differ from those under oligopoly. Although the percentage changes in the unemployed labour force and the real GDP are weakened, due to the fixed demand elasticity assumption. Since the mark-up is not affected by the shock, the inefficient entry of firms is barred. Thus, non-members perceive lower negative effects compared to the welfare outcomes under oligopoly in Table 14.

4.2.5 Monopolistic Competition with Heterogeneous Products in Sectors *sec2* and *sec3* (Barred Entry/Exit)

According to the EV results in Tables 14-17, the differential welfare effects of the preferential tariff cuttings with and without entry barriers under monopolistic competition are analogous to those under Cournot oligopoly. In principal, the regional EV outcomes for both member and non-member regions are accentuated with barred entry. Therefore, this paper finds that, overall, the barred entry assumption yields robust and consistent welfare effects to the world economy.

5 Aiming At the Necessarily Welfare-Improving CU Formation

Building on the previous simulations in section 4, section 5 then takes on the concept of endogenous external tariffs from Kemp and Wan (1976) to investigate the channels through which a country can set up a necessarily welfare-enhancing CU by adjusting their import tariff rates against non-members so as to maintain trade patterns with the rest of the world at the pre-CU level. Thus, consistent with negotiations on trade liberalisation under the World Trade Organisation (WTO) scheme, the ultimate goal is to eliminate the potential trade diversion that incurs efficiency losses when reallocating international resources. In line with the simulation framework proposed by Waschik (2006), this paper pushes forward by simulating CU scenarios under three types of market structures.[17] Once again, the dataset from section 4 in which one tradable sector (*sec1*) is always under perfect competition, while the rest are simulated under different market structures, is adopted. The primary findings are that, even with endogenous external tariffs, under imperfect competition, non-members may still find the regional grouping slightly disadvantageous.

First, the percentage changes in bilateral imports for each scenario are summarised in Table 18. For scenario 0, CU members only reduce import tariffs among themselves; hence the results replicate those in section 4, where trade diversion is present. Then, tariffs are endogenised in scenario 1, where CU members adjust their tariff rates against imports by non-members, so that their trade volumes are maintained at the benchmark levels, and any detrimental effects of trade diversion are prevented. Further, in scenario 2, non-members in return endogenise the tariff rates on imports from CU regions. Table 19 then reports the required adjustments in tariff rates between member and non-member regions, given that the initial bilateral tariff revenues are 50% of their import values in world currency. Finally, Table 20 illustrates welfare implications of the above scenarios at the macroeconomic level, and the simulation results in the above tables are analysed as following.

[17] Note that the cases of imperfect competition with free entry are not analysed in this section, since in reality, most of the imperfectly competitive sectors are subject to entry barriers for a number of reasons explained in section 4.

Table 18: Percentage Changes in Bilateral Imports Under Different Market Structures

Market structures / % changes in bilateral imports				Perfect competition	Cournot oligopoly (barred entry)	Monopolistic competition (barred entry)
Scenario 0 (trade creation and trade diversion)	CU member imports	from CU member	sec1	187.566	183.538	185.601
			sec2	187.565	194.220	192.384
		from non-member	sec1	-14.380	-12.124	-12.866
			sec2	-14.380	-17.159	-16.145
	Non-member imports	from CU member	sec1	-22.496	-24.901	-23.972
			sec2	-22.496	-20.220	-20.979
		from non-member	sec1	15.431	16.427	16.028
			sec2	15.431	12.364	13.364
Scenario 1 (no trade diversion)	CU member imports	from CU member	sec1	169.953	167.487	169.227
			sec2	169.953	173.050	172.171
		from non-member	sec1	*(fixed)*	*(fixed)*	*(fixed)*
			sec2	*(fixed)*	*(fixed)*	*(fixed)*
	Non-member imports	from CU member	sec1	0	-3.075	-1.781
			sec2	0	3.122	1.866
		from non-member	sec1	0	1.942	1.112
			sec2	0	-1.851	-1.290
Scenario 2 (no trade diversion; non-members fix their imports from CU members)	CU member imports	from CU member	sec1	169.953	167.097	168.996
			sec2	169.953	172.964	172.132
		from non-member	sec1	*(fixed)*	*(fixed)*	*(fixed)*
			sec2	*(fixed)*	*(fixed)*	*(fixed)*
	Non-member imports	from CU member	sec1	*(fixed)*	*(fixed)*	*(fixed)*
			sec2	*(fixed)*	*(fixed)*	*(fixed)*
		from non-member	sec1	0	-0.008	0
			sec2	0	0.262	0

