Incomplete draft and not to be cited

EVALUATING THE IMPACT OF EPAS: PARTIAL EQUILIBRIUM MODELLING AND BEYOND

APRIL 2007

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1. INTRODUCTION

The EU is currently deep in negotiations with the African, Caribbean and Pacific countries on a new set of trading arrangements, known as the Economic Partnership Agreements (EPAs). These negotiations are proving to be difficult and contentious. They are difficult for a number of reasons, but one key underlying factor is that the need for a change in the existing arrangements was forced upon both the EU and ACP countries, because of the WTO incompatibility of the existing regime. Hence the status quo is not an option. It is not obvious, therefore, that either or both parties would have initiated this process. They are contentious because of differences between the EU and the ACP states both in what they would like to be included in any agreement, and also in the modalities of any agreement. In particular the EU has repeatedly stated that its' objective is for the EPAs to be "development friendly". In many ACP states this translates into a position, that wants to directly link the trade agreement to the provision of development assistance, while the EU is firm in rejecting such direct linkage and is also insisting on the inclusion of a variety of "deep integration" measures.

The EPA process is one therefore of two groups of countries negotiating a regional trade agreement, which if signed, will at a minimum include reciprocal market access covering substantially all trade; but which may also include measures of deep integration and development assistance. These agreements are likely be important for the ACP states and their future development paths, and hence it is important to provide sensible and clear analysis in order to inform the negotiations as well as to consider the likely outcomes of an agreement.

Modelling the impact of changes in trade policy has become increasingly widespread over the last twenty years or more. Much of that work has naturally focussed on general equilibrium modelling, though there has always largely a background interest in partial equilibrium (PE) modelling. More recently, partial equilibrium modelling has started to witness some resurgence, with PE models being applied to a number of cases of trade liberalisation — including the EPA process (for example several such papers were presented at the GTAP conference, 2006).

This paper focuses on the EPA process and considers the light that PE models can usefully bring to bear on this process, as well a how insights from PE models might be incorporated into CGE models. This is done in the context of the negotiations with the CARIFORUM grouping, and the Eastern and Southern Africa (ESA) grouping, where we focus on the case of Ethiopia. The advantage of PE models is that they can be used at a very high level of disaggregation, which allows for considerable detail. This can be very useful both for the evaluation of outcome but also in terms of informing negotiators considering issues such as which HS categories to include or exclude from a given agreement. However, there are important disadvantages in using PE models such as their inability to deal with general equilibrium interactions. Together with CGE models they share the relative inability to adequately capture deep integration, and also a number of broader considerations which are typically of concern when signing preferential agreements. We argue that identification of such issues can be done using carefully selected diagnostic or descriptive statistical indicators.

The methodology we employ in this paper is therefore two-fold. First, we explore some of the key issues which emerge from using the Sussex Framework based diagnostic indicators for the evaluation of EPA style liberalisation. Secondly, we undertake the partial equilibrium

modelling of Caribbean and Ethiopian trade at a potentially very detailed level of product disaggregation. We run the model for each of the Cariforum countries for which data was available as well as for Ethiopia. We also run several different variants of the model in order to explore the sensitivity of the results to different assumptions. Hence, we allow for both perfect and imperfect competition, we allow for the use of different underlying elasticities, and different levels of aggregation, and finally we explore the implications of different liberalisation scenarios.

The structure of the paper is as follows. In the first part of the paper, we apply some key elements of the Sussex Framework to the Caribbean and ESA EPA process. In the second part of the paper we evaluate the potential EPAs by using the TAPES partial equilibrium model. The final section draws the analysis together and provides some concluding thoughts on the EPA process.

2. APPLYING THE SUSSEX FRAMEWORK

In assessing the likely implications of an EPA it is first important to have a clear picture of the underlying economic structure and performance of the economies concerned. Table 1 below, provides some key information on a range of Caribbean economies and for Ethiopia. There are a number of important features which emerge from this table: First there is clearly a significant difference in economic performance and structure between Ethiopia and the Caribbean economies. In terms of the former, GDP per capita is $138 in Ethiopia whereas it is more than double this in the poorest of the Caribbean economies (Haiti), and well over 100 times that in the Bahamas. Ethiopia is also almost nine times larger in terms of population than the most populous of the Caribbean economies (the Dominican Republic). In terms of economic structure, we see that agriculture comprises 47.7% of economic activity in Ethiopia, whereas for most of the Caribbean economies it accounts for less than 10%, with the principle exceptions of Haiti (28.4%), and Dominica (18%). Ethiopia also has the lowest share of industry at 12%. Services are important for all the economies but this is particularly true in the Caribbean where in some countries the share of services exceeds 70%. Secondly, we see that Secondly, we see a strong correlation between the degree of openness of the economies, and per capital GDP (with a correlation coefficient of 0.7). Hence, Ethiopia is the least open of the economies with trade as a percentage of GDP at 38.7%. Thirdly, it is worth pointing out that there are substantial differences within the Caribbean region itself – this is true with respect to size, economic performance and structure. Hence St Kitts and Nevis has a population of less than 50,000, while the Dominican Republic has more than 8 million; GDP per capita ranges from $347 for Haiti to $16,866 for the Bahamas, and the share of agriculture ranges from 1.4% for Trinidad and Tobago to 28.4% for Haiti.

The considerable differences across the countries both within a given region – the Caribbean, and between the Caribbean and Ethiopia show quite clearly that the economic imperatives of the countries concerned are likely to be considerably different. While many if not most countries recognise the importance of integration into the world economy, and while it may be possible that the EPAs are instrumental in this regard, the evidence in this table suggests that the way in which the economies integrate into the world economy, the way in which an EPA might facilitate this is likely to differ widely according to the country circumstances. This alone suggests that a one-size fits all approach (even within a given region) might be problematic – and this is from two perspectives. First, it might not prove to be suitable for the countries concerned; and secondly it might be more difficult to achieve agreement on a

common approach or common set of policies given the differences in the countries' underlying imperatives.

Table 1: Key Economic Characteristics for 2000

	Population ('000)	*GDP/Capita ($ current prices)*	*Trade as % of GDP*[+]	*Value Added as % of GDP*		
				Agriculture	*Industry*	*Services*
Small Islands:						
Antigua and Barbuda	78.58	10770	128.9	3.9	19.8	76.3
Barbados	270.58	9979	107.5	6.2	21	72.8
Dominica	71.21	3554	116.7	18.1	23.4	58.4
Grenada	104.60	4279	104.4	7.7	24.3	68
St. Kitts and Nevis	46.71	8843	117.2	2.7	28.9	68.4
St. Lucia	160.59	3934	98.5	7.4	19.6	73
St. Vincent & the Grenadines	109.16	3329	109.5	10.8	24	65.2
Medium Countries:						
Bahamas, The	317.41	16866				
Belize	273.70	3831	119.2	17.2	21.1	61.7
Dominican Republic	8738.64	1839	84.5	11.1	33.9	54.6
Haiti	8439.80	347	50.1	28.4	16.6	55
Jamaica	2642.63	3003	92.4	6.7	31.3	62
Trinidad and Tobago	1312.66	8225	96.5	1.4	47.5	51.1
Ethiopia	70,000*	138*	38.7*	47.7	12.4	39.9

Source: *World Development Indicators*, World Bank.
* data is for 2004; [+] data for 2002

The EPAs are intended to be trade agreements, which are development friendly. In assessing the EPAs it is therefore necessay to consider the likely impact on the economies concerned of the proposed process of trade liberalisation. In the first instance preferential trade liberalisation involves a process of shallow integration, which can be defined as the removal of border barriers to trade, typically tariffs and quotas. As is well known the potential net benefits from shallow integration are inherently ambiguous. This arises because of the likelihood of both trade creation (which is welfare increasing) and trade diversion (which is welfare reducing). Trade creation arises when more efficiently produced imported goods from the new partner country replace less efficient domestically produced goods. Trade is "created" and yields welfare gains. Trade diversion occurs when sources of supply switch away from more efficient non-partner countries to less efficient partner countries. This arises because the less efficient partner countries have tariff-free access within the RTA and may be able therefore to undercut more efficient non-partner countries. Trade diversion therefore reduces welfare. The net welfare impact of a PTA will depend on the relative size of the two effects.

