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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

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BY

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CONTENTS

1. INTRODUCTION

1.1 Overview

This paper employs a numerical general equilibrium model of the Pacific Basin to study the effects of various trade liberalization strategies on ASEAN and Australia. We particularly focus on the alternatives to participation in multilateral tariff liberalization schemes, such as the Kennedy and Tokyo Rounds concluded under the auspices of the GATT. The tariff reductions negotiated in these Rounds concentrated on manufacturing trade, and we pursue that emphasis in our simulation of alternative policies.

A major conclusion of our study is that the economic benefits from ASEAN and Australian participation in GATT-type multilateral tariff liberalization schemes, although positive and robust to uncertainty about the parameters used in our model, are not particularly large. Moreover, these benefits to ASEAN and Australia are small in relation to either the benefits from liberalization of non-tariff barrier liberalization or a customs union. The political difficulties of moving in either of these policy directions are not considered here. We strongly believe that one important role for economic analysis and quantitative modelling is to identify areas in which existing political constraints should be relaxed (i.e., areas in which it is worthwhile for the politicians and diplomats to go to work).

Section 2 introduces the general equilibrium (GE) model, which is described in detail in Harrison [1984a]. It is firmly neoclassical and static in structure, and is empirically calibrated to represent the global economy as of 1975. Policy simulations are reported in Section 3. Three sets of policies are considered: (i) global liberalization in tariffs and non-tariff barriers (NTB's); and (ii) regional liberalization of tariffs and NTB's by ASEAN nations alone and by ASEAN and Australia. Related policy applications appear in Harrison and Kimbell [1985], Harrison [1984a] [1985a] and Harrison and Rutström [1985].

We are implicitly arguing throughout this paper that GE methods of analysis, whether theoretical or numerical, are of some value in the policy process. We do not want to appear dogmatic on the possible use of alternative methods of analysis or models. Indeed, we argue in Section 4 that significant reformulations of existing numerical GE models are necessary to properly address many trade policy issues of importance in ASEAN and Australia. Moreover, the alternatives to GE analysis are not well-defined, since many GE features may be implicit. An important example is the use of Input-Output modelling assumptions underlying "effective protection" calculations such as those presented elsewhere in this volume. We now turn to consider in detail the relationship between those calculations and our own.

1.2 Effective Protection Calculations

The development of effective protective rates (EPR's) in empirical trade analysis has been an attempt to design a tool to forecast effects on resource-allocation of protectionist policies in a more complex setting than in the simple world without intermediate goods where nominal tariff rates perform this task adequately.

Corden [1966] uses the input-output structure of the economy to derive a formula for EPR which is simply a ratio of value-added under protection to value-added in free-trade. His basic conclusion is that, after ordering economic activities according to the rate of effective protection, it is possible to determine the direction of sectoral resource reallocation: there will be a movement of resources out of activities with low (effective) protection into activities with high (effective) protection. The highest protected activity will be a net receiver of resources and the lowest protected activity will be a net loser of resources. As Corden is assuming fixed input-output coefficients, though, he cannot tell the net effects on the activities in-between these two extremes. More information on production substitution elasticities is needed for this to be possible. This implies the need for a second step after the calculation of EPR. The reason for keeping these coefficient fixed is that the EPR is designed to indicate the direction of resource pull of a specific tariff scheme, and thus should not already incorporate any of the reallocation effects it is supposed to indicate. The input-output coefficients to be used in the EPR calculations should ideally be the coefficients applicable under free trade. The second step in the resource movement forecasting would then be to use estimated production substitution elasticities in an economy-wide analysis of resource shifts, following the computation of changes in relative net benefits of the effective protection scheme in different sectors. At this stage we are approximating a GE framework to a significant extent.

Another complication with EPR's is substitution between traded and non-traded final goods that will change the real exchange rate and thereby provide a uniform rate of effective (positive or negative) protection for all tradables. In essence this represents an introduction of the demand-side of the economy into the calculations. Another step towards an explicit GE analysis.

A third complication is to take the effects of foreign tariffs into account. At the final goods level an import tariff imposed by a trading partner acts as an equivalent to an export tax. A scale of combined effective rates could therefore be constructed to analyze the resource movements under a multilateral tariff scheme, although this is rarely done in EPR analyses. A further complication of foreign tariffs is included if one allows for trade in intermediate goods (as "middle products"). When calculating changes in value-added for an industry as a measure of EPR the cost of intermediate goods is subtracted, and these could include not only protection of domestically produced intermediates but also protection in the country of production of imported intermediates. This is especially important when discussing multilateral trade-liberalization schemes. This is not accounted for in extant EPR analyses, but is automatically taken into account in a multi-country GE framework.

One important difficulty encountered when empirically calculating EPR's is that the free-trade input-output coefficients are, in general, not known. This introduces an error in the calculations as substitution effects in production (due to the existing tariff distortions) are already incorporated in the EPR estimate. The structure of intermediate imports from a given trade-partner is also assumed to be constant because of fixed input-output coefficients in trade in intermediates. Because of this any resource reallocation considerations of implementing a multilateral trade liberalization scheme will be based on the trade pattern applying in the (distorted) situation with barriers to trade. Again, a complete GE model, especially with some degree of substitutability in intermediate trade, can easily take this factor into account when considering the comparative static effects of a given change in protection.

Bhagwati and Srinivasan [1973] raise the question of sufficiency conditions for EPR theory to perform the same forecasting role in a world with traded inputs as nominal tariffs perform in traditional models with no traded inputs. Under certain conditions they are able to devise a "price" of value-added to rank production activities so that reallocation of "quantities" of value-added can be predicted. They find that this is possible only under the relatively restrictive class of separable production functions if we want to analyze an economy with more than two final goods. It should be noted that the GE model presented below assumes such production functions (see Section 2.3), albeit not in the especially restrictive class of Leontief production functions typically adopted in EPR models. A further restriction is that the pattern of "prices" of value-added cannot in general be computed solely from knowledge of the tariff structure; information on production functions also would be needed, especially the functional dependence of the share of traded inputs on output prices. The problem is not as severe in Cobb-Douglas production functions, where sharea are constant, as in the general CES production function. Our conclusion is that with the effort and amount of information that is required in order to compute an EPR with good predictive power there is no real reason for preferring EPR over GE computations.

One important feature of the GE model presented in the next section is the use of a technique for allowing intermediate input substitutability that does not involve significant increases in computational expense.[1] This feature is particularly important for international trade models in the face of the empirical significance of trade in intermediate and prevailing estimates of non-zero import price elasticities.

2. A PACIFIC BASIN GENERAL EQUILIBRIUM MODEL

By way of perspective, we employed three broad criteria in specifying the model. The first was that it be understandable, in the sense of having a (neo-classical) structure that would be readily familiar to all economists despite great sectoral detail and a large number of trading regions. The second was that it be readily operational with existing data sources. The third requirement was that it be repeatedly soluble for the purposes of systematic sensitivity analysis. A number of additional requirements, specific to a diverse range of intended policy applications, are of secondary importance but have nonetheless influenced the chosen specification.

2.1 Trading Regions

The model identifies eleven trading regions, listed in Table 1 along with several aggregate statistics, plus a residual "Rest of World". These regions represent a diverse range in terms of degree of industrialization, size, and "openness" to international trade. In terms of geographic coverage, our model subsumes the three-region (U.S., Japan, EEC) model presented in Whalley [1980a] [1980b] [1982a] [1984] and Brown and Whalley [1980], while providing certain country-specific detail for less-developed countries abstracted from in the 7-sector (U.S., Japan, EEC, Other Developed Countries, OPEC, Newly Industrialized Countries and Less Developed Countries) model presented in Whalley [1982b] [1984].

TABLE 1

Trading Regions

Region	GDP	Exports	Imports	Population	GDP per capita
1. Australia	87.3	11.7	9.5	13.8	6326
2. Canada	165.2	33.9	34.3	22.7	7277
3. Indonesia	30.5	6.9	5.5	135.2	226
4. Malaysia	9.3	3.8	3.5	11.9	781
5. Philippines	15.8	2.3	3.5	42.1	375
6. Singapore	5.6	5.1	7.5	2.3	2435
7. Thailand	14.6	2.2	2.8	41.9	348
8. Korea	20.6	5.0	6.7	35.3	583
9. Japan	501.9	54.7	49.7	111.6	4497
10. U.S.A.	1518.3	107.1	98.1	213.6	7108
11. E.E.C.	1373.2	146.3	148.0	258.0	5323

Notes: GDP, Exports (fob) and Imports (fob) are measured in billions of U.S. dollars in 1975, and were obtained from lines 99b, 77aad and 77abd, respectively, of the International Financial Statistics of the IMF (period average exchange rates used). Population is measured in millions, and is obtained from line 99z of the IFS. GDP per capita is measured in U.S. dollars. Note that the Exports and Imports listed here are not the model-equivalent values. The model also includes a twelfth region, a residual "Rest of World".