Table 19: Percentage Changes in Tariff Rates Necessary to Maintain the Corresponding Bilateral Imports at the Benchmark Levels

Market structures / % changes in tariff rates			Perfect competition	Cournot oligopoly (barred entry)	Monopolistic competition (barred entry)
scenario 1 (no trade diversion)	Members' tariff rates on imports from non-members	sec1	-42.869	-40.202	-41.171
		sec2	-42.870	-45.302	-44.363
scenario 2 (no trade diversion; non-members fix imports from members)	Members' tariff rates on imports from non-members	sec1	-42.869	-39.817	-40.836
		sec2	-42.870	-45.926	-44.628
	Non- members' tariff rates on imports from members	sec1	0	-4.313	-2.626
		sec2	0	4.651	2.673

Table 20: Welfare Implications Under Different Market Structures

		Perfect competition			Cournot oligopoly (barred entry)			Monopolistic competition (barred entry)		
		CU member	Non-CU member	World	CU member	Non-CU member	World	CU member	Non-CU member	World
scenario 0 (trade creation and trade diversion)	Real GDP (%)	1.808	-0.475	0.667	2.474	-1.322	0.576	2.359	-1.022	0.668
	Total imports (%)	52.935	-9.853	21.541	53.199	-10.242	21.478	53.327	-10.085	21.621
	Ttotal exports (%)	47.525	-4.443	21.541	47.919	-4.963	21.478	48.014	-4.771	21.621
	Regional income (%)	8.020	-3.976	2.022	7.950	-4.336	1.807	8.134	-4.218	1.958
	Equivalent variation ($)	33.562	-17.781	31.563	51.037	-23.002	56.070	43.738	-21.348	44.781
	- Real income effect ($)	47.039	-24.107	45.864	61.414	-27.217	68.394	55.325	-26.407	57.835
	- Consumer effect ($)	-13.476	6.326	-14.301	-10.377	4.215	-12.324	-11.587	5.060	-13.054
scenario 1 (no trade diversion)	Real GDP (%)	1.995	0	0.998	2.489	0.025	1.257	2.402	-0.042	1.180
	Total imports (%)	56.651	0	28.325	56.756	0.031	28.394	56.900	-0.002	28.449
	Total exports (%)	56.651	0	28.325	56.772	0.015	28.394	56.928	-0.030	28.449
	Regional income (%)	7.859	0	3.929	7.766	0.071	3.919	7.891	-0.033	3.929
	Equivalent variation ($)	32.557	0	65.114	53.706	1.719	110.849	43.474	-0.022	86.904
	- Real income effect ($)	46.088	0	92.176	64.713	2.007	133.442	55.282	-0.017	110.531
	- Consumer effect ($)	-13.531	0	-27.062	-11.008	-0.288	-22.592	-11.808	-0.005	-23.626
scenario 2 (no trade diversion; non-members fix imports from members)	Real GDP (%)	1.995	0	0.998	2.423	0.081	1.252	2.361	0	1.181
	Total imports (%)	56.651	0	28.325	56.677	0.042	28.360	56.850	0	28.425
	Total exports (%)	56.651	0	28.325	56.677	0.042	28.360	56.850	0	28.425
	Regional income (%)	7.859	0	3.929	7.693	0.122	3.907	7.855	0	3.928
	Equivalent variation ($)	32.557	0	65.114	53.347	1.702	110.100	43.433	0	86.866
	- Real income effect ($)	46.088	0	92.176	64.304	1.982	132.573	55.240	0	110.479
	- Consumer effect ($)	-13.531	0	-27.062	-10.957	-0.280	-22.473	-11.806	0	-23.613

Note: *1. The total import is simply the sum of bilateral imports, not the ones aggregated by the Armington function.*
2. The regional income is the sum of disposable incomes of the household, government, and saving.
3. The equivalent variation comprises the real income and consumer surplus effects, and are expressed in world currency ($).