In addition to these effects there may be further welfare gains arising from the induced growth effects stimulated by, for example, productivity growth, increased specialisation, and/or positive externalities between firms, sectors or across sectors (e.g. between manufacturing and services) which are typically more likely to arise in the presence of deeper

integration. In contrast to shallow integration, "deep" (or positive) integration involves policies and institutions that facilitate trade by reducing or eliminating regulatory and behind-the-border impediments to trade, where those impediments may or may not be intentional. These can include issues such as customs procedures, regulation of domestic services production that discriminate against foreigners, product standards that differ from international norms or where testing and certification of foreign goods is complex and perhaps exclusionary, regulation of inward investments, competition policy, intellectual policy protection and the rules surrounding access to government procurement.

In assessing any FTA including potential EPAs it is therefore important to identify the implications arising from the implied shallow integration and then building upon this to consider the possible role and importance of measures of deeper integration. There are a number of rules of thumb, which can be employed in order to shed light on the likely shallow integration impacts. These are:

1. ***The higher are the initial tariffs / barriers,*** the greater are the likely effects on both trade creation and trade diversion. With high initial (MFN) tariffs, the greater is the initial distortion. This in turn means that in principle there is greater scope for both trade creation and trade diversion as those tariffs are preferentially removed.
2. ***The greater the number of FTA partners,*** the more likely it is that there will be trade creation as opposed to trade diversion. The more countries, which are included in the FTA, the greater is the likelihood of including the more efficient suppliers. This in turn minimises the extent of trade diversion, and simultaneously maximises the likelihood of trade creation.
3. ***Wide differences in comparative advantage*** between partner countries are likely to lead to a welfare improving FTA. Trade creation occurs when there are differences in efficiency and costs across partner countries – hence the RTA enables the partners to source the goods from the most efficient RTA partner. These trade creation gains thus arise where there are differences in comparative advantage across countries. The greater those differences in comparative advantage (and hence in costs across the countries) the greater is the likely gain from trade creation.
4. ***The more similar is the product mix*** in the economies concerned and the higher the elasticities of supply, the greater would be the possibility of trade creation. Recall that trade creation occurs when the importing country produces less of the good itself and instead imports the good from its FTA partner. This is only possible where there is overlap in what is produced in the partner countries.
5. ***The higher the percentage of trade with potential partners,*** the greater the possibility of the FTA enhancing welfare. Consider an initial situation where there was very little trade with the potential partner country. This would suggest that in the initial situation, third countries were more efficient suppliers. An FTA is therefore more likely to result in trade diversion under these circumstances.

Table 2 provides information on the direction of imports by source, as well as on the average degree of protection. As seen earlier we know that the typical Caribbean country is highly integrated with the world economy. From the table below we see that the USA is the main

trading partner for the Caribbean countries, accounting for 44% of CARIFORUM imports (as well as 35% of exports). It is followed by intra-CARIFORUM trade and trade with the EU, who account for roughly just over 15% and 13% of imports respectively. Although this is not given in the table below it is worth also noting that The EU accounts for 26% of Caribbean exports. The importance of the three main trading partners is reflected by the preferential trading agreements in force. Caribbean-EU trade relations arise from the Lomé conventions, and more recently the Cotonou agreement. Relations with US arise under the Caribbean Basin Initiative (CBI), while intra-regional integration is a consequence largely of CARICOM, the Organisation for Eastern Caribbean States (OECS) and to some extent Free Trade Area of The Americas (FTAA).

Table 2: Pattern of Imports and Protection

	US	*CARIFORUM*	*EU15*	*World*	*Tariffs*	*NTBs*
Antigua and Barbuda	49.28	12.57	11.11	27.04		
Bahamas, The	85.62	0.67	2.13	11.58		
Barbados	41.27	20.44	16.46	21.84		
Belize	43.53	3.49	7.86	45.11		
Dominica	36.87	29.45	14.33	19.35		
Dominican Republic	44.81	1.10	10.65	43.44		
Grenada	44.34	24.88	14.08	16.70		
Guyana	35.65	21.14	12.27	30.94		
Jamaica	44.59	12.13	9.80	33.48		
St. Kitts and Nevis	53.79	17.58	9.43	19.20		
St. Lucia	43.18	22.11	16.68	18.04		
St. Vincent and the Grenadines	38.87	28.84	16.15	16.14		
Suriname	26.31	20.06	27.67	25.96		
Trinidad and Tobago	33.32	3.18	15.94	47.55		
Unweighted Caribbean average	44.39	15.55	13.18	26.88		
	US	*COMESA*	*EU15*	*World*		
Ethiopia						

From the point of view of the proposed EPAs this information is striking. For the Caribbean economies the EU is not the primary source of imported goods – the US is a much more important supplier, and the Caribbean region itself also supplies more import than does the EU. From the first, second and fifth rules of thumb identified earlier, the low share of imports from the EU, and the presence of medium-high tariffs, this indicates that there is clearly considerable scope for trade diversion arising from a future EPA with the EU which is likely to be welfare reducing. There is more limited scope for trade creation, and it is of course also possible that there will be some trade reorientation towards the EU and away from other Caribbean suppliers, which could also mitigate against the consequences of trade diversion.

Further light on this can be shed by looking at Table 3, which gives Finger-Kreinin indices of export similarity across a range of bilateral country pairings. This which summarises the extent to which countries export structures are similar. The index ranges from 0-1, and where the index is equal to 1 this means that the export (import) structures of the pair of economies being considered is identical, and where it is equal to zero the export (import) structure has no overlap whatsoever. Suppose the FK index is equal to 0 and suppose that export structure can be taken as a reasonable proxy for a given country's production structure. An index equal to zero suggests no overlap in the countries' production and export bundles, which in turn

suggests no possibility for trade creation on the production side. There remains some possibility for trade creation on the consumption side. Equally, suppose the FK index = 1. This would mean that there is a very high degree of overlap in the two countries export and production bundles, which in turn suggests a higher possibility for trade creation on both the production and consumption side. However, with regard to each of these extreme cases the possibilities for trade creation will depend on from whom the importing country is initially importing. If, initially the Caribbean is importing heavily from the EU, and the EU-Caribbean FK index is high this suggest more scope for trade creation. If however, the Caribbean is initially importing heavily from the US, and the EU-Caribbean FK index is high this suggests that there is likely to be considerable trade diversion. Where the FK index is low, then the only possibility for trade creation is on the consumption side, and again this will only occur where EU exports to the Caribbean are high.

