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AN INTEGRATED APPROACH TO AGRICULTURAL TRADE AND DEVELOPMENT ISSUES: EXPLORING THE WELFARE AND DISTRIBUTION ISSUES

by

Robert Scollay
APEC Study Centre
and
Economics Department, University of Auckland
New Zealand

John Gilbert
Department of Agricultural Economics
Washington State University
United States of America

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ABSTRACT

Computable general equilibrium (CGE) analysis has been widely used to analyse the economic effects of trade liberalization initiatives. By way of illustration, this paper begins by reviewing CGE studies of trade liberalization within the Asia Pacific Economic Cooperation (APEC), including studies of the effects of agricultural trade liberalization. Although these studies predict substantial welfare gains, they fail to address the developmental and political economy issues which typically cause Governments to hold back from agricultural trade liberalization. Distributional effects are central to these issues. Using a proposal known as the APEC Food System as a case study, the paper outlines and illustrates an extension of CGE methodology that allows an exploration of the distributional effects of agricultural trade liberalization, and of how welfare and distribution outcomes can be modified by various types of policies designed to improve labour productivity in the agricultural sector. In the process it is shown how this extended CGE methodology can throw light on the potential of appropriately designed policies of this kind to simultaneously improve both welfare and distribution outcomes of trade liberalization.

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I. INTRODUCTION

Computable general equilibrium (CGE) analysis has become a well-established methodology for the estimation of trade and welfare effects resulting from trade liberalization. This paper reports on the possibility of extending the use of CGE analysis to explore important issues related to the link between trade and development, in particular the impact of trade liberalisation on income distribution, and the ways in which both the welfare and distribution effects of trade liberalization may be modified by various development-related policies. These possibilities are illustrated by reference to research on agricultural trade liberalization in the Asia Pacific Economic Cooperation (APEC) region, but it is suggested that the approach used may have more general application. While the policy issues raised in relation to APEC are interesting they are not the main focus of this paper, having been covered more extensively elsewhere, for example in Gilbert, Scollay and Wahl (2000). A considerable amount of explanatory material about the APEC issues is provided for illustrative purposes, but this is primarily aimed at highlighting the potential analytical contribution of the methodological approach which is the main focus of the paper.

The paper begins with a brief backgrounding of the APEC initiatives which are the subject of the research used in the paper for illustrative purposes. A brief outline of the use of CGE techniques in modelling trade and welfare effects then follows. Next, the paper shows how CGE modelling has been extensively applied in a relatively conventional way to analyse trade and welfare effects of potential APEC trade liberalization. The nature of the results obtained from these modelling efforts is then discussed at some length, and particular attention is paid to recent work on agricultural trade liberalization. This leads into a discussion of how these conventional approaches, which reflect the standard analytical approaches to trade liberalization, fail to address the political economy problems and development concerns which are fundamental to the practical policy issues raised by agricultural trade liberalization. A proposal known as the APEC Food System which emerged within APEC in an attempt to address these concerns is then briefly outlined. Any economic modelling approach aimed at exploring the policy implications of such a proposal clearly has to be capable of taking distributional effects into an account. The remainder of the paper describes how the conventional CGE modelling techniques were extended in an effort to meet this requirement, and the nature of the results which were obtained. While the modelling experiments described here are obviously crude and exploratory, it is suggested that the approach taken has the potential to be developed as a useful tool in the analysis of trade and development issues.

II. THE APEC APPROACH

The APEC programme is an interesting example of the kind of trade liberalization initiative which has been the subject of extensive CGE modelling work. In 1994 the leaders of the APEC member economies agreed to the goal of free trade and investment in the Asia-Pacific region by 2010 for industrialized economies and by 2020 for developing economies. This objective was to be pursued within APEC through members' commitment to programmes of trade and investment liberalization and facilitation (TILF) and economic and technical cooperation ("Ecotech"). Since APEC includes all major economies of the Pacific Rim,[1] including the United States, Japan and China, and accounting for over half of world gross domestic product (GDP) and a little under half of world trade, this is potentially a very significant initiative.

APEC distinguished itself from conventional preferential approaches to regional trade liberalization by adopting the