5.1 Perfect Competition

In scenario 0 of Table 18, CU members increase their bilateral imports from CU members, while they demand less from non-members. Although not explicitly explained in previous sections, it is always true that member regions' demands for imports from non-members drop less than their export supplies to these regions. This result is robust across market structures, since imports are differentiated by their origins due to the Armington assumption, while exports are homogeneous regardless of their destinations. As a result, aggregate imports of member regions from the rest of the world increase more than the rise in their aggregate exports. Also, non-members increase trade among themselves to make up for losses from trade diversion. In Table 20, it is clear that the EV gains in CU regions can offset the non-members' welfare losses, and the welfare effect on the world as a whole is unambiguously positive. The world trade volume grows by 21.5%, which in turn increases the world's real GDP by 0.7% and the world gross income by 2.0%. The EV in each region is decomposed into the real income and consumer surplus effects. These two effects commonly have opposite signs, since a higher (lower) real income tends to raise (reduce) the regional price index, thus lowering (increasing) the consumer welfare. However, it is always the case that the real income effect dominates the resultant regional EV.

Subsequently, in scenario 1, CU regions keep their bilateral imports from the rest of the world at the pre-CU levels by cutting their tariff rates by 42.9%. Under perfect competition, this arrangement in turn exogenises their bilateral exports to the rest of the world, thus non-members are completely isolated from the CU shock. Consequently, scenarios 1 and 2 yield identical outcomes under perfect competition, and non-members need not respond to the CU shock by adjusting their external tariff rates against member regions. As trade diversion effects on non-members are ruled out, the world economic welfare becomes higher, compared to scenario 0, and the 'real' gains to the CU economies are augmented. In Table 18, the percentage increase in bilateral trade within the grouping is reduced, because CU members no longer substitute imports from non-members with those from their CU counterparts. Although, as observed in Table 20, overall imports and exports of CU regions are boosted, thus it is guaranteed that the elimination of trade diversion equivalently yield welfare gains to all regions, resulting in higher real GDP growth rates. However, the CU regional income gains decrease without trade diversion, since their tariffs against non-members are endogenised in Table 19.

5.2 Cournot Oligopoly with Barriers to Entry/Exit

In scenario 0 of Table 18, the Cournot oligopolistic assumption yields similar changes in bilateral imports to the case in section 5.1. However, the magnitude of changes in the Cournot tradable sector (*sec2*) is stronger than that in the perfectly competitive sector (*sec1*). Allegedly, *sec2* in a CU region expands its production and trades more than *sec1* after the policy change because of the flexible elasticity of demand and the economies of scale. More expansion in *sec2* lowers the increase in its export supply price, thus we observe that *sec2*'s exports to the rest of the world are smaller than *sec1*'s. As such, CU members perceive higher real GDP growth rates, total imports and exports, compared to the results in section 5.1.

In terms of the changes in import levels from non-members (scenario 0), trade diversion in *sec2* is stronger than in *sec1*. Thus, to eliminate trade diversion, scenario 1 in Table 19 requires that CU members lower their tariffs on imports from non-members more in *sec2* than *sec1*. Then, the aggregate changes in Table 20 suggest that each member in scenario 1 will find itself the higher regional EV and accelerated real GDP growth than in scenario 0, given its higher regional trade flows. Yet, the regional income gain slightly declines, as the government loses its revenues endogenising tariff rates against non-members.

Now we focus on the welfare effects of scenario 1 on non-members under Cournot oligopoly (as opposed to perfect competition). Surprisingly, when the above-mentioned tariff endogenisation is in effect, the changes in macroeconomic variables of non-member regions in Table 20 indicate some positive effects attributable to the oligopolistic setting with the increasing returns to scale and the flexible demand elasticity. In scenario 1, the demand elasticity of the Cournot sector in a non-member region increases, due to the changes in expenditure shares, as aggregate imports and Armington demands of CU members (i.e. their export destinations) are higher. The resultant higher price sensitivity effectively reduces the mark-up rates and guarantees more efficient markets for non-members. Consequently, in Table 20, scenario 1 under Cournot oligopoly yields the highest welfare outcomes to individual regions and the world as a whole, compared to the results from the other two scenarios. Especially, from Table 20, the overall outcomes for non-members in scenario 2 are not as desirable as in scenario 1, because the exclusion of any change in bilateral imports from members to non-members prevents the CU economies from exploiting the increasing returns to scale to the fullest, and that results in the lessened welfare gains for themselves and the world as a whole.