Table 3: Finger-Kreinin Indices of similarity

2000	Caricom	Dom Rep	Jamaica	St. Lucia	Trinidad & Tob.	EU15	USA	Comesa	China	Ethiopia
CARICOM	1									
DOM	0.297	1								
JAM	0.464	0.214	1							
LCA	0.194	0.096	0.061	1						
TTO	0.74	0.293	0.312	0.249	1					
EU	0.286	0.159	0.082	0.058	0.334	1				
USA	0.266	0.121	0.058	0.051	0.305	0.691	1			
Comesa						x	x	1		
China						x	x	x	1	
Ethiopia						x	x	x	x	1

Consider first the EU-US pairing. Here the index is 0.691, which suggests a high degree of overlap between the US and the EU, therefore considerable scope for gains from trade between this pair of countries. The high index of similarity also suggests that these countries exports are likely to be substitutes, which in turn means that there is scope for trade diversion arising from an EU-Caribbean EPA. If we consider the similarity of trade and production structures between Caricom and the EU, and Caricom and the US is now 0.286 and 0.266 respectively. This is considerably lower and suggests much less scope for trade creation on the production side. This average figure masks considerable diversity among the Caribbean economies themselves, where we have only included a subset in this table. We see that for the majority of the Caribbean economies there is extremely little overlap in export (and therefore probably production) bundles. For many of the economies the index is considerably below 0.1. If we couple this with the statistics earlier on imports by source we can see that there is very little evidence to suggest that for many of these economies there is much scope for trade creation either on the production or consumption side.

Need to include some information on indices of revealed comparative advantage and on intra-industry trade indices. Next iteration.

3. PARTIAL EQUILIBRIUM MODELLING

In this part of the paper we explore the possible implications of EPA induced liberalisation using the more formal approach of partial equilibrium modelling. There are two principal

modelling structures we employ here – an Armington perfectly competitive model, and an imperfectly competitive model. The model that forms the basis of the analysis is a slightly modified version of Francois & Hall (1997). This follows the Armington (1969) assumption that we have well behaved preferences over a weakly separable product category that has similar, but not identical products. The products are differentiated by their place of origin and a constant elasticity of substitution is assumed among different products in the same class. The imperfect substitutes approach was preferred over perfect one, because the Caribbean imports are mainly manufacturing goods and thus they are similar but not identical. The exercise is a fairly standard comparative static one. The model parameters: CES weights, constants in supply functions and constant in demand for composite good are calibrated to replicate the base data. Full details of the model can be found in the Appendix.

When conducting an experiment, in which we reduce tariff barriers, two qualitative outcomes are possible. In the first one, due to the reduction in the domestic price of a given product, consumers are better off and with the money saved on one product, they want to consume more of every other product in the market. This behaviour is purely trade creating and most of the change is driven by the income effect. In the other case, the same fall in price induces consumers to switch from the other products, to the one that has become cheaper. This scenario is in principle trade diverting and is more likely to lead to a welfare loss, as it switches from the most efficient sources in the world to the one which price fell. In the case of the CARIFORUM countries, this supply switching could lead to a welfare increase if switching from preferentially treated regional suppliers, to the most efficient suppliers in the joint CAIFORUM-EU market. This is known as trade reorientation.

Because the products are imperfectly substitutable, the reallocation never leads to extreme cases, such as completely stopping the consumption of a given product. The magnitude of changes depends strongly on the exact values of model parameters, the most important of them being: the elasticity of substitution σ and elasticity of demand for composite good - NA. It can be shown (de Melo & Robinson, 1992) that the welfare outcomes depends on the ratio of these elasticities. If the former is greater, then the latter, then trade diverting scenario will dominate, if it is the opposite case then we will observe trade creation. When both are equal, the consumption of a good which price fell will rise and consumption of other goods remains constant. Given the importance of both elasticities, one would expect that in the literature there is a good understanding as to their approximate values. However, this is not the case. Different models often use quite different elasticities, and thus the conclusions arising from partial and general equilibrium models need to be treated with some caution (Laird, 1992, Hertel, 2004). For our modelling exercise, we adopt a fairly standard set of elasticities and then conduct sensitivity analysis around these. Generally, also, it seems more plausible that the elasticity of substitution will be greater than the composite elasticity of demand, and this is incorporated in our modelling.

The model was implemented for fourteen Caribbean countries, and for Ethiopia. The model can be run at any given level of aggregation. For the Caribbean simulations we have run the model at HS 6-digit, 4-digit and 2-digit. The tariffs used come from the latest available period and were obtained from the TRAINS database. The trade flows were obtained from UN COMTRADE database that was accessed using World Integrated Trade Solution (WITS).

3.1 Simulating the Impact of EPA induced liberalisation

In the Caribbean simulations the model was run with four principal sources of supply competing in a given Caribbean market – the US, the EU15, CARIFORUM and World[1]. As there are no detailed data on production in the Caribbean, domestic Caribbean production was excluded from the model. The justification for this is that the Caribbean countries produce little amounts of their main imports (Greenaway & Milner, 2003). The supply sources used are.

The remainder of this section details our results under different modelling scenarios. First, and as a benchmark case we consider the liberalisation of all trade with the EU, under the Armington perfectly competitive modelling assumptions. This serves as the benchmark both with regard to the product coverage and with regard to the underlying modelling assumptions. Subsequently we explore the consequences of changing these assumptions. Hence we are interested in seeing how sensitive the results may be to a switch from a perfectly to an imperfectly competitive model, how sensitive the results may be to different levels of aggregation, and how sensitive they may be to different liberalisation scenarios. Two issues are important here. The first is concerned with the extent to which the Caribbean liberalised only with the EU, or also with respect to other countries. This issue is explored directly in this section. The second is concerned with the fact that it is clearly unlikely that all trade with the EU will be liberalised under a future EPA. Important here is the issue of definitions of substantially all trade. Although we ran the model for each country separately at different levels of aggregation, here we report on the average results for the CARIFORUM countries as a whole as well as the small sub-grouping within the Caribbean known as the Organisation of Eastern Caribbean States. We also give the coefficient of variation, which gives a measure of the dispersion of the outcomes across the Caribbean states.

The benchmark scenario simulates the upper bound for the likely effects of trade liberalization between Caribbean countries and EU arising from an EPA. It assumes that all of the tariffs on goods imported from the EU are completely reduced and that products are imperfect substitutes as in Armington (1969). It is simulated at the most detailed level of aggregation the HS 1996 classification at the six digits, which typically covers around four thousand products for each country. Among those, the trade with the EU covers, on average, approximately two thousand product categories. We run the simulations for each of the Cariforum group of countries for which data was available. As discussed earlier we have chosen mid-range values for the underlying elasticities and have also assigned three separate groups of elasticities depending on the product group. Hence, we differentiate between agricultural goods, raw materials and manufactured goods, as can be seen from the table below.

Table 4: Set of Benchmark Elasticities

Products (HS 1996)	*Import demand elasticity*	*Elasticity of Substitution*
Agriculture (01-24)	-1.75	-4.2
Raw Materials (25-27)	-2.25	-9.0
Manufactured goods (28-97)	-2.75	-6.0

[1] World here means rest of the world, and CARIFORUM refers to the CARICOM countries + the Dominican Republic.