2.2 Commodities

Two levels of commodity aggregation are adopted, and are listed in Table 2. The reasons we adopt two levels of aggregation are the relative ease of computation and interpretation of results with the aggregated model. We discuss the aggregation procedures employed in Section 2.8 below. In addition to the commodities listed, each household in each trading region allocates income to "savings", which are in turn allocated to the purchase of a bundle of investment goods (primarily, but not exclusively, in the household's own region).

2.3 Production Structure

Each of the commodities listed in Table 2 are assumed to be produced in each region and are, in principle, tradeable. Each commodity is distinguished by producing region, implying that our model has 84 or 240 commodities (depending on the aggregation adopted; this is the familiar "Armington assumption" distinguishing products by point of production. Each sector uses intermediate inputs from its own region and from all other regions, as well as primary factors (labour and capital). Although it is useful to visualize the use of intermediate inputs in the form of a complete multi-regional (international) input-output table, an important feature of the present model is that the implied technical coefficients are not fixed with respect to relative input prices. That is, we do not employ a Leontief technology in the use of intermediate inputs, but assume instead a Cobb-Douglas technology. Thus intermediate inputs are substitutable and, as a composite, substitutable with a composite of primary inputs. Primary inputs, in turn, are characterized with a standard CES technology.

TABLE 2

Commodities Considered

Twenty Sector Aggregation	Seven Sector Aggregation
1. Agriculture, Forestry and Fishing	1. Agriculture, Forestry and Fishing (1)
2. Minerals and Extractive Ores	2. Mining and Quarrying (2,3)
3. Energy Products	3. Manufacturing (4/15)
4. Food, Beverage and Tobacco	4. Utilities (16)
5. Textiles, Clothing, Footwear and Leather	5. Construction (17)
6. Lumber and Wooden Products	6. Trade and Transport (18)
7. Pulp, Paper and Printing	7. Services (19,20)
8. Chemicals	
9. Rubber and Plastic Products	
10. Non-Metallic Mineral Products	
11. Basic and Fabricated Metal Products	
12. Industrial Machinery	
13. Electrical and Other Machinery and Equipment	
14. Motor Vehicles	
15. Other Transport Equipment	
16. Electricity, Gas and Water Supply	
17. Construction	
18. Trade, Transport and Communications	
19. Services	
20. Public Administration and Community Services	

Notes: The bracketed numbers for the seven sector aggregation indicate the aggregated sectors from the twenty sector list.

We adopt a Cobb-Douglas technology for intermediate inputs here for two reasons. The first is the comparative unease that economists have in accepting unchanging "trade coefficients" (viz., the off-diagonal blocks of the multi-regional IO table) in an international, as opposed to inter-regional (sub-national), context. The second reason is the need to calibrate our model to (own-price) import elasticities that are significantly different from zero. These elasticities typically reflect imports intended for intermediate use and also directly for final demand; the available estimates do not differentiate between these two, and must therefore be somehow allocated to each.[2] Employing a Leontief technology in intermediates implies an inordinately high import elasticity for final demand; employing a Cobb-Douglas technology in intermediates implies much more reasonable final demand import elasticities.

The two primary factors employed in each sector are characterized by a CES technology. In general, the Heckscher-Ohlin (HO) factor mobility assumptions are adopted: each factor is free to move within the sectors of each region but not between regions. In some cases alternative Ricardo-Viner (RV) factor mobility assumptions are also examined, with capital in one region being specific to either Manufacturing or Non-Manufacturing sectors (and mobile within the sectors of each block). Kimbell and Harrison [1984] discuss the procedure for calibrating the model to these alternative factor mobility assumptions. Whalley [1980a] [1980b] [1982a] [1982b] and Brown and Whalley [1980] adopt the HO approach; Whalley and Wigle [1982] adopt, _inter alia_, the RV approach.[3]

There are two major data sources required to calibrate this production structure: a complete multi-regional IO table for the regions listed in Table 1 (including sectoral value-added data), and extraneous estimates of the elasticities of substitution between labour and capital. The Institute of Developing Economies [1982] and Harrison [1984b] describe the construction of the IO table. The relative availability of national IO data for 1975 determined the dating of our model.

Table 3 lists the point estimates of the elasticity of substitution for each of the Australian sectors based on 1947/67 U.S. time-series estimates from Mayor [1971], U.S. cross-section estimates for Manufacturing sectors from Zarembka and Chernicoff [1971], and estimates for all other sectors from Piggott and Whalley [1984; Table 6.1] or Whalley [1980b; p. 1191, fn. 5].[4] Standard errors for each point estimate are also shown, and are used in our sensitivity analysis (discussed in Section 2.7).[5] The estimates for Manufacturing sectors shown in Table 3 represent value-added weighted averages of estimates obtained at the IO level of aggregation (109 sectors in the Australian case). They are "Australian" estimates simply because Australian value-added weights were employed to compute the averages. Thus each trading region has different elasticities corresponding to those in Table 3 to the extent that the share of each sector in that region's total value added differs from the corresponding Australian share.

2.4 Demand Structure

The demand pattern in each trading region is represented by a single private household and a single public household. Thus the model identifies 24 households in all.

TABLE 3

Elasticities of Substitution Between Primary Factors

"Australian Estimates"

Sector	Cross-Section		Time Series	
	Point Estimate	Standard Error	Point Estimate	Standard Error
Twenty-Sector Aggregation				
1. Agriculture, Forestry and Fishing	0.640	0.640	0.780	0.200
2. Minerals and Extractive Ores	0.500	0.500	0.110	0.540
3. Energy Products	1.132	0.790	0.858	0.683
4. Food, Beverage and Tobacco	1.044	0.173	0.801	0.140
5. Textiles, Clothing, Footwear and Leather	1.293	0.170	1.317	0.100
6. Lumber and Wooden Products	0.925	0.172	0.995	0.235
7. Pulp, Paper and Printing	1.105	0.107	0.328	0.173
8. Chemicals	1.462	0.337	0.599	0.152
9. Rubber and Plastic Products	1.041	0.135	0.450	0.212
10. Non-Metallic Mineral Products	0.828	0.422	1.453	0.160
11. Basic and Fabricated Metal Products	1.141	0.128	0.567	0.224
12. Industrial Machinery	0.701	0.179	0.460	0.563
13. Electrical and Other Machinery and Equipment	0.662	0.260	0.736	0.222
14. Motor Vehicles	1.706	0.362	1.030	0.250
15. Other Transport Equipment	0.871	0.220	0.327	0.339
16. Electricity, Gas and Water Supply	0.167	0.167	0.360	0.050
17. Construction	0.324	0.324	0.324	0.324
18. Trade, Transport and Communications	0.970	0.970	0.970	0.970
19. Services	0.970	0.970	0.240	0.400
20. Public Administration and Community Services	0.970	0.970	0.970	0.970
Seven-Sector Aggregation				
1. Agriculture, Forestry and Fishing	0.640	0.640	0.780	0.200
2. Mining and Quarrying	0.500	0.500	0.110	0.540
3. Manufacturing	1.096	0.205	0.749	0.215
4. Utilities	0.167	0.167	0.360	0.050
5. Construction	0.324	0.324	0.324	0.324
6. Trade and Transport	0.970	0.970	0.970	0.970
7. Services	0.970	0.970	0.240	0.400

Private households maximize a nested utility function with three levels (for convenience we shall assume the 20-sector commodity aggregation). The "top" level is a Klein-Rubin utility function,[6] leading to an Extended Linear Expenditure System (ELES) defined in principle over eight commodity groupings (Food, Clothing, Housing, Durables, Personal Care, Transportation, Recreation, and Other Services) and savings. The "middle" level is a CES function defined over the commodities within each of these eight commodity groupings. Thus "Agriculture, Forestry and Fishing" and "Food, Beverage and Tobacco" from Table 2 are combined in a CES function to form the composite grouping "Food".[7] Finally, the "bottom" level is a CES function defined over each of the commodities listed in Table 2 differentiated by origin.

The consumption problem of the private household may therefore be viewed in three stages. Given the income to be allocated to consumption (i.e., non-savings), the allocation of expenditure to the eight commodity groupings is decided. Then, conditional on the expenditure for each group, the allocation to each of the (varying number of) commodities within each group is decided. Finally, the household decides between alternative sources of each commodity given the expenditure allocated to that commodity. Specific functional forms aside, this type of utility nesting structure is common to recent international trade GE models.