5.3 Monopolistic Competition with Barriers to Entry/Exit

Sectors under Cournot oligopoly and monopolistic competition commonly share the property of the economy of scale, which ensures that imperfectly competitive sectors will expand more than perfectly competitive ones. Thus, we find similarity in the adjustments of bilateral imports under both types of imperfect competitions as explained in section 5.2. In terms of the magnitude, however, monopolistic competition yields weaker effects on real variables compared to Cournot oligopoly, because of the fixed elasticity of demand derived from the parameter called the elasticity of substitution between varieties. Thus, for all scenarios in Table 18, the monopolistically competitive sector (*sec2*) with barred entry finds the changes in its bilateral imports to be stronger than that under perfect competition, but yet weaker than that under Cournot oligopoly.

Next, we turn to the macroeconomic outcomes of each scenario reported in Table 20. Under monopolistic competition, CU members in scenario 0 perceive lower real GDP growth rates and regional EVs compared to the Cournot case. Similarly, non-members also observe smaller trade diversion in *sec2*, thus their macroeconomic indicators record less negative values. Overall, it is not clear which type of imperfect competition is more beneficial to the world economy, though the results are always positive in both cases.

Then, the world economy unambiguously gains after the CU’s external tariffs are endogenised in scenario 1. Taken as a whole, such transformation is analogous to what already explained in section 5.2, although the non-members’ welfares remain slightly negative. The reason is that the demand elasticities do not adjust to the shock; hence such positive effects on non-members (as seen under oligopoly) are barred. Besides, since imperfectly competitive market structures yield stronger negative effects on non-members than the perfectly competitive ones due to the scale economy, non-members then find CU producers more efficient product suppliers. As a result, the non-member economies slightly contract provided that the demand elasticity is invariable.

The welfare outcomes of non-members accordingly fixing their imports from CU members in scenario 2 are consistent with those under oligopoly. Though non-members can prevent themselves from being negatively affected by the grouping, such welfare improvement is trivial, not to mention institutional adjustment costs potentially incurred by this policy. Moreover, the CU members will be worse off, and that may reduce the world welfare as a whole.

To sum up, the welfare results illustrated in sections 5.1-5.3 suggest that scenario 1 seems to yield the most efficient outcomes to the world economy. On the other hand, when non-members endogenise their import tariffs against member regions in response to scenario 1, they can expect no change under perfect competition and insignificant gains under imperfect competition. Since member regions also find the policy welfare-neutral under perfect competition and slightly welfare-worsening under imperfect competition, there is little rationale for non-members to react to such the external CU shock.

6 Sensitivity Test

Section 6 checks the sensitivity of the model to elasticity parameters and macroeconomic closure. Since it turns out that the adjustment of key variables to changes in parameters and macroeconomic closure is similar across scenarios, section 6 only shows some test results from the CU simulations under different market structures.

6.1 Elasticity of Substitution between Primary Factors (σF)

The sensitivity of the CU simulation outcomes to the substitutability between capital, labour, and land in the production function is reported in Table 21, where the 100% increase in σF yields very small changes in real variables and regional EVs:

Table 21: The Sensitivity of Key Variables to the Substitution Elasticity Between Primary Factors (σF) in the CU Simulations Under Different Market Structures (Benchmark: σF = 0.8)