3.2 Impact on Trade Flows

Table 5 gives the results from a range of simulations. The first panel of the table, gives the results arising from the complete liberalisation of imports from the EU. The values reported are percentage changes where the base is the level imports coming from a given source. Hence we see that for the Cariforum countries on average there is a decline in imports from the World by 3.5%, a decline from other Cariforum countries and the US by 2.8% and 2.7% respectively, and an increase in imports from the EU by 58.6%. Similar orders of magnitude are, on average, experienced by the OECS countries. These results clearly suggest trade diversion as a result of the EPA, which can be seen in the decline in imports from the US and the rest of the Word. There is also some trade reorientation: which is the results of source of supply shifting from possibly less efficient CARICOM suppliers which had been favoured by the previous trade agreement to the EU. As discussed earlier, trade diversion is welfare decreasing while trade reorientation is welfare increasing. The third row of the table gives the coefficient of variation – this gives us an indication of the degree of dispersion of the results across the countries for which we ran the simulation. We see that there quite a high degree of dispersion with the CVs in all cases significantly different from zero. The greatest dispersion occurs with respect to imports from the EU.

It is worth comparing these results to those in panel 6 of the table. Here we allow for the trade to take place under conditions of imperfect competition. Here we have assumed that the nature of competitive interaction is Cournot. Thus, all of the firms simultaneously chose the quantity that they wish to supply to the Caribbean. The firms in this specification will have some degree of market power depending mainly on their share of market. This should lead to a smaller change then in the benchmark scenario as the firms have some influence on the price, so they keep the output lower to retain higher prices. Of course, we do not have detailed information on the number of firms and therefore on the extent of competitive interaction at this detailed level of disaggregation for the countries in our model. In reality, it is quite possible that the sectors may be characterised by a large number of competing firms. It may also be the case that manufacturing is more imperfectly competitive with more differentiated products than agriculture. As we do not have the underlying information, we have assumed that there is a single firm in each country supplying the Caribbean market. It is likely that for a number of industries that this may overstate the degree of monopoly power exercise by each firm. We have investigated the sensitivity of the results to alternative specifications and the results are broadly similar. Nevertheless, the results should thus be taken as being fairly highly stylised and as giving an upper bound of the likely effects. On average, and in comparison to the preceding simulation, the increase in imports coming from the EU is smaller by 10%. The scope for trade diversion and trade reorientation also appears smaller. This is in line with expectations as the firms have more market power and hence the price changes are more muted. The pattern of changes across countries is also very similar to that reported earlier though the degree of dispersion in the impact across countries is slightly greater

Table 5: Simulation results - Caribbean

	World	*CARIFORUM*	*EEC15*	*US*
1	***Full liberalisation with the EU - perfect competion***			
CARIFORUM average	-3.5	-2.8	58.6	-2.7
OECS average	-3.9	-2.9	52.2	-3.1
Coefficient of variation	0.42	0.36	0.70	0.37
2	***Sensitivity analysis – CARIFORUM: elasticities***			
halving the elasticities	-1.5	-1.2	23.3	-1.2
doubling the elasticities	-9	-7.4	193.9	-6.6
3	***Sensitivity analysis – CARIFORUM: levels of aggregation***			
2 – digits	-5.2	-4.2	83.9	-4.8
4 – digits	-3.8	-2.7	67.8	-3.3
6 – digits	-3.5	-2.8	58.6	-2.7
4	***Substantially all trade***			
CARIFORUM average	-1.9	-2.3	38.2	-2
OECS average	-2.4	-2.5	36.3	-2.5
CV	0.45	0.47	0.74	0.35
5	***MFN liberalisation***			
CARIFORUM average	41.5	-13.8	29.2	33.1
OECS average	43.5	-14.9	30.1	34.2
CV	0.58	0.84	0.37	0.58
6	***Full liberalisation with the EU - imperfect competition***			
CARIFORUM average	-1.5	-1.4	47.2	-0.9
OECS average	-1.7	-1.3	41.9	-1
CV	0.52	0.50	0.75	0.53
7	***Sensitivity analysis – CARIFORUM: elasticities***			
halving the elasticities	-0.6	-0.3	22.6	-0.3
doubling the elasticities	-4.6	-4.4	160.6	-2.6
8	***Sensitivity analysis – CARIFORUM: levels of aggregation***			
2 – digits	-2.42	-2.64	66.32	-1.59
4 – digits	-1.68	-1.54	54.35	-1.04
6 – digits	-1.52	-1.41	47.17	-0.87

The second and third panels, and the seventh and eighth then conduct some sensitivity analysis over these perfectly competitive and imperfectly competitive simulations. In the second and seventh panels we explore how sensitive the results are to changing the underlying elasticities. We either double or half both the import demand elasticity and the elasticity of substitution. This gives us an interval for the demand elasticity from 0.875 to 5.5 and for the elasticity of substitution from 2.1 to 18. Those intervals cover all of the values typically found in the literature. Not surprisingly the results are indeed sensitive to changes in

the elasticities, though not in a linear fashion. Hence we see that reducing the elasticities dampens the impact on trade flow, and increasing the elasticities results in a much larger impact. The increase in trade flow from the EU now ranges between 23.3% to 193.9% in the perfectly competitive scenarios, and from 22.6% to 160.6% under imperfect competition. In panels three and eight we investigate how sensitive the results are to different levels of aggregation.

A key advantage of partial equilibrium modelling in comparison to general equilibrium modelling is that there is much greater flexibility over the level of aggregation which can be used, and that in principle the simulations can be run at a very detailed level of aggregation. Hence, the preceding sets of results were all run at the 6-digit level. We now compare these results to those run at the 2-digit and 4-digit levels of aggregation, both under the assumption of perfect competition, and under imperfect competition. The first one is based on *chapters* from HS 1996. This level of aggregation is at the two-digits level, and there are 98 different product groups covered. The second level of aggregation is based on HS 1996 *headings,* is at the four-digits level, and covers around 1300 different product groups. The final and the most detailed one is based on HS 1996 *sub-headings* and covers over 5000 different products. The results indicate that in terms of the direction of changes, unsurprisingly, the level of aggregation does not matter. Trade with the EU increases in all cases and declines with respect to the other partners. However, the degree of disaggregation does impact on the magnitude of the changes. Hence, at the 6-digit level of disaggregation imports from the EU increased by 58.6% under perfect competition and 47.17% under imperfect competition. At the two digit level the corresponding figures are 83.9% and 66.32%. This suggest that working at a more aggregated level is likely to overstate the impact on trade flows.

Finally, table 5 also reports on two alternative scenarios. The first of these is reported in panel 4 of the table. In all of the preceding experiments, we have assumed that the Cariforum economies liberalise their tariffs on all their imports from the EU. This is clearly an outer bound for as is well known Article XXIV of the WTO allows for regional trade agreements but under the condition that the agreements serve to liberalise "substantially all trade". The term substantially all has not been precisely defined and is therefore open to some interpretation. However, there appears to be common acceptance among analysts that the term applies to the value of trade (as opposed to, for example, the number of product lines included). There also appears to be some acceptance that liberalising 90% of the value of trade between partners is deemed to meet the criterion of substantially all.