The basic data to parameterize the top level of our utility function for each private household are obtained from Lluch, Powell and Williams [1977] (LPW) and input-output data on final demand expenditure shares. LPW (pp. 74/80) estimate an approximate relationship between the ELES "Frisch parameter"[8] and real GNP per capita. This relationship is used to estimate the value of this "parameter" for those countries in our model (Table 1) that are not directly included in the LPW study.[9] Expenditure elasticities, and their implied asymptotic standard errors, are obtained from Table 3.12 of LPW (p. 54); for those countries not directly covered by their estimates the average estimates for "real GNP per capita" class intervals are used.[10] Harrison [1984a] and Harrison and Kimbell [1985] discuss the calibration of the top level Klein-Rubin utility function using these estimates and expenditure shares (including savings) obtained from the input-output data.

The middle and bottom levels of our utility function are calibrated to uncompensated own-price elasticities using the procedures outlined in Mansur and Whalley [1984] and widely used in other models. The relevant elasticities, and implied standard errors, for the middle level calibration are obtained from LPW (Table 3.13, p. 55) in the same manner as the expenditure elasticity estimates discussed above. Where available, import price elasticities obtained from Alouze [1977], Stern, Francis and Schumacher [1976; pp. 15/24] and Stone [1979] were similarly used to calibrate the bottom level. Such data were available for Australia, Canada, Japan, U.S.A. and the EEC. For every other country in our model the own-price elasticity estimates used at the middle level were also used at the bottom level.[11]

Household savings are allocated entirely to the purchase of a Cobb-Douglas composite of commodities from all regions for the purpose of capital formation. These expenditures refer to purchases of real goods and services.

Public households in each region spend their revenues on various own-region and foreign commodities. A Cobb-Douglas utility function is used for these households, and is calibrated using expenditure shares by each government (for current consumption purposes and capital formation).

Private household income is generated from the sale of their factor endowment to own-region industries and from transfers received from their government. Each government receives revenue from the taxes, tariffs and non-tariff barriers that it levies on own-region and foreign economic activity; these policy instruments are discussed in more detail in the next section. In principle the model allows for inter-government transfers, in the form of (untied) aid; in practice we have been unable to obtain adequate data to include these transfers in the present model.

Although each and every household has a "balanced budget" in equilibrium, there is no explicit or implicit presumption in the model that bilateral trade flows between any two regions balance.

2.5 Tariffs and Non-Tariff Barriers

In principle the model incorporates a wide range of taxes, tariffs and non-tariff barriers (NTB's) differentiated by commodity, region and stage-of-production of (legal) incidence, and taxing government. In practice, however, data limitations severely circumscribe the detail, coverage and accuracy of our "model equivalent" estimates of these policy instruments.[12]

The basic source of data on tariffs was the international input-output table presented in Institute of Developing Economies [1982] and Harrison [1984b]. We draw a distinction between tariffs levied on imports of intermediate inputs and those levied on imports of final goods. Recall that we allow a given sector to import intermediates from all other sectors in all regions. Thus the total import duties paid by this sector reflects the various tariff rates applicable to the range of intermediates it imports, weighted by the expenditure on each imported intermediate. The "ad valorem" tariff implied by this procedure need bear no similarity to the posted tariff on imports of the commodity of the sector in question.[13] Moreover, the same tariff rate applies to all intermediate input imports of the given sector. The implied tariff rates on final demand imports bear a direct similarity to posted rates (due allowance being made for "water in the tariff, such as might be expected on tariffs on ASEAN imports of snow-making machines). Although our model-equivalent tariff rates on intermediate input imports do not correspond directly to posted rates, it can be shown that they can be reconciled satisfactorily with the 1976 rates used by Whalley [1980b; Table 2] for the U.S., EEC and Japan.

The available data on "ad valorem equivalents" of NTB's are notoriously poor. We rely heavily on the aggregative estimates listed in Whalley [1982b; Table A1] and the detailed estimates employed in Whalley [1980a] and Yeats [1978]. We adopt the measures of the "ad valorem" equivalent of agricultural NTB's in Japan and Korea reported in Saxon and Anderson [1982] and Anderson [1981], respectively. The measures adopted for Australia, Canada, Indonesia, Malaysia, the Philippines, Singapore and Thailand were derived from Tyers and Chisholm [1982; Table A1]. Government procurement practices are approximated by a 50% tariff applied to imports of each public household in each region, following Whalley [1982a; p. 356]. Domestic tax systems are often viewed as NTB's (see Lloyd [1973; Ch. 7]), and their discriminatory features are included in the model. Asher and Booth [1983] provide an excellent description of the comparative role of indirect taxes in ASEAN countries; our model reflects many of their estimates of sales, excise and foreign trade taxes.

2.6 Solution Procedures

A benchmark equilibrium solution for 1975 was obtained by solving "backwards" for certain parameter values in the usual fashion. Apart from the treatment of intermediate input substitutability these procedures were standard to the literature. Mansur and Whalley [1984; Section 3] and

Piggott and Whalley [1984; Ch. 4] provide general discussions of these procedures, and Kimbell and Harrison [1984; Section 3.2] discuss the calibration of models with immobile factors (i.e., our Heckscher/Ohlin assumption). Given some counterfactual policy change, we solve the model for a new equilibrium using the Factor Price Revision Rule introduced by Kimbell and Harrison [1983].[14]

2.7 Sensitivity Analysis

The policy-relevance of numerical GE models, and their avowedly "empirical" nature, render them open to casual criticism. Most economists are deeply familiar with their underlying neoclassical structure; we are not therefore concerned to defend them here from criticisms based on rejection of that structure (see Section 4 for several structural criticisms that we consider important). On the other hand, criticism based on suspicion of the particular empirical calibration adopted currently leads to non-systematic and/or uninformed debate. The general techniques used to calibrate numerical GE models are discussed in the references given above. Given, then, that users of numerical GE models are increasingly "informed" as to the various sources of data embodied in their simulations, how is one to identify the robustness of the results for some particular policy decision? Our response to this important question is to undertake a systematic sensitivity analysis of our policy simulations in Section 3.

A number of critical dimensions to such analysis may be readily identified from any discussion of the procedures used to calibrate GE models. For one obvious example, consider the elasticities of substitution listed in Table 3 that are used to calibrate the CES production functions of each sector. Popular calibration procedure is to employ the vector of point estimates based on a search of the available econometric literature. Such estimates are usually accompanied by standard errors, such as those also listed in Table 3. The vectors of estimates formed by considering all combinations of estimates within (say) one standard error either side of the point estimate for each sector provides a continuum of distinctly calibrated GE models whose comparative static (policy) properties need not be identical.

In the present case we undertake a systematic sensitivity analysis for each policy simulation with respect to three sets of elasticities: the elasticities of substitution between primary factors (Section 2.3), the import demand elasticities (Section 2.4), and the own-price demand elasticities (Section 2.4). In the first and third cases we have available well-defined standard errors and a presumption that the distribution of each parameter estimate is well behaved (i.e., follows a t-distribution); we may therefore completely define a Bayesian prior distribution for these elasticities.[15] In the case of the import elasticities we adopt the aggregative standard errors compiled in Harrison, Jones, Kimbell and Wigle [1985; Appendix A] <u>or</u> the same prior as used for the demand elasticities when we had no separate import elasticity estimates available. Harrison, Jones, Kimbell and Wigle [1985] explain the procedure used to weight each of the simulations in the sentivity analyses.

Harrison, Jones, Kimbell and Wigle [1985] distinguish between "conditional" and "unconditional" systematic sensitivity analyses. The former refers to a series of simulations in which each parameter is perturbed from its point estimate a certain number of times (four in the present case) conditional on all other parameters being set only to their point estimate value. The latter refers to perturbations of each parameter conditional on all other parameters also being perturbed from their point estimate a certain number of times; thus the set of simulations is "unconditional". Clearly the latter type of analysis is more complete than the former, but at a severe cost in terms of the number of required simulations. Given the size of the present model and the large number of parameters subject to perturbations (252 in the seven-sector model and 720 in the twenty-sector model), we have opted for the conditional systematic sensitivity analysis.[16]

We shall consider five values for each parameter, including the point estimate. Thus we have four perturbations for each parameter. Two of these perturbations will be one-half of a standard error above and below the point estimate, and the other two will be one standard error above and below the point estimate. The exact marginal probabilities for these values depend on the relevant degrees-of-freedom for the parameter estimate; where we are unable to infer that value from published data it is assumed large enough for asymptotic results to hold. We therefore require 1009 simulations for each policy change in the seven-sector model (252 relevant parameters times 4 perturbations per parameter, plus one simulation with all parameters equal to their point estimate), and 2881 simulations in the twenty-sector model. In all cases reported in Section 3 we initially solved the seven-sector model for the given policy change with all parameters set equal to their point estimates. The solution vector of relative factor prices (containing 23 elements) was then employed as starting values for the twenty-sector model.