Market structures / Changes In real values (%) and regional welfares		Perfect competition		Cournot oligopoly (barred entry)		Monopolistic competition (barred entry)	
		σF = 0.4	σF = 0.8	σF = 0.4	σF = 0.8	σF = 0.4	σF = 0.8
Household consumption	CU members	11.25	12.11	10.76	11.81	11.21	12.33
	Non-members	-3.87	-3.55	-3.94	-3.82	-3.90	-3.73
Investment	CU members	2.81	3.05	2.70	2.96	2.87	3.16
	Non-members	-0.97	-0.89	-0.98	-0.96	-0.97	-0.93
Government consumption	CU members	-1.61	-1.36	-0.74	0.16	-1.08	-0.37
	Non-members	-2.25	-2.62	-3.46	-3.91	-2.99	-3.43
Real GDP	CU members	1.25	1.81	1.51	2.47	1.49	2.34
	Non-members	-0.40	-0.48	-1.08	-1.32	-0.82	-1.02
Total imports	CU members	52.00	52.94	51.93	53.20	52.10	53.33
	Non-members	-10.02	-9.85	-10.33	-10.24	-10.19	-10.09
Total exports	CU members	46.54	47.53	46.54	47.92	46.69	48.01
	Non-members	-4.55	-4.44	-4.94	-4.96	-4.78	-4.77
Regional EV	CU members	30.09	33.56	46.21	51.04	39.31	43.74
	Non-members	-17.85	-17.78	-23.77	-23.00	-21.83	-21.35

In general, the world welfare gains increase with the level of *σF*. To understand why the higher substitution elasticity enhances the benefits arising from a CU formation, consider a unit isoquant diagram given three factor inputs in Figure 6:

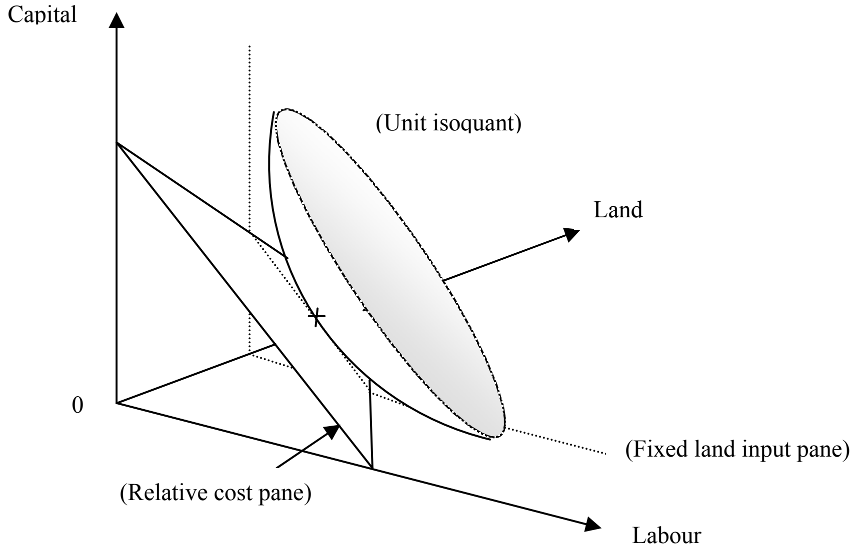

Figure 6: Three-Dimensional Unit Isoquant Given Three Factor Inputs

In Figure 6, the relative prices of these three factors determine the three-dimensional slope of the relative cost pane. The curvature of the unit isoquant is derived from the benchmark values, and the equilibrium point is where the isoquant is tangent with the cost pane. If land is sector-specific, then the amount of land inputs to the production sector is fixed, and the equilibrium point after a proposed change is always located on the 'fixed land input' pane, parallel to the capital-labour pane. Hence, when a policy shock alters the slope of the relative cost pane, the substitution elasticity determines the extent to which the producer will substitute a relatively more expensive factor with the other. Since the land input is fixed, even though the shift in the relative cost pane is three-dimensional, the key determinant of the equilibrium factor inputs is the relative rental rates of labour and capital. Figure 7 is thus derived by slicing Figure 6 vertically down along the fixed land input pane to clarify the effects of the relative factor price changes.