Even if agreement on the above can be achieved, a further issue then arises as to whether each partner is required to liberalise 90% of trade, or whether asymmetry across partners is possible. In the recent EU- South Africa agreement, this issue was resolved by the EU liberalising (almost) all its trade, while South Africa liberalised 90% of the value of its tariff lines. In this way, the average degree of liberalisation was 90%. It seems clear that in the EPA context a similar form of symmetry is likely to be agreed upon. Hence for the purpose of the simulations that we report on here we are assuming that the Caribbean economies will be required to liberalise 80% of the value of their trade upon which there are currently tariffs on imports from the EU.

This is in turn raises the next set of problems or issues that need to be addressed – notably what is the criterion that is to be used in order to decide which industries are to be included and which are to be excluded. Each negotiating country will clearly have their priorities based on the domestic political, economic and social situation. In the absence of detailed

information about those priorities there appear to be two principal criteria open to the modeller. The first is to assume that the existing structure of protection reflects the underlying political economy within each economy. Hence, those industries, which face a high tariff, are those, which the country has in some sense historically chosen to protect. It seems reasonable therefore to assume that the same industries are likely to be the ones that the economy would wish to continue to protect. Hence, the first criterion which could be employed is to exclude the highest tariff industries from the process of trade liberalisation.

An alternative approach is to say that what is important for each economy, and particularly so in the Caribbean is the amount of tariff revenue that is collected. Substantial declines in tariff revenue are likely to lead to the need to governments to switch to alternative revenue raising measure, which may be politically difficult to achieve. Hence, the alternative criterion is to protect the highest tariff-revenue generating industries. Note that these are unlikely to be the same industries as the high tariff industries. At the limit, a very high tariff prevents all imports from entering and hence the amount of tariff revenue raised is nil. In the Caribbean context a disadvantage of the first criterion, is that most of the Cariforum countries are part of Caricom which levies a common external tariff. That common external tariff has arisen through a complex process of negotiations and to the extent that it reflects the political economy of the region, it is more likely to reflect some weighted average of preferences across the Caricom economies, as opposed to identifying or reflecting well individual country preferences. Given also the importance of tariff revenue in the region, for the purposes of this sensitivity analysis we have therefore run the model on the basis of the second criterion.

Hence, for this simulation we have excluded from the liberalisation those industries, which generate the highest tariff revenue, where we exclude the industries which together give 20% of the total imports from the EU. We have done this separately for each country, which clearly means that each country is excluding a different set of industries. This has clear implications for the region and for the negotiations. It is worth noting that due to the high concentration of imports the criterion adopted usually means that only a few industries end up being excluded.

Excluding the high tariff revenue generating industries on country by country basis substantially reduces the impact on trade flows arising from an EPA. For the Cariforum average the increase in imports from the EU is now 38.2%, where previously it was 58.6%, and for the OECS economies it is now 36.3% where previously it was 52.2%. Interestingly the diminution in the impact on trade flows is primarily with regard to trade with the EU, and much less with regard to trade with the other partner country groupings.

Finally, panel 5 we compare the preceding results with the outcomes that would obtain under full MFN liberalisation. From the theoretical point of view full unilateral liberalization, if the markets are perfectly competitive, should maximise the overall welfare gains. With this simulation, we see that the changes in trade flows are substantially different to those in the benchmark experiment. The largest increase in imports occurs for goods imported from rest of the world, then for US, and for the EU. There is also big trade reorientation from inefficient suppliers in the CARIFORUM countries to the ones outside it.

3.2 Welfare effects

We now turn to considering the impact on welfare, and the details of this can be found in Table 6, which is organised into panels analogously to Table 5. The first column of the table gives the notional change in tariff revenue as a percentage of base tariff revenue, the second column gives the change in consumer surplus. We then report on two measures of overall welfare. The third column gives the sum of tariff revenue and consumer surplus as a % of base imports. The last column holds when we have imperfect competition as then we also have to account for firms' profits. Where there is monopoly power, than there is the possibility of monopoly profits. Changes in tariffs will of course induce monopolists to adjust their price and output accordingly, and thence impact on profits. There is an important issue to be addressed as to who receives those profits. Essentially, there are two possible extreme outcomes. The first is that the monopoly profits are received by the exporting firm/country. To the extent that this is the case, this does not impact directly on Caribbean welfare. However, most of the Caribbean countries are relatively small and often also have only one firm (distributor), who imports the goods from European Union and then sells them to local entrepreneurs. This, of course, suggests that the monopoly power may in fact reside with the domestic distributor as opposed to the foreign exporter. At the limit, then, the domestic distributor could capture all of the available profits. Hence, in calculating the welfare impact of the proposed change in tariffs we need to bear each of these possible outcomes in mind – in the former the profits are attributed to the exporting country, in the latter the profits are attributed to the importing Caribbean country. In reporting on the welfare outcomes then we distinguish between these two cases.

We see from the first column is that the changes in tariff revenue arising from an EPA are quite substantial. However, as the EU is typically not the major exporter to the Caribbean the change in tariff revenue as a proportion of base revenue is just over 20%. This rises to nearly 30% when we double the underlying elasticities. This occurs as more trade is diverted to the EU there is consequently less tariff revenue being generated from imports from elsewhere. For many of the Caribbean economies tariff revenue is an important source of government revenue, and hence reductions of this magnitude are clearly non-trivial. Clearly, such changes in and of themselves would lead to a significant worsening of governments' budget balance which would then require some form of compensating policy – either increases in alternative forms of taxation, or decreases in expenditure.

From the third column we see that while the overall welfare changes are positive (and this is true for all countries), the overall changes in welfare arising from a potential EPA are very small indeed. For all the countries the average change in welfare is equal to 0.23% of the value of base imports, and for the OECS economies, this figure is slightly higher at 0.27%. The countries experiencing the biggest welfare changes are Suriname (0.55%), St Lucia (0.39%) and Dominica (0.37%). The smallest welfare increase is for The Bahamas (0.12%). The reason for the very small increases in welfare can be seen with reference to Table 5. The proposed liberalisation here essentially leads to some trade creation, some trade reorientation, and a substantial degree of trade diversion. It is the presence of trade diversion, which diminishes the size of the welfare gains.

Table 6: Impact on Welfare

	Change in tariff as % of base tariff revenue	*Change Consumer Surplus*	*Change in Welfare as % of base imports*	*Change in Welfare + profits as % of base imports*
Full liberalisation with the EU - perfect comp				
CARIFORUM average	-22.32	15.37	0.23	
OECS average	-21.64	4.04	0.27	
CV	0.59	1.14	0.63	
Sensitivity analysis: elasticities				
halving the elasiticities	-19.61	12.07	0.07	
doubling the elasticities	-29.47	27.92	0.99	
Sensitivity analysis: levels of aggregation				
2 – digits	-21.56	19.83	0.24	
4 – digits	-21.47	17.75	0.22	
6 – digits	-22.32	15.37	0.23	
Substantially all trade				
CARIFORUM average	-12.39	8.88	0.13	
OECS average	-13.6	2.5	0.16	
MFN liberalisation				
CARIFORUM average	-100	118.9	2.69	
OECS average	-100	21.38	2.26	
Full liberalisation with the EU - imperfect comp				
CARIFORUM average	-20	13.8	0.45	1.95
OECS average	-19.32	3.54	0.48	2.13
Sensitivity analysis: elasticities				
halving the elasiticities	-18.98	12.71	0.42	1.22
doubling the elasticities	-23.62	24.18	1.48	3.16
Sensitivity analysis: levels of aggregation				
2 – digits	-19.18	17.91	0.51	1.45
4 – digits	-19.15	15.9	0.42	1.35
6 – digits	-20	13.8	0.45	1.95

The lower half of the table gives the changes in welfare arising from the imperfectly competitive simulation. As before, the change in tariff revenue is mainly driven by the initial loss of the tariffs levied on the EU imports. However, there are also some secondary losses, which are caused by the trade structure shifting towards EU imported goods. Those effects are generally much smaller. Here the change in tariff revenue is smaller by 2% then in the benchmark model, this is entirely due to the lower secondary loses. In addition as discussed

above, if there is a single firm/distributor, which imports the goods from abroad it can capture a part of profits or even whole profits of the supplier from abroad. This is because it is controlling the access to the market of a country in question. If this is the case, than any rise in profits arising from the change in tariffs may well be captured by the domestic distributor.