Given the solution values for this simulation as starting values for the sensitivity analysis simulations involving a perturbed elasticity, we were able to find the new solution values extremely quickly.[17]

2.8 Aggregation Procedures

Harrison and Manning [1984] propose a "best approximate aggregation" (BAA) method of constructing aggregate IO systems that minimizes the mean-square-error of aggregate predictions. The BAA method is proposed as an alternative to Naive aggregation procedures (that ignore the decision-theoretic objective of the eventual use of the IO model) and the Holy Grail of Consistent (or Exact) Aggregation (which is simply not feasible in general).[18] The illustrative applications of BAA reported by Harrison and Manning [1984] indicate the dangers of using Naive aggregation procedures on the Leontief Inverse Transpose. Moreover, BAA in these cases yields significant improvements in the predictive power of the aggregate IO model. This result has some importance for applied GE models, in the context of well-known examples of the loss in predictive power when one aggregates sectors (e.g., Fullerton, Henderson and Shoven [1984] on the Harberger two-sector aggregation scheme). Harrison, Jones, Kimbell and Wigle [1985] demonstrate that applying the BAA method to the IO data of the present GE model in several tariff reduction policy simulations indeed allows predictions of welfare effects in the resulting aggregate GE model that are virtually identical to those obtained with the disaggregated GE model.[19] Several of the policy results reported in Section 3 are based on a "best approximate" aggregate GE model in this limited sense.[20]

3. POLICY RESULTS

In this section the welfare incidence of a series of hypothetical trade liberalization strategies is reported. The welfare change for the private household in each region is measured by the Hicksian equivalent variation between the benchmark equilibrium (the GE solution that replicates the observed data in the base year, 1975) and the various counterfactual equilibria (the GE solution with some policy change that does not, in general, correspond to any observed historical episode). This measure is then expressed as a percentage of GDP in the base year in order to allow comparisons between regions of such diverse size.

3.1 Global Trade Liberalization

Table 4 presents the welfare impacts of two separate global policies, one that eliminates tariffs in all regions and another that eliminates NTB's in all regions. The Point Estimate column reflects the impacts of the policy in the counterfactual equilibrium conditional on all parameters being set equal to their respective point estimates. The remaining three columns report summary statistics for the set of counterfactual equilibria implied by our sensitivity analysis. The Mean Welfare impact is the average change in the welfare impacts, with the prior probability density functions mentioned earlier being used to weight the results. The Standard Deviation of the welfare impact is similarly computed from the pdf of welfare impacts.[21] The final column reports the Probability of Welfare Gain, obtained by numerically evaluating the (proper) pdf of welfare gains. This column provides a useful measure of the confidence one can attach to <u>qualitative</u> inferences about welfare impacts in the model.

Several features of the results in Table 4 are noteworthy. First, it is apparent that NTB liberalization confers greater benefits than tariff liberalization to each nation except the U.S.A. Note that the benchmark year tariffs are

TABLE 4

Welfare Impact of Global Trade Liberalization

Policies	Impacted Region	Point Estimate	Mean	Standard Deviation	Probability of Welfare Gain
Tariffs	Australia	0.03	0.49	0.08	0.91
	Canada	0.26	0.41	0.04	0.87
	Indonesia	-0.56	-0.70	0.03	0.28
	Malaysia	1.93	2.65	0.04	0.94
	Philippines	-0.80	-0.98	0.04	0.16
	Singapore	1.65	2.01	0.02	0.95
	Thailand	-1.94	-1.75	0.08	0.18
	Korea	1.34	2.34	0.07	0.98
	Japan	1.11	1.79	0.03	0.95
	U.S.A.	0.21	0.24	0.02	0.87
	EEC	0.41	0.61	0.06	0.94
NTB	Australia	1.26	1.43	0.19	0.93
	Canada	1.82	1.96	0.13	0.96
	Indonesia	1.67	1.78	0.23	0.90
	Malaysia	2.41	2.36	0.39	0.79
	Philippines	2.75	2.82	0.31	0.84
	Singapore	2.87	3.01	0.41	0.96
	Thailand	4.31	4.81	0.50	0.98
	Korea	3.59	3.73	0.46	0.76
	Japan	0.92	1.05	0.09	0.85
	U.S.A.	-0.44	-0.38	0.07	0.31
	EEC	0.37	0.41	0.08	0.77

those applying prior to the Tokyo Round multilateral tariff reductions, suggesting that our conclusion about the relative importance of liberalizing NTB's is of even greater relevance for current circumstances. This conclusion is echoed in results obtained in the Whalley [1984] GE trade policy models. Whalley [1980a; p. 224] concludes that:

> Abolition of tariff barriers alone would increase world trade by [1973] US$10 bill. While abolishing non-tariff barriers would increase trade by US$20 bill. The two sets of policies thus have a compounding effect on the level of world trade. The effects of these two areas of policy appear unequally balanced and suggests that more stress should be placed on non-tariff barriers in the current Tokyo Round negotiations.

The simulations reported in Brown and Whalley [1980; Table 14, Experiments 6 and 10] indicate that the global welfare gains from (multilateral) NTB liberalization are roughly double those from tariff liberalization. Whalley [1982a] concludes that "...under some assumptions the changes in the NTB codes in the [Tokyo Round] Agreement may be more significant than the tariff cuts" (p. 360), although quantification of the negotiated NTB reduction is particularly speculative in this case.

Second, the results in Table 4 are qualitatively identical to, but proportionately larger than, those reported in Harrison [1985a] and Harrison and Kimbell [1985] for <u>fifty percent</u> tariff and NTB reductions. It is not too surprising that a one hundred percent reduction in a set of distortions (such as shown in Table 4) generates greater welfare impacts, but what is notable is that the welfare losses incurred by some countries are less severe and the welfare gains incurred by <u>some</u> countries are more than double those reported in the other studies. These findings are easily explained--<u>removing</u> all distortions of a certain type not only reduces the size of the distortion, but it "equalizes" it (by definition, at "zero") across all sectors and all regions. The latter effect is present in the results shown in Table 4 but not in the simulations reported elsewhere.

Third, to the extent that the results for tariffs and NTB's in Table 4 are additive and symmetric, they support a widespread and cynical view of the last few decades of multilateral trade "liberalization". Hamilton and Whalley [1983; p. 3], for example, note that:

> Those who are pessimistic about the GATT process argue that successive GATT rounds have not produced substantive progress in limiting and reducing non-tariff barriers. They also argue that non-tariff barriers are increasingly being used as a way of offsetting reductions in protection produced by negotiated tariff cuts. A cynical view of trade liberalization sometimes expressed is that countries participate in GATT tariff cuts hoping that partners will take the tariff cut seriously, with the reduction in own protection subsequently offset by an erection of non-tariff barriers.

This view is supported in the present model. The results in Table 4 are approximately additive in the sense that removing tariffs and NTB's together results in welfare impacts close to those implied by adding the impacts shown for each policy separately. The results for NTB's are also approximately symmetric in the sense that an across-the-board increase leads to welfare impacts that are roughly equal in size and opposite in sign to those impacts resulting from a decrease in NTB's.[22] These approximations are much more exact if one is looking at partial reductions (e.g., fifty percent) or increases in the particular policies rather than their complete elimination.

Fourth, the welfare impacts may seem "small" when one considers the radical policy changes involved (viz., complete elimination of certain trade barriers for all countries). However, it should be noted that these impacts represent annual gains or losses that could accrue over many years to represent "large" impacts. Moreover, the welfare gains for Malaysia (2.65%), Singapore (2.01%), Korea (2.34%) and Japan (1.79%) due to tariff liberalization are hardly small. Similarly, the gains to ASEAN nations (especially Thailand) from NTB liberalization are quite large in relation to previous estimates. Also note that many of the stated welfare impacts are extremely robust to uncertainty about the parameters of the model (i.e., high values for Probability of Welfare Gain), even if the Mean impact is deemed "small" by some standard.