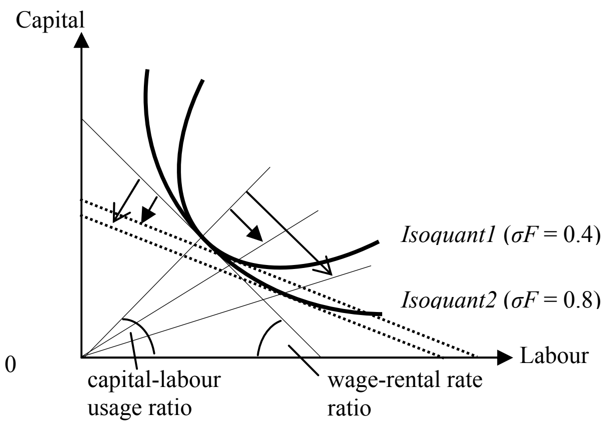

Figure 7: Unit Isoquants Given Different Substitution Elasticities and Their Responses to Changes in the [Wage/Rental Rate] Ratio

In Figure 7, a policy shock causes labour wages to become cheaper than capital rents. So, the relative cost line becomes flatter as illustrated by dotted lines. In response, producers substitute capital with labour while keeping outputs at the same levels. From Figure 7, it is clear that given higher substitution elasticity, producers can alter their capital-labour usage ratio to a greater extent. In fact, this implies higher productivity of the technology with higher substitution elasticity, because the firms adopting the *isoquant2* technology can produce more than those using the *isoquant1* technology, given the same capital-labour bundle. Thus, firms with higher substitution elasticities clearly adjust to the shock better, and the world economy reaps higher benefits from such regional economic integration, consistent with the sensitivity test results in Table 21.

6.2 Trade Elasticities (σA and σBM)

This section considers the sensitivity of welfare outcomes to trade elasticities, which comprise the upper-level Armington's substitution elasticity between domestic products and aggregate imports (σA); and the corresponding lower-level elasticity between imports from different origins (σBM).

Table 22: The Sensitivity of Key Variables to the Substitution Elasticities Between Domestic Products and Imports (σA); and Imports from Different Origins (σBM) in the CU Simulations Under Different Market Structures (Benchmark: σA = 2; σBM = 4)

Changes in real values (%) and regional welfares \ Market structures		Perfect competition		Cournot oligopoly (barred entry)		Monopolistic competition (barred entry)	
		σA= 1.5 σBM= 3	σA= 2 σBM= 4	σA= 1.5 σBM= 3	σA= 2 σBM= 4	σA= 1.5 σBM= 3	σA= 2 σBM= 4
Household consumption	CU members	10.93	12.11	10.62	11.81	10.99	12.33
	Non-members	-3.42	-3.55	-3.58	-3.82	-3.54	-3.73
Investment	CU members	2.73	3.05	2.66	2.96	2.82	3.16
	Non-members	-0.86	-0.89	-0.89	-0.96	-0.88	-0.93
Government consumption	CU members	-1.41	-1.36	-0.05	0.16	-0.56	-0.37
	Non-members	-2.12	-2.62	-3.27	-3.91	-2.88	-3.43
Real GDP	CU members	1.63	1.81	2.26	2.47	2.09	2.34
	Non-members	-0.47	-0.48	-1.16	-1.32	-0.93	-1.02
Total imports	CU members	37.47	52.94	37.69	53.20	37.71	53.33
	Non-members	-7.70	-9.85	-7.97	-10.24	-7.87	-10.09
Total exports	CU members	31.90	47.53	32.29	47.92	32.27	48.01
	Non-members	-2.13	-4.44	-2.58	-4.96	-2.43	-4.77
Regional EV	CU members	29.62	33.56	45.00	51.04	38.57	43.74
	Non-members	-16.25	-17.78	-20.39	-23.00	-19.50	-21.35

In Table 22, higher trade elasticity considerably increases consumer demands in CU regions, and the percentage changes in total imports and exports are stronger for all regions. The reason for this is analogous to what previously explained in the case of the substitution elasticity between factors (σF): higher elasticity allows us to reallocate our consumption portfolios in accordance with relative price changes more efficiently. By the same token, total imports and exports adjust to a greater extent given higher trade elasticity, which means that both trade creation and trade diversion become stronger. Hence, CU members reap higher benefits, and non-members lose further from the proposed change. Overall, the welfare effects of preferential tariff cuttings are very sensitive to this set of parameters, thus a credible data source is required to ensure accuracy in the simulation results.