This is captured in the last column of the table, which gives the change in welfare where we have attributed the change in profits to the domestic economy. The third column of results then gives the welfare changes where the change in profits goes to the firm in the exporting country. The former clearly gives an upper bound on the possible welfare impact, while the latter a lower bound. What emerges clearly from the table is that the welfare impact where the domestic economy captures the monopoly profits is substantially higher – indeed, on average, the welfare increase is effectively quadrupled. In turn, this implies that welfare is about ten times greater than in the Armington scenario. What is also interesting is that the relative ranking across countries also changes across the two welfare measures. It is important also to underline here that while welfare is in aggregate much higher when the profits are captured domestically, in principle that increase arises from the change in profits, which accrues to the domestic importer/ distributor. This means that the welfare gains are largely concentrated and experienced by this firm.

The welfare measures are interesting because they exhibit a slightly different behaviour to the trade flows. The changes in tariff revenue and consumer surplus are both non-linear. The first increase of elasticities causes the rise of both values around one fifth but the second one multiplies them by 1.5. At the same time the changes in welfare under the Armington assumption are linear - each increase in the elasticities approximately quadruples the welfare values. We also see that the liberalization of trade between the Caribbean countries and European Union is welfare enhancing, no matter which elasticities we choose but that the level of welfare gain is sensitive to the underlying elasticity. These results suggest that for the Cariforum group of countries as a whole the welfare gain ranges from between 0.07 of base imports to 0.99%; while for the OECS economies it ranges from between 0.09% of base imports to 1.05%. It should, however, be pointed out that even at the upper end of the estimates the overall welfare gains are still very small.

Under imperfect competition we see that the same qualitative conclusions can be drawn, although as in the earlier experiments there are some quantitative differences. The changes in trade flows are generally lower than in the Armington case and this arises because of the greater market power that firms have which thus impacts on their pricing decision. In changing the elasticities, we obtain a similar non-linear set of changes. The first increase in the elasticities tends to doubles the changes while second triples them. In contrast, the impact on welfare differs somewhat from the Armington case. The changes in welfare are no longer linear and the welfare gain is much larger in the extreme cases then in the previous experiment. Hence, with the upper-end elasticities the change in welfare + profits rises to 3.16% of base imports for the Cariforum group of countries as a whole, to 3.36% of base imports for the OECS economies. The increase in the elasticities also narrows the gap between the lower and upper bound for the change in welfare. To the extent that an imperfectly competitive market structure is a more realistic depiction of Caribbean import markets, than the choice of elasticities in assessing the impact of trade liberalisation scenarios tends to be more significant.

Whereas the pattern of trade varied somewhat across the different levels of aggregation, this is not the case with regard to the overall welfare change, nor with regard to the component parts of welfare[2]. Overall, the impact on welfare is relatively stable. For the Cariforum group of countries as the level of disaggregation is increase the welfare impact as a proportion of total welfare falls slightly, while the reverse takes place for the OECS economies. In comparison under imperfect competition we see that this is no longer the case. For the Cariforum group of countries as a whole as you move from the 2-digit to the 6-digit level of aggregation welfare increases from 1.45% of base imports to 1.95%. In contrast for the OECS economies the welfare gains is highest at the 2-digit level, at 2.13% of base imports, and lowest at the 6-digit level where the welfare change is 1.37% of base imports. The results in the imperfectly competitive model depend on the a given "firms'" market share – those market shares can move in different ways depending on the levels of aggregation used and this is driving these differences in the results. This again suggests that interpreting the results needs to be done with a degree of caution with regard to the quantitative conclusions, though as earlier the qualitative conclusions are highly consistent.

If we turn to the substantially all experiment than given that we have excluded the highest tariff revenue generating industries it is of little surprise that there is quite a substantial impact on the amount of tariff revenue which is lost as a result of this experiment. The decline in tariff revenue is now more than 40% less than it was in the benchmark experiment for the Cariforum countries, and approximately 35% less for the OECS countries. In the benchmark experiment there was an average loss of tariff revenue for the Cariforum grouping, equal to 22.32% of base tariff revenue, whereas the loss is now 12.39%; and the corresponding figures for the OECS are 21.64% and 13.6%. What is also perhaps not surprising from this table is that while there is again an increase in welfare this has now considerably declined. For the Cariforum countries, the welfare gain is nearly 45% lower than it was initially, and for the OECS group of countries it is just over 40% lower. Hence, where there was already a very modest gain in welfare in the benchmark scenario, that gain would be significantly lower through the exclusion of the high tariff-revenue generating industries[3].

Finally we consider the MFN. As this represents a complete liberalisation of all tariffs all tariff revenue is lost. Not surprisingly then also we see that the MFN trade liberalisation is welfare enhancing giving an average welfare increase of 2.69 % which is around 1.6% of GDP for the average Caribbean country. In order to compare the MFN liberalization to the previous experiments, we also ran an experiment in which we only include those product groups, which are imported from the EU in the base. Hence, here the thought experiment is to imagine that the Caribbean liberalises its tariffs on all its imports from the EU, and on the same products on imports from all other sources. The impact of this experiment was very similar to the MFN experiment reported here. This suggests that trade in the products imported from the EU tends to reflect the patterns observed in trade in all goods.

[2] It is worth noting that the base for calculating change in the tariff revenue changes slightly across the different levels of aggregation, and this is driven by differences in the raw data across the different HS levels of aggregation.

[3] We ran a number of simulation with alternative criteria concerning substantially all trade, and not surprisingly the qualitative results in terms of the welfare impact were as would be expected.

4. WHAT DO WE LEARN FROM THE PRECEDING ANALYSES

Several things to be discussed here:

1. drawing conclusions about the comparison of results between the Sussex Framework analysis and the partial equilibrium modelling plus what the relationship is with CGE modelling.
2. What conclusions can be drawn with respect to deep integration which is where we think the big gains are. Why are PE and CGE models may be poor at this, and why even the SF can only be indicative.
3. Trade related development assistance, development benchmarks + special and differential treatment. The discussion below of SDT needs to be shortened and incorporated.