The results in Table 5 demonstrate how the overall welfare gains reported in Table 4 are reduced when one only considers the multilateral liberalization of protection (tariffs and NTB's) directed at Manufacturing sectors. Recall from Table 2 that we define "Manufacturing" as sectors 4 through 15. This implies that we are reducing protection, inter alia, on the "Textiles, Clothing, Footwear and Leather". This sector has, of course, been one of the holiest of Sacred Cows in recent GATT-ordained multilateral trade negotiations, even though it has been desecrated with the distortions of the Multi-Fibre Agreement.

The importance of the results in Table 5, when compared with those in Table 4, is the focus they place on Agricultural protection by NTB's. Consider, for example, the large gains for Japan and Korea in Table 4 and their relatively meager gains in Table 5. These results for Japan and Korea reflect two powerful, but contrasting, effects: the efficiency gains in production from removal of distortions favoring Agricultural and Food Products, and the significant decline in incomes of their farming sector due to changes in the terms-of-trade (TOT). In each case the former effect dominates. This result is consistent with the findings of Anderson [1981; p. 41] with respect to NTB agricultural protection in Korea that

TABLE 5

Welfare Impact of Global Manufacturing Trade Liberalization

Policies	Impacted Region	Point Estimate	Mean	Standard Deviation	Probability of Welfare Gain
Tariffs and NTB	Australia	0.85	0.84	0.12	0.94
	Canada	0.91	0.91	0.10	0.97
	Indonesia	1.30	1.26	0.19	0.91
	Malaysia	1.89	1.72	0.28	0.82
	Philippines	1.72	1.65	0.30	0.86
	Singapore	2.41	2.44	0.34	0.93
	Thailand	1.01	1.04	0.21	0.71
	Korea	2.80	2.85	0.31	0.75
	Japan	0.94	0.93	0.12	0.87
	U.S.A.	-0.31	-0.33	0.10	0.28
	EEC	0.14	0.16	0.06	0.73

Note: These results were generated by the "best approximate" aggregate model.

> ...partial equilibrium analysis...suggests that the policies of the late 1970's were responsible for transferring about $4 billion per year to producers, but at a cost to consumers-cum-taxpayers of about $4.8 billion, the difference (about 1.6 percent of GNP) being a net loss to the economy because of foregoing the opportunity to take advantage of the gains from international trade. (The loss that would be calculated using general equilibrium analysis would be even larger, since it would also measure the increase in the value of production that is possible with the more efficient employment in manufacturing, etc. of the labour and other resources that would be freed from the removal of agricultural protection.)

Similar remarks also apply to Thailand, although here there is also a significant worsening of the TOT.

The TOT effects just noted are also a feature of the Tokyo Round simulations reported by Whalley [1982a] and Harrison and Kimbell [1985], given that the tariff reductions negotiated during that Round are heavily concentrated on Manufacturing goods (notwithstanding the treatment of Textiles). The expansion of trade in those goods which follows such tariff or NTB reductions outweighs the direct effect on Manufacturing prices, leading to a net move in the trade-weighted TOT against countries that largely export non-Manufacturing goods. These countries are generally LDC's whose export trade is currently oriented towards Agricultural products and/or Mining.

3.2 Regional Trade Liberalization

Table 6 reports the welfare impacts of unilateral liberalization of Manufacturing sector tariffs and NTB's in ASEAN nations and also in ASEAN and Australia. Not surprisingly, the welfare impacts on the larger trading region (Japan, U.S.A. and the EEC) are trivial.[23] Korea and Canada are, however, adversely impacted along the lines of familiar "trade diversion" arguments from the customs union literature, even though the liberalizations in Table 6 are not designed to be discriminatory.

Compare the results for the two regional liberalization strategies in Table 6 with those for global liberalization in Table 5. Indonesia and the Philippines clearly do not gain as much in the regional liberalization exercise,

TABLE 6

Welfare Impact of Regional Manufacturing Trade Liberalization

Policies	Liberalizing Region	Impacted Region	Point Estimate	Mean	Standard Deviation	Probability of Welfare Gain
Tariffs and NTB	ASEAN Nations	Australia	-0.2	-0.2	0.001	0.31
		Canada	-0.03	-0.02	0.001	0.26
		Indonesia	0.7	0.7	0.004	0.94
		Malaysia	0.9	1.1	0.01	0.91
		Philippines	0.2	0.2	0.01	0.80
		Singapore	1.0	1.1	0.01	0.87
		Thailand	0.9	0.8	0.005	0.91
		Korea	-0.01	-0.004	0.0	0.15
		Japan	-0.003	-0.002	0.0	0.12
		U.S.A.	-0.001	0.0	0.0	0.29
		EEC	0.0	0.0	0.0	0.31
Tariffs and NTB	ASEAN and Australia	Australia	0.6	0.5	0.01	0.90
		Canada	-0.07	-0.02	0.002	0.13
		Indonesia	0.7	0.7	0.003	0.95
		Malaysia	1.0	1.0	0.01	0.93
		Philippines	0.3	0.3	0.01	0.84
		Singapore	0.7	0.7	0.01	0.81
		Thailand	0.6	0.6	0.004	0.90
		Korea	-0.02	-0.002	0.0	0.13
		Japan	-0.002	-0.003	0.0	0.10
		U.S.A.	-0.002	-0.001	0.0	0.26
		EEC	0.0	0.0	0.0	0.32

due to the relatively small share of their trade with ASEAN ("small" in absolute terms and in comparison with other ASEAN countries). It is interesting that Australia loses from an intra-ASEAN trade liberalization and gains significantly if it also liberalizes. Australia's gain appears to be at the expense of Singapore and largely involves trade in manufactured intermediate (rather than final consumer goods). Apart from Singapore, each ASEAN nation gains (or does not lose significantly) from a broadening of the liberalization to include Australia.

The results in Table 6 may be contrasted with those reported in detail in Harrison and Rutström [1985] for various customs union initiatives. Table 7 reproduces those results for the customs union (CU) involving tariffs *and* NTB's; the results involving a CU in tariffs only are much smaller and less robust. A CU is defined here as an absence of trade barriers between member nations *and* a common external *tariff* computed as a weighted average of pre-union trade barriers on all other countries (with exports used as weights). We do not claim to have computed an "optimal" external tariff for the CU's.

There are two major differences between the policies considered in Tables 6 and 7. The changes in trade barriers due to the CU are not confined to Manufacturing sectors, and they therefore capture some of the extra efficiency gains considered earlier when comparing Tables 4 and 5. Secondly, the CU simulations represent a geographically discriminatory arrangement with respect to non-union countries. The regional liberalizations considered in Table 6 are unilateral and non-discriminatory.

Each ASEAN nation clearly benefits from the formation of a CU, whether or not Australia is included. Australia *loses* if ASEAN excludes it from the CU. The impacts on most other regions are again negligible, although generally unfavourable.

TABLE 7

Welfare Impact of Customs Unions

Members of Customs Union	Impacted Region	Point Estimate	Mean	Standard Deviation	Probability of Welfare Gain
ASEAN Nations	Australia	-0.1	-0.1	0.0	0.21
	Canada	0.0	0.0	0.0	0.15
	Indonesia	1.3	1.2	0.03	0.98
	Malaysia	0.8	0.7	0.002	0.97
	Philippines	1.2	1.3	0.01	0.98
	Singapore	1.7	1.8	0.003	0.99
	Thailand	2.2	2.2	0.002	0.99
	Korea	-0.01	-0.01	0.0	0.08
	Japan	-0.02	-0.03	0.0	0.03
	U.S.A.	0.0	0.0	0.0	0.42
	EEC	-0.01	-0.01	0.0	0.10
ASEAN and Australia	Australia	0.7	0.5	0.01	0.91
	Canada	-0.01	-0.01	0.0	0.12
	Indonesia	1.5	1.4	0.03	0.99
	Malaysia	1.0	0.9	0.005	0.99
	Philippines	1.4	1.4	0.01	0.99
	Singapore	1.1	1.0	0.004	0.92
	Thailand	2.0	1.8	0.004	0.93
	Korea	-0.02	-0.01	0.0	0.06
	Japan	-0.02	-0.02	0.0	0.08
	U.S.A.	0.0	0.0	0.0	0.48
	EEC	-0.01	-0.01	0.0	0.11

Note: The results for both policies were generated by the "best approximate" aggregate model.

The admission of Australia into the CU has some interesting effects on individual ASEAN nations. Indonesia, Malaysia and the Philippines enjoy an even greater welfare gain, but Singapore and Thailand have a noticeably reduced welfare gain. The explanation for these results is simple: the trade creation gains to Singapore and Thailand (in tertiary and primary trade, respectively) are reduced when Australia is included in the CU, and these reductions are not offset by increased trade creation benefits with Australia. A similar reduction in trade creation benefits is more than offset by increased trade creation benefits with Australia for the remaining three ASEAN nations.