6.3 Macroeconomic Closure

The sensitivity of the results to the macroeconomic closure is reported in Table 23, where the real effects of the regional grouping are considerably robust across the exchange rate regime, while the import prices in domestic markets are directly affected by the closure rule.

Table 23: The Sensitivity of Key Variables to the Macroeconomic Closure in the CU Simulations Under Different Market Structures (Benchmark: Flexible Exchange Rate Regime)

Changes in real values (%) and regional welfares \ Market structures		Perfect competition		Cournot oligopoly (barred entry)		Monopolistic competition (barred entry)	
		Flexible exchange rate	Fixed exchange rate	Flexible exchange rate	Fixed exchange rate	Flexible exchange rate	Fixed exchange rate
Household consumption	CU members	12.11	11.62	11.81	11.25	12.33	11.75
	Non-members	-3.55	-2.99	-3.82	-3.32	-3.73	-3.18
Investment	CU members	3.05	-12.52	2.96	-11.02	3.16	-11.12
	Non-members	-0.89	14.68	-0.96	13.00	-0.93	13.34
	World	*2.16*	*2.16*	*2.00*	*1.98*	*2.23*	*2.22*
Government consumption	CU members	-1.36	-1.97	0.16	-0.57	-0.37	-1.06
	Non-members	-2.62	-2.05	-3.91	-3.24	-3.43	-2.78
Real GDP	CU members	1.81	1.74	2.47	2.30	2.34	2.21
	Non-members	-0.48	-0.40	-1.32	-1.16	-1.02	-0.87
Total imports	CU members	52.94	50.44	53.20	50.86	53.33	50.97
	Non-members	-9.85	-7.57	-10.24	-8.16	-10.09	-7.96
Total exports	CU members	47.53	50.91	47.92	50.84	48.01	51.02
	Non-members	-4.44	-8.04	-4.96	-8.14	-4.77	-8.01
Regional EV	CU members	33.56	24.14	51.04	42.14	43.74	34.56
	Non-members	-17.78	-8.34	-23.00	-14.59	-21.35	-12.19

Under the flexible exchange rate regime, the CU formation appreciates the local currency of member regions, thus they are encouraged to import more and export less than under the fixed one. Besides, their foreign savings are not affected by the policy change, since there are price buffers at border. On the other hand, the CU members under the fixed rate regime adjusts to the shock in a way that the currency appreciation is transformed into capital outflows, hence we observe the decline in domestic savings and investments, and the percentage changes in investment demands turn negative. Consequently, the fixed rate regime yields less positive effects on real variables and regional EVs of the CU members than the flexible one.

As for non-members, under the flexible rate regime, the exchange rates tend to depreciate after a CU is formed. Hence, the welfare effects of switching between the two regimes are the opposite of those perceived in CU regions, and the capital flows from the CU economies to these regions will boost their investment demands and lessen the negative impacts of being left outside the grouping. Note that the difference in ‘domestic’ investment demand growth under the two regimes can be explained by the row reporting the ‘world’ investment demand growth, of which the rates under different regimes are nearly identical. Therefore, the exchange rate regime is the determinant of international investment allocation.

In sum, the fixed exchange rate regime tends to lower welfare gains in CU regions and lessen welfare losses for non-members, which is the result of resource reallocation and changes in trade patterns and world demands of tradable goods after the policy change.

7 Conclusion

This paper examines the properties of regional trade liberalisation in low-dimensioned models with highly-controlled data sets. For the CU simulations between regions of different sizes under perfect competition, it is clear that the larger the CU counterpart region is, the bigger the regional welfare gains can be expected. Thus, potentially big regions may lose by forming a CU with a much smaller region, given that the rest of the world may retaliate by forming another CU in response. As a consequence, welfare gains arising from regional trade liberalisation may be offset by the losses of trade volumes and tariff revenues as relatively larger regions are left outside the grouping. For the CU simulations between regions of identical sizes but under various market structures, the welfare effects of forming a CU with the presence of imperfect competition are stronger than those under a perfectly competitive environment. By the same token, Cournot oligopoly yields higher benefits from regional trading arrangements than monopolistic competition, due to larger economies of scale. As for the entry barriers, models with stringent firm mobility find lower gains for CU members measured in terms of real GDP growth rates. However, since gains from CU formation are transferred to the household in the form of firms' profits, this assumption raises the money-metric EV after a region joins the grouping. As for the experiment on the elimination of trade diversion accrued to CU formation, having CU members endogenising their tariff rates against imports from non-members while keeping their import levels fixed significantly raises regional and world welfares in all types of market structures. As long as CU members adjust their tariff rates when forming a CU, non-members' losses will be minimised and there is no need for them to react by endogenising their tariffs on imports from CU regions so as to keep themselves isolated from the external shock. Finally, the sensitivity of the results is thoroughly investigated. The welfare results with respect to changes in parameters are reasonably robust and theoretically sensible. However, with respect to the macroeconomic closure, the results vary in a non-negligible way, especially in terms of the percentage changes in investment demands and border prices.