As discussed earlier, in the preceding "substantially all" simulation we allowed the products which are excluded from the trade liberalisation process to vary across the countries. In that experiment, each country separately determined the list of high tariff-revenue generating industries, which were to be excluded. De facto then the simulation we have run allows for the possibility of differential treatment across the countries. In the EPA negotiations the issue of special and differential treatment is a potentially thorny one. The position of the EU on this appears to be that it would not wish there to be special and differential treatment in the form of different product lists for each country. The position of the Cariforum grouping is less clear on this. On balance it is clear that the LDCs, and hence many of the OECS islands, tend to favour special and differential treatment including in the form of different product lists, whereas this is not necessarily the case for the MDCs. Similarly, discussion of SDT in the literature leads to contrasting views. This can be seen from the following two citations:

It is worth, therefore, exploring this issue of special and differential treatment (SDT) in a little more detail. Justification for SDT typically derives from a perceived lack of resources / structure to engage fully and successfully in the integrated economy. That perceived lack of resources or structure can refer to either a lack of human or physical infrastructure, or because of weaknesses in the underlying institutions be they legal, regulatory or fiscal for example, difficulties in accessing appropriate forms of credit, and/or due to the size or location of a given economy and hence its' potential vulnerability. It is undoubtedly the case that for certain, often very small economies, there are indeed difficulties associated with one or more of the above which make it more difficult for them to engage more successfully in the global economy[4].

There may indeed be a case for special and differential treatment for particular economies under certain circumstances. However, there remains the important question of what form any SDT could or should take? In particular, it is important to consider whether the form of proposed SDT is more likely to help or to hinder the successful integration of a given country into the global economy. In terms of trade negotiations the forms of SDT that are typically discussed include: (i) differential and improved access to the markets of trading partners, (ii) differential restrictions with regard to access of the trading partners to the domestic market; (iii) flexibility in the implementation of given agreements, for example with respect to timing or coverage of goods, and (iv) differential rules being applied to different partners. There is also an issue of whether any differential treatment which is granted should be done so on a

[4] See Winters & Martin for a discussion of some of these issues.

permanent or temporary basis, as the incentives within a given economy are likely to differ if any differential treatment is time-limited or not.

In order to be successful SDT needs to be able to distinguish between countries and thus to be able to recognise their different needs, and the evolution of those needs over time. Other wise SDT is likely to be a blunt instrument that arbitrarily includes / excludes countries, and is less likely to be successful in addressing the needs of specific countries. Discussions of SDT in the Caribbean context and particularly in the context of the EPA negotiations are complicated by three factors.

The first is the existing presence of SDT within the region itself. This can be seen in the long-standing distinction between LDCs and MDCs. The principal form of SDT which thus exists within the region, essentially allows for the application of different rules or different tariff levels across countries and according to with whom they are trading. As discussed earlier, there is great diversity across the Cariforum region as well as great diversity across both the MDCs and the LDCs. In particular, it is clear that the LDC's are not simply the poorer members of the region. Clearly, some of the LDCs are indeed the poorer members and this is a potential justification for SDT. Others clearly are not, and the presence of SDT appears to be more justified by their perceived vulnerability due to both size and location, and in particular with regard to natural disasters.

The second complication involves the inclusion of the Dominican Republic in the Cariforum grouping, and hence in the EPA negotiations. Formal trade relations between the Dominican Republic and the Caricom countries are also asymmetric with regard to the treatment of MDCs and LDCs. Perhaps more importantly the Dominican Republic is significantly bigger than any of the other Caribbean islands and there are concerns in the region with regard to this size asymmetry – both in terms of implications for trade and production but also possibly with regard to migration issues.

The third complication is to do with the relationship between the EPA process, and the process of regional integration in the region and in particular progress towards the Caribbean Single Market and Economy. As discussed earlier, the Caribbean region is in the process of attempting to greatly deepen the process of integration within the region, and hence to move from being a common market to being more of a single market. This is rightly seen as being important in terms of increasing the competitiveness and flexibility of the region as it engages increasingly with the world economy. The success of that process in terms of economic growth and prosperity, and in terms of enabling the integration of the Caribbean islands successfully into the globalised world economy, will thus depend crucially on the extent to which the CSME is de facto implemented. The greater the removal of shallow integration barriers, the greater the promotion of measures of positive or deep integration the more likely it is that the process will generate higher rates of economic growth. However, clearly then, any obstacles or barriers to that process are likely to work in the opposite direction. Special and differential treatment by introducing asymmetries in the treatment of countries, by for example, allowing for asymmetries in tariff levels etc across countries, effectively introduces distortions and thus barriers to successful regional integration. Not only does it introduce and maintain those forms of distortions which is likely to increase economic inefficiencies, it also greatly increases the bureaucratic and administrative burden. This is in a context, where the underlying institutional capacity is already very limited.

It is therefore extremely important to be very clear about the grounds for any special and differential treatments (infrastructure, institutions, size/location), and given those grounds to consider carefully optimal policy responses. The view in this report is that introducing asymmetries in trade rules, asymmetries in tariff lists etc. is highly likely to increase distortions and increase inefficiencies and in the long run to make it more difficult for the Caribbean economies to successfully integrate into the world economy, and that therefore such form of SDT should be avoided.

What are the practical implications of this for the EPA process? We would argue that introducing different lists across countries should be avoided on the grounds detailed above. If differential treatment with regard to tariff liberalisation is to be sought a preferable option, though far from ideal would be to have a common list, but possibly with different time scales for specific countries. Clearly introducing different time scales also introduces distortions and adds to bureaucratic complexity, but less so than with differential lists. In addition as the sole difference is over time scale in principle the SDT is time delimited which should introduce more appropriate incentives in the long run.

A much more satisfactory way of addressing the problem of different countries' development needs is not to introduce diversity in (trade) rules, but in the implementation of development assistance and aid. We would therefore argue that there is a need for addressing the concerns of specific countries via this route as opposed to via introducing distortions in the underlying trade rules. That development assistance could be channelled in various way. However, two obvious routes are worth mentioning in the context of the Caribbean. The first, is within the region itself through the creation of a regional development fund which could thus help to facilitate the process of intra-regional integration and help to ensure that the benefits from that process of regional integration are more broadly spread. There have been discussions for some time in the region concerning such a fund, but these discussions are still on-going and such a fund has not yet been realised. The second is in the context of the EPA process. Here, as in the Cotonou agreement there is explicit recognition by both sides of the importance of development assistance and aid. It is clearly extremely important that this is realised in an effective and timely manner.

5. SUMMARY AND CONCLUSIONS

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APPENDIX: PARTIAL EQUILIBRIUM MODEL

In this appendix we introduce and discuss the underlying methodology used for the simulations. There are two principal modelling structures we employ here — an Armington perfectly competitive model, and an imperfectly competitive model. Here we detail the key features of the perfectly competitive model as well as discussing the welfare measures used in the modelling exercise.

6.2.1 THE BENCHMARK MODEL – ALGEBRA

The model that forms the basis of the analysis is a slightly modified version of Francois & Hall (1997). This model follows the Armington (1969) assumption that we have well behaved preferences over a weakly separable product category that has similar, but not identical products. The products are differentiated by their place of origin and a constant elasticity of substitution is assumed among different products in the same class. The imperfect substitutes approach was preferred over perfect one, because the Caribbean imports are mainly manufacturing goods and thus they are similar but not identical. The model is specified as a non-linear system of equations and numerical methods are used for solving. The GAUSS programming language was used to implement the model.

We begin by firmly grounding the model in standard consumer theory.