4. ALTERNATIVE FORMULATIONS

In this section we indicate several alternatives to the neoclassical GE model presented and applied in the previous two sections. It is our firm belief that numerical GE models are only beginning to reach the point at which they can be used to indicate policy-relevant effects of trade policies. Given the "ad hockery" or inadequacy of alternative quantitative techniques currently in use, we urge careful consideration of the issues noted below in future modelling work.

4.1 Rent-Seeking and Scale Economies

4.1.1 Rent-Seeking

Apart from the direct consumer and producer losses incurred by barriers to trade, such as tariffs and quotas, an additional loss in terms of resource use in rent-seeking is incurred in many developing countries under an import quota system. Under a tariff system the revenues are collected and (in principle) redistributed by the government to different sectors of the economy. Apart from any distortionary effects that might be created by particular redistribution schemes, there are no losses other than the above-mentioned consumer and producer losses. It is solely these losses (the "Harberger Triangles") that are captured in the welfare impacts reported in Section 3. Under an import licensing scheme the revenues from a restrictive trade policy actually accrue to the licensee but could be totally lost in the process of competing for obtaining the licence (and attendant rents). This is known as the rent-seeking process. One example would be when licences are allocated in proportion to firms' capacity. In this case investments in excess capacity would increase the probability of receiving the licence. Krueger [1974] has shown that under the assumption that rent-seeking activities are perfectly competitive, the value of the waste of resources devoted to rent-seeking will equal the value of the rents of the import licences (i.e., the revenues from the restrictive trade policy).

Hamilton, Mohammad and Whalley [1984] have incorporated rent-seeking activities for developing countries in a global numerical general equilibrium model. By requiring that an import "ticket" (a licence) has to be purchased whenever a dollar's worth of imports is brought into either of the model's two developing regions (LDC's and NIC's), the value of the tickets sold will equal the value of the rent (known colloquially as "Krueger Rectangles").

The formalization of such wasteful rent-seeking activity should ideally be based on true resource use, which of course could be different for different kinds of rent seeking. By assuming that virtually all rent-seeking is performed as investments in excess capacity, the rent-seeking activity would use the same factor proportions as the licensee's activities. Hamilton, Mohammad and Whalley [1984] approximate this behavioral assumption by reducing the factor endowments of the importing region proportionally, with the value of factor loss equalling the value of tickets. In the same paper it is shown that large rent-seeking costs will have a significant impact on the results of simulating the model.

An important theme to emerge from these early numerical results is that Krueger Rectangles appear to be <u>much</u> larger than Harberger Triangles. In other words, the welfare losses from imposing quotas are much larger when we take into account the resource-waste that is involved in seeking the rents accruing to these quotas than when we just measure the traditional efficiency loss due to resources being misallocated as a result of the quota-induced distortion. In the traditional analysis factors are always employed in some gainful activity; they may just not be employed in the most gainful activities possible. In the newer rent-seeking analysis, however, resources are not used in any gainful employment. It is not surprising, therefore, that the latter effects of trade distortions often swamp the former traditional effects.

On the other hand, one should not casually infer that allowing for such rent-seeking activities will always lead to greater welfare gains due to trade liberalization. It is perfectly possible for tariff liberalization to reduce welfare in the presence of quotas and rent-seeking, by increasing the value of the rents accruing to the quota (and hence encouraging greater allocation of resources to rent-seeking activities).

In any case, it is apparent that more scholarly attention should be devoted to estimating the extent and nature of rent-seeking activities. Hamilton [1984] illustrates the type of data-collection and analysis that are needed for ASEAN countries.

4.1.2 Economies of Scale

Pearson and Ingram [1980], evaluate the potential gains from economic integration in Ghana and the Ivory Coast, emphasizing the importance of unrealized internal economies of scale under existing protection schemes in developing countries. Their approach closely follows Corden [1972], who incorporated economies of scale into customs union theory and suggested cost-reduction and trade-suppression effects in addition to the standard Vinerian trade creation and trade diversion effects. The effect is sometimes called "fragmentation of production" in LDC's and considers a situation in which several firms produce similar products at scales of output less than the level of long-run minimum average costs. Fragmentation of production could, for example, be expected under certain forms of import licensing, leading to rent-seeking behavior, as suggested in Krueger [1974]. She states that a pro rata allocation of licences in proportion to the applications for those licences would result in a larger-than-optimal number of firms, operating on the downward-sloping portion of their cost curves.

In Harris' [1985] terminology, the intra-industry adjustments from changing trade barriers under imperfect competition would be quite strong and might shift the comparative advantages for a country to such an extent that traditional analysis of changing trade patterns might be incorrect. Harris [1985] also introduces non-competitive industries in a general equilibrium framework for Canada (also see Harris [1984] and Cox and Harris [1984]). Two pricing hypotheses are used; the monopolistic competition hypothesis using a Lerner rule to set prices conditional on an elasticity of a perceived demand curve and the Eastman-Stykolt hypothesis where domestic firms determine their prices from a collusive focal point, which is provided by the world price of the foreign competing good, plus a markup of the domestic tariff. The pricing rule in the model is a linear combination of these two hypotheses with exogenously given weights. Harris concludes that introducing scale economies does change the results from a cut in tariffs -- there will be significant efficiency gains from rationalization of manufacturing industries. These welfare gains are extremely sensitive to the pricing hypothesis adopted, however (see Harrison [1985b] and Harrison, Jones, Kimbell and Wigle [1985] for further discussion of this point).

4.2 Labor Market Distortions

Most developing countries are characterized by high urban unemployment rates and/or underutilization of labor in the agricultural sector. It is therefore important to introduce a labor market formulation in the general equilibrium framework that allows for these modifications of traditional neoclassical assumptions.

A situation with underutilization of labor is most often referred to as a "surplus labor" economy and was first discussed by Lewis [1954]. It has been developed further by Ranis and Fei [1961], Fei and Ranis [1964] and Dixit [1971], inter alia. Lewis was mainly concerned with analyzing the agricultural sector of the economy, while later authors have analyzed the interactions between that sector and the industrial sector.

Urban unemployment was analyzed in Harris and Todaro [1970] by the introduction of a fixed wage in the urban industrial sector, with migration from the countryside depending on the relation between the actual wage in agriculture and the expected wage in urban industry. The basic assumption is that there is full employment in rural agricultural areas and no imperfections in rural labor markets. Expectations of urban wage differ from the actual wages because of the probability of becoming unemployed after moving to the urban area. The Harris-Todaro analysis has been the basis for further studies of first-best and second-best policy alternatives for reaching full employment and/or maximum social welfare. Among the most notable contributions in this area are Bhagwati and Srinivasan [1973b] [1974] [1975] and Blomqvist [1979]. Blomqvist and McMahon [1983] simulate different policy alternatives in a numerical general equilibrium model for Kenya with Harris-Todaro features.

This section discusses theoretically the effects of trade policy alternatives first for a "surplus labor" economy and then for the urban unemployment economy.

4.2.1 Surplus Labor

The notion of "surplus labor" stems from the assumption that labor is underutilized in certain sectors of the economy in developing countries, especially in agriculture. One reason for this could be that the marginal product of farm members is close to zero (thus land is the scarce resource rather than labor) but earnings exceed the value of this low marginal product.

Every farm member is assumed to have a property right on the farm while residing there, which implies that earnings include not only a return to labor but also a return to land. Wages thus include the land rent in this sector of the economy, and will be determined by the value of average product rather than the value of marginal product. In the range with very low (approximately zero) marginal product, the average product is higher than the marginal product and wages will exceed the neoclassical wage. Intuitively we might think of this sector of the economy as a subsistence sector, from which only a very small surplus might be marketed in contrast to commercial (industrial) sectors where no production is for subsistence consumption and everything is marketed. The commercial sectors are assumed to be neoclassical with wages equal to the value of marginal product. With a fully mobile labor force, wages will be equalized and the average revenue product in subsistence agriculture will be equal to the marginal revenue product in the commercial sectors. A reallocation of labor from the subsistence farms to the commercial sector of the economy, where they would have a higher marginal product, would, ceteris paribus, increase welfare.

One important constraint in the analysis is a geographical separation of the subsistence sector from the commercial sectors, so that it is impossible for labor to work in the commercial sector while residing on the farm with a retained property right in the land. If this was possible, labor would reallocate until the MRP in rural commercial sectors equals the MRP on farms and the labor market would be neoclassical without other assumptions of imperfections in rural labor markets.