Bibliography

Bhagwati, J. (1968) "Trade Liberalization Among LDCs, Trade Theory and GATT Rules," Chapter 2 in *Value, Capital, and Growth*, ed. Wolf, J. N., P.21-43, Oxford University Press.

Blake, A. (1998) *Computable General Equilibrium Modelling and the Evaluation of Agricultural Policy*, PhD Thesis, University of Nottingham, UK.

Blanchflower, D. G.; Oswald, A. J. (1995) "An Introduction to the Wage Curve," *Journal of Economic Perspectives*, Vol.9, No.3, P.153-167.

Brander, J.A. (1981) "Intra-Industry Trade in Identical Commodities," *Journal of International Economics*, Vol.11, P.1–14.

Cooper, C. A.; Massell, B. F. (1965) "Toward a General Theory of Customs Unions for Developing Countries," *Journal of Political Economy*, Vol.73, No.5, P.461-476.

Corden, W. M. (1972) "Economies of Scale and Customs Union Theory," *Journal of Political Economy*, Vol.80, P.465-475.

Dixit, A.; Stiglitz, J. (1977) "Monopolistic Competition and Optimum Product Diversity," *The American Economic Review*, Vol.67, No.3, P.297-308.

EcoMod Network (2006) "Trade Policy Modelling with GAMS: Technical Notes," presented at the EcoMod Modelling Summer School, The Free University of Brussels, Belgium.

Green, H.A.J. (1964) *Aggregation in Economic Analysis*, Princeton University Press.

Horstmann, I.J.; Markusen, J.R. (1986) "Up the Average Cost Curve: Inefficiency Entry and the New Protectionism," *Journal of International Economics*, Vol.20, P.225-247.
Johnson, H. G, (1960) "The Economic Theory of Customs Union," *Pakistan Economic Journal*, Vol.10, No.1, P.14-32.
Johnson, H. G, (1965) "An Economic Theory of Protectionism, Tariff Bargaining, and the Formation of Customs Unions," *Journal of Political Economy*, Vol.73, P.256-283.
Kemp, M.C.; Wan, H.Y. (1976) "An Elementary Proposition Concerning The Formation of Customs Unions," *Journal of International Economics*, Vol.6, P.95-7.
Leontief, W.W. (1947) "Introduction of a Theory of the Internal Structure of Functional Relationships," *Econometrica*, Vol.15, P.361-73.
Lipsey, R.G. (1957) "The Theory of Customs Unions; Trade Diversion and Welfare," *Economica* Vol.24, P.40-46.
Meade, J. E. (1955) *The Theory of Customs Union*, Amsterdam, North Holland.
Mundell, R. (1964) "Tariff Preferences and the Terms of Trade," *Manchester School of Economics and Social Studies*, Vol.32, P.1-13.
Varian, H.R. (1992) *Microeconomic Analysis*, Norton, P.110-111.
Viner, J. (1950) *The Customs Union Issue,* Carnegie Endowment for International Peace, New York.
Waschik, R. (2006) "Modelling Kemp-Vanek Admissibility: The Effects of Free Trade Areas on Non-Members," presented at Western Economic Association International Conference, 4-8 July 2005, San Francisco, CA, USA.
Willenbockel, D. (2004) "Specification Choice and Robustness in CGE Trade Policy Analysis with Imperfect Competition," *Economic Modelling*, Vol.21, P.1065-99.