Consider a market with *n* products from different countries: $X_1,...,X_n$. We can introduce composite good made from all of the competing products: $X = u\left(X_1,...,X_n\right)$. This gives as a quantity-index of consumption in given market, which can be viewed as a utility function of a representative consumer. We assume that *u* has generalized CES form:

$$X = u\left(X_1,...,X_n\right) = \left(a_1 X_1^{\rho} + ... + a_n X_n^{\rho}\right)^{\frac{1}{\rho}} \qquad (1.1)$$

where a_n are called CES weights and ρ is a constant less then one. If we combine it with budget constrain $Y = \sum_{i=1}^{n} P_i X_i$, we can set up a dual - viewing consumer as choosing a consumption bundle that minimises the level of expenditures while retaining specific level of utility. The problem then becomes:

$$\min_{X_1,...,X_n} \quad Y = \sum_{i=1}^{n} P_i X_i \quad \text{s.t.} \quad u\left(X_1,...,X_n\right) = X \qquad (1.2)$$

To solve it we set up Lagrangian:

$$L\left(X_1,...,X_n,\lambda\right) = \sum_{i=1}^{n} P_i X_i + \lambda\left(u\left(X_1,...,X_n\right) - X\right) \qquad (1.3)$$

Differentiating the above expression, we can obtain the conditions for an optimal solution:

$$\frac{\frac{\partial u}{\partial X_j}}{\frac{\partial u}{\partial X_k}} = \frac{P_j}{P_k}, \qquad k = 1,...,n \qquad (1.4)$$

This means that the marginal rate of substitution between two goods equals their price ratio. In our case, the marginal utility for good X_i equals:

$$\frac{\partial u}{\partial X_i} = a_i X_i^{\rho-1}\left(a_1 X_1^{\rho} + ... + a_n X_n^{\rho}\right)^{\frac{1}{\rho}-1} \qquad (1.5)$$

Which gives us:

$$\frac{\frac{\partial u}{\partial X_j}}{\frac{\partial u}{\partial X_k}} = \left(\frac{a_j}{a_k}\right)\left(\frac{X_j}{X_k}\right)^{\rho-1} = \frac{P_j}{P_k}, \qquad k = 1,...,n \tag{1.6}$$

Solving for X_k we obtain:

$$X_k = \left(\frac{a_j P_k}{a_k P_j}\right)^{\frac{1}{\rho-1}} X_j, \qquad k = 1,...,n \tag{1.7}$$

Before moving any further, some simplifications can be made. By rearranging, we can see that the elasticity of substitution between X_k and any other product competing in the market is constant and equal to $\frac{1}{\rho-1}$:

$$\frac{X_k}{X_j} = \left(\frac{a_j}{a_k}\right)^{\frac{1}{\rho-1}} \left(\frac{P_k}{P_j}\right)^{\frac{1}{\rho-1}}, \qquad k = 1,...,n \tag{1.8}$$

Following the traditional notation we assume $\sigma = \frac{1}{\rho-1}$, then the equation simplifies to:

$$X_k = \left(\frac{a_j P_k}{a_k P_j}\right)^{\sigma} X_j, \qquad k = 1,...,n \tag{1.9}$$

We can now use the final equation arising from using Lagrange method:

$$\frac{\partial L}{\partial \lambda} = X - u\left(X_1,...,X_n\right) = 0 \tag{1.10}$$

Substituting gives us:

$$X = \left[\sum_{k=1}^{n} a_k \left(X_j \left(\frac{a_j P_k}{a_k P_j}\right)^{\sigma}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} = X_j a_j^{-\sigma}\left[\sum_{k=1}^{n} a_k^{\sigma}\left(\frac{P_k}{P_j}\right)^{\sigma-1}\right]^{\frac{\sigma}{\sigma-1}} \tag{1.11}$$

Solving for the X_j we obtain Hicksian demands:

$$X_j = X \cdot a_j^{\sigma}\left[\sum_{k=1}^{n} a_k^{\sigma}\left(\frac{P_k}{P_j}\right)^{\sigma-1}\right]^{\frac{\sigma}{1-\sigma}} \tag{1.12}$$

We could now continue with the model implementation, but it is much better to simplify the obtained expression using property arising from Armington (1969) assumptions:

$$P = P_1 / \frac{\partial u}{\partial X_1} = ... = P_n / \frac{\partial u}{\partial X_n} \tag{1.13}$$

where *P* is an exact price index corresponding to the cost of a unit of utility. Substituting the relevant derivatives leads to:

$$P = P_j a_j^{-1} X_j^{\frac{1}{\sigma}} X^{-\frac{1}{\sigma}}, \qquad j = 1,...,n \tag{1.14}$$

Substituting for X_j and rearranging we end with:

$$\left(\frac{P}{P_j}\right)^{\sigma} = \left[\sum_{k=1}^{n} a_k^{\sigma}\left(\frac{P_k}{P_j}\right)^{\sigma-1}\right]^{\frac{\sigma}{1-\sigma}} \tag{1.15}$$

That along with the linear homogeneity of the utility function permits us to write the demand in a more compact form:

$$X_j = X \cdot a_j^{\sigma} \left(\frac{P}{P_j} \right)^{\sigma} = \left(\frac{a_j}{P_j} \right)^{\sigma} Y \cdot P^{\sigma-1}, \qquad j = 1,...,n \tag{1.16}$$

To obtain the price index P we need to calculate the expenditure function for a unit of utility:

$$PX = e(p, X) = \left(\sum_{i=1}^{n} P_i^{1-\sigma} a_i^{\sigma} \right) P^{\sigma} X, \qquad X = 1 \tag{1.17}$$

$$P = \left(\sum_{i=1}^{n} P_i^{1-\sigma} a_i^{\sigma} \right)^{1-\frac{1}{\rho}} \tag{1.18}$$

Now if we make assumption about functional form of demand for composite good and supply functions for different goods, we can specify the model used for analysis. Assuming supply function with constant supply elasticity, we obtain excess demand conditions for each of the products:

$$\begin{gathered} \left(\frac{a_1}{P_1} \right)^{\sigma} Y \cdot P^{\sigma-1} - k_1 \left(\frac{P_1}{(1+t_1)} \right)^{\varepsilon_1} = 0 \\ \vdots \\ \left(\frac{a_n}{P_n} \right)^{\sigma} Y \cdot P^{\sigma-1} - k_n \left(\frac{P_n}{(1+t_n)} \right)^{\varepsilon_n} = 0 \end{gathered} \tag{1.19}$$

where: k_i are supply constants, t_i are aggregated trade barriers and ε_i are supply elasticises. Adding the excess demand condition for composite good:

$$Y - k_a P^{1-NA} = 0 \tag{1.20}$$

and price index equation:

$$P - \left(\sum_{i=1}^{n} P_i^{1-\sigma} a_i^{\sigma} \right)^{1-\frac{1}{\rho}} = 0 \tag{1.21}$$

we obtain a model ready for implementation. The model can be summarised in a simple table:

Table 6.8 Model Summary

Variables:	$P_1,...,P_n$ - product prices, Y – total expenditure, P – composite good price index
Parameters (calibrated):	$a_1,...,a_n$ - CES weights, $k_1,...,k_n$ - supply constants, k_a - demand for composite constant
Parameters (data):	$X_1,...,X_n$ - base trade flows, $t_1,...,t_n$ - base tariffs
Parameters (assumed):	σ - elasticity of substitution, NA - composite elasticity of demand, $\varepsilon_1,...,\varepsilon_n$ - elasticises of supply