So far the discussion has followed Lewis' partial equilibrium analysis of the economy, mainly concentrating on the agricultural sector, but as Fei and Ranis (see Ranis and Fei [1961]) and Dixit [1971] have pointed out there are strong interactions in the system, especially in a dynamic setting. The most important link is probably the domestic relative price between food and industrial sector goods. As the migration continues due to exogenously increasing MRP in the industrial sector, the marketable surplus of food will initially increase in proportion to the consumption previously held by migrants while farm members. This will enable the migrants to consume the same quantity of food at constant prices while employed in the industrial sector. Eventually though, when labor is becoming a scarce resource in agriculture, the marginal product will start to rise in agriculture so that some production actually will be lost because of the migration. This will, to some extent, slow down the increase in marketable food surplus while demand will continue to grow at the rate of migration, forcing up the relative price of food. The price change will have a redistributional impact, increasing incomes in the agricultural sector and thus reducing the incentive to move. Wages in the industrial sector would have to increase even faster to induce further migration. With a positive income elasticity for food in the agricultural sector there would be an increase in demand for own-produced food, constraining the increase in the marketable surplus even more, pushing the relative price up even further. Even with a zero marginal product, migration would cause agricultural incomes to change because of changes in the average product and thus an increase in the relative price of food would occur (due to the positive income elasticity for food). The price of food will also be influenced by the substitutability of food for other goods in demand, when prices of other goods change in response to the introduction of protectionist policies (for example).

Following Dixit [1971], a simple two-sector model can be used to show this price link between agriculture and industrial goods. Assume a simple production relationship for each sector as a function of labor:

(1) $$Q_i = Q_i(L_i),$$

where $i = A, M$ for agriculture and manufactured goods, with decreasing marginal products (thus assuming implicitly some additional sector-specific production factor, presumably land in agriculture and capital in manufacturing). The wage is assumed fixed and equal to the value of average product in agriculture evaluated in terms of the manufactured good:

(2) $$w = pa_A,$$

where

(3) $$a_A = Q_A/L_a.$$

Define y as labor income in terms of manufactured goods and write the demands as functions of this income and the relative price, thus assuming that all labor income is spent on consumption and all capital income in the industrial sector is saved:

(4) $C_A = C_A(y,p)$ and

(5) $C_M = y - pC_A(y,p)$.

Equilibrium in the food market requires that supply equals demand:

(6) $Q_A = C_A(y,p)$.

By making use of this equilibrium condition and the wage equation (2) we can differentiate logarithmically with respect to the agricultural labor force to get elasticities (assuming that $\frac{ey}{eL_A} = \frac{ew}{eL_A}$):

(7) $$\frac{ew}{eL_A} = \frac{ep}{eL_A} + \frac{ea_A}{eL_A}$$

(8) $$\frac{eQ_A}{eL_A} = \frac{eC_A}{ew}\frac{ew}{eL_A} + \frac{eC_A}{ep}\frac{ep}{eL_A}$$

where $\frac{ew}{eL_A}$ is the elasticity of the wage with respect to changes in the agricultural labor force and $\frac{eQ_A}{eL_A}$ is the output elasticity of labor in agriculture. Define

(9) $$s_A \equiv eQ_A/eL_A,$$

which is simply the ratio of marginal to average product. Then

(10) $$\frac{ea_A}{eL_A} = s_A - 1.$$

Rewrite (7) and (8) as

(7′) $$\frac{ew}{eL_A} = s_A - 1 + \frac{ep}{eL_A}$$

(8′) $$s_A = \lambda\frac{ew}{eL_A} - \theta\frac{ep}{eL_A},$$

where λ is the income elasticity and $-\theta$ the price elasticity of demand for food. From (7′) and (8′) we can then derive expressions for price and wage elasticities with respect to changes in the agricultural labor force:

$$\text{(11)} \qquad \frac{ep}{eL_A} = \frac{s_A - \lambda(s_A - 1)}{\lambda - \theta}$$

$$\text{(12)} \qquad \frac{ew}{eL_A} = \frac{s_A + \theta(1 - s_A)}{\lambda - \theta} .$$

The numerators are both positive for $0 < s_A < 1$ (i.e., the production range where the marginal product of labor in agriculture is less than its average product, a basic assumption in the "surplus labor" theories). If the price elasticity of demand for food is smaller than the income elasticity, both the relative price of food and the wage will increase with migration from the agricultural to the industrial sector.

In a situation where migration to the industrial sector has ceased and the equilibrium wage is equal to the value of the average product in agriculture, the effects of imposing a tariff on industrial goods depends on the change in the relative price caused by migration. If this relative price change due to migration is smaller than the change in relative price due to the imposition of the tariff we would expect increased employment in the industrial sector and a higher level of production.

One of the main arguments <u>against</u> using a "surplus labor" assumption for the ASEAN countries emphasizes the peak seasonal demand for labor in agriculture. Peak demand for labor in harvesting and planting seasons would make the "surplus labor" assumption invalid as a permanent concept. As a temporary concept though, characterizing times of slack demand for labor in agriculture, it may stil be valid. The estimation of welfare gains from migration would be more complex in this case, as the possibility of under-utilization of capital in the industrial sector during the agricultural peak seasons must be considered.

The theory of "surplus labor" has been used by economists analyzing development problems in Asia. We believe that it can be justified in countries with rapidly growing population with a resulting demographic pattern of large numbers of young people entering productive age. In economies with property rights to farm members this growing population would create a surplus labor force in agriculture.

4.2.2 Urban Unemployment

High urban unemployment rates are something which the "labor surplus" theory does not explain. One explanation of this phenomenon is suggested by Harris and Todaro [1970] by assuming a fixed wage in the industrial sector above the equilibrium wage, which will cause unemployment. The most commonly used explanations for a fixed wage are labor union activities or legislated minimum wages relating the urban wage to some price index. Unemployed people can be assumed to earn a subsistence income in urban informal sectors such as service, trade and craftmanship or maybe by begging and stealing, with close to zero marginal product per worker as any decline in labor supply in this sector would probably result in an increased work effort per worker rather than a decline in output. People residing in rural areas would form expectations about the earnings they would receive if they lived in the urban area by assigning probabilities to obtaining urban employment and to having to earn their living in the informal sector. If these expected urban earnings exceed the wage they would get in agriculture, there will be migration into the cities.

The case with neoclassical rural labor markets and a wage distortion of the type suggested above has been analyzed by Bhagwati and Srinivasan [1973b] [1974] and [1975] and Blomqvist [1979]. Bhagwati and Srinivasan discuss the case of both a small [1973b] and a large [1975] open economy, fixing the wage in terms of the manufactured good alone for both cases and assuming production factors other than labor to be sector-specific. They find that an export subsidy (or an import tariff) on agriculture will improve employment for both types of economies, but in the case of a large country the change in international terms of trade will counteract the gains from employment creation and might even cause social welfare to decline. The main reason for an export subsidy on agriculture being the preferred trade policy (at least for the small country) as opposed to an import tariff on manufactures i the assumption that the manufacturing wage is fixed in terms of the manufactured good, so that a change in the relative price of this good has no impact on manufacturing employment. Instead the impact will be on the migration decision as labor earnings in rural areas will increase, thus decreasing urban unemployment and increasing agricultural output.

In Blomqvist [1979] this assumption is altered to allow the wage to be fixed in terms of both goods. This assumption seems realistic enough, since concern about real wages in terms of a price index of a composition of consumption goods is one likely reason for the wage distortion in the first place. By defining the elasticity of the manufacturing wage to changes in the price of manufactures (ϵ_m) Blomqvist is able to analyze cases ranging from $\epsilon_m = 1$, where the wage is fixed in terms of the manufactured good, to $\epsilon_m = 0$ where it is fixed in terms of the agricultural product. For the first case he verifies the Bhagwati-Srinivasan result. For the second case he finds that the wage elasticity of demand for agricultural labor is crucial. If this elasticity is infinitely large the optimal trade policy is free trade, as the opportunity cost of migration (i.e., the loss of agricultural output) will equal the wage in the manufacturing sector and the only effect of the tariff will be a welfare lowering distortion. If, on the other hand, the wage elasticity of demand for agricultural labor is less than infinity, Blomqvist demonstrates that a tariff on the manufacturing sector is the best trade policy for increasing welfare. He further shows that the optimal tariff is inversely related to the absolute value of the wage elasticity of demand for agricultural labor.

Some numerical illustrations of the sensitivity of the effects of trade policy on the nature of the wage rigidity are given by Blomqvist and McMahon [1983] for the Kenyan economy. In a formulation similar to Blomqvist and Bhagwati-Srinivasan they find that fixing the wage only in terms of the agricultural good implies an optimal import tariff of ten percent, while fixing the wage in terms of both goods implies an import subsidy of thirty percent. The two alternative wage equations are

$$W_M = .875P_A + 1.654(1 + t_M)P_M \tag{13}$$

$$W_M = 2.86P_A \tag{14}$$

where P_A is price of agricultural goods, P_M is the price of manufactures and t_M is the import tariff (positive or negative) on manufactured goods. The coefficients are determined on the basis of the shares of agricultural and non-agricultural goods in Kenya's 1978 GDP; thus, in the first equation the urban worker can continue to buy a given basket of the two goods with the same composition as GDP.

Blomqvist and McMahon also discuss the importance of other tax distortions in the economy on the choice of trade policy. They also demonstrate that the assumption of sector-specific factors is crucial for the results. For example, when specifying the wage in terms of agricultural goods the optimal trade policy is an import tariff with capital assumed sector-specific, but an import subsidy with capital assumed mobile and the manufacturing sector assumed more capital intensive than agriculture.

4.2.3 Conclusion

In summary, there are two types of "surplus labor" situations discussed above. One is what could be called an agricultural labor surplus, where the underutilized labor get their earnings from the farm. The other is an informal sector labor surplus or unemployment in the city caused by a minimum wage in manufacturing. For both formulations it seems likely that a protectionist policy could increase labor utilization by increasing employment in manufacturing (or in agriculture, for some of the urban unemployment formulations). If this is the case, the free-trade argument for the small country is no longer valid. Other policy alternatives, such as taxation and subsidization could of course be preferred to trade restriction, but might be more difficult to introduce. This is also discussed by Blomqvist [1979] where he argues that the administrative difficulties with imposing separate production and consumption taxes for a specific commodity or with subsidizing agricultural employment (policy measures that are demonstrated to be first-best alternatives in Bhagwati-Srinivasan) are significant enough to force us to concentrate on second-best measures, such as trade policy.

5. SUMMARY

A numerical general equilibrium model of the Pacific Basin is employed to study the welfare effects on ASEAN and Australia of alternative manufacturing trade liberalization strategies. The model indicates that ASEAN and Australia would generally benefit from strategies that are more regional in focus, as compared to the GATT-type multilateral strategy. Moreover, these benefits are shown to be robust to the particular empirical calibration of the model. In other words, reasonable uncertainty about certain key elasticities used in the model does not appear to imply significant uncertainty about the direction of welfare change due to any particular policy. Finally, we argue that significant reformulations of the *qualitative* structure of existing general equilibrium models is necessary to address many trade policy issues of importance to ASEAN and Australia. These include an allowance for resource-wasting rent-seeking activities in the context of non-tariff trade barriers, allowance for economies of scale in manufacturing sector production in small economies, and the implications of alternative formulations of labor markets in developing economies.

FOOTNOTES

[1]Whalley [1980b; p. 1185] notes the significant computational expense involved in solving his 33-sector model when CES intermediate input substitutability is allowed. Indeed the additional expense is such as to force him to aggregate his model to five sectors (contrast Whalley [1980a]). The use of Cobb-Douglas intermediate input substitutability was apparently first developed by Boadway and Treddenick [1978; p. 430 ff.]. Harrison [1984a] provides a formal statement of this approach and its benchmark calibration.

[2]See Burgess [1974a] [1974b] and Dixon, Parmenter, Sutton and Vincent [1982; pp. 182-183] for an explicit recognition of this point.

[3]Cook [1981] and Hartigan and Tower [1982] explore the implications of alternative factor mobility assumptions in models of "small" open economies applied to the United States.

[4]Whalley [1980b; p. 1191, fn. 15] attributes his estimates primarily to the compendium in Caddy [1976], although Caddy only presents estimates for Manufacturing sectors. Mayor [1971] does present estimates for several non-manufacturing sectors, and we use these for our sectors 1, 2, 16 and 19 (time series estimates). Harrison, Jones, Kimbell and Wigle [1985] present new estimates for use in the Whalley model.

[5]A standard error exactly equal to the point estimate indicates that no data-based error estimate is available. This is common in non-manufacturing sectors, and is consistent with a reasonably diffuse prior on the point estimate. The sensitivity analysis reported below employs the time series estimates in Table 3.

[6]Lluch [1973] and Howe [1975] advance alternative interpretations of the formal household problem leading to the ELES; see also Lluch, Powell and Williams [1977; p. 14].

[7]In several cases, given the level of commodity aggregation adopted, this level of the utility tree is redundant (e.g., the grouping "Clothing" includes only one commodity from Table 2, "Textiles, Clothing, Footwear and Leather") or ambiguous (e.g., the commodity "Services" in Table 2 is allocated to two groupings, "Recreation" and "Other Services"). The full ELES disaggregation is retained, in the face of such redundancy and ambiguity, for three reasons: (i) data exist for two trading regions (Australia and the U.S.) to split up commodities between commodity groupings, removing any ambiguity; (ii) it is possible to simply aggregate commodity groupings to remove any remaining ambiguity; (iii) we hope to employ greater commodity disaggregation in due course (and do not wish to recode the model or data).

[8]The "Frisch parameter" under LES is the expenditure elasticity of the marginal utility of expenditure; this "parameter" is well-defined under ELES, and is the concept we are directly concerned with.

[9]Korea, Thailand, Australia and the U.S. are directly covered by LPW.

[10]An alternative approach might be to use the regressions across countries of expenditure elasticity against GNP per capita reported in Table 3.18 (p. 62) of LPW. However, the explanatory power of four of the eight regressions is extremely low.

[11]The bottom level of the utility function for these countries is obviously redundant with this formulation. It is retained for coding convenience and to allow for the possible future use of import elasticities for these countries.

[12]Harrison [1984a] [1984b] provides details on the data sources for the estimates used, as well as a description of the various taxes included in the model. Given the present focus on trade policy, we do not discuss the treatment of taxes in any detail.

[13]Unless, of course, all of those imports were directed solely to the corresponding domestic sector (i.e., the off-diagonal elements of the off-diagonal trade blocks in our international IO table are all zero). This is not the case in the present IO table.

[14]The substitutability of intermediate inputs is algorithmically transparent in the sense that any procedure that can solve models with fixed intermediate requirements will also be able to solve models assuming (Cobb-Douglas) substitutability. Moreover, this new feature only adds one matrix operation during each iteration of the algorithm.

[15]There is an implicit presumption here that the off-diagonal elements of the covariance matrix of our elasticity estimates are all zero. Although non-zero elements are theoretically available for certain blocks of elasticity estimates (e.g., the demand elasticities) this presumption is adopted in the present model.

[16]Pagan and Shannon [1985] propose a technique which may be used to provide a computationally feasible approximation to an unconditional systematic sensitivity analysis. Harrison, Jones, Kimbell and Wigle [1985] examine the accuracy of the approximation involved, and illustrate that their technique is often quite accurate.

[17]A procedure for computing "good" starting values for large GE problems, based on an analytic solution for a stylized version of the original GE model, is proposed in Kimbell and Harrison [1983; Section 6.3]. Indeed this method was employed to solve the seven-sector model (parameters equal to their point estimates) with substantial savings in execution time compared to a "cold start" (initial solution values equal to the benchmark solution values). Using the seven-sector solution values as starting values for the twenty-sector model proved more efficient (in all cases studied) than using the analytic approximation technique directly on the larger model.

[18] BAA generalizes the notion of Consistent aggregation (i.e., if the latter is feasible it is the BAA solution). In the present context we are assuming that the aggregation scheme is given (e.g., see Table 2).

[19] Note that there is some significant loss in predictive power for certain endogenous variables other than the welfare measures.

[20] The aggregation is "limited" in the sense that we do not apply the BAA principle to the final demand and primary factor demand systems (Naive aggregation was employed in these cases). Harrison, Jones, Kimbell and Wigle [1985] discuss this issue in more detail.

[21] Note that there is absolutely no presumption that the policy impacts (welfare impacts in this case) have a Gaussian distribution. One should not therefore assume that the Mean and Standard Deviation are in any way "sufficient statistics" of that distribution. In fact, many of the policy impact pdf's encountered elsewhere are slightly skewed.

[22] The simulations underlying these claims of additivity and symmetry are not reported here. Whalley [1985] and Harrison [1985a] provide examples of sets of trade policies that are neither additive nor symmetric (e.g., compare unilateral cuts in trade barriers with multilateral cuts).

[23] A value of "0.0" in Table 6 indicates that the computed value was not significant to four decimal points (i.e., it is less than 0.00005 in absolute value). All computations were undertaken at much higher levels of accuracy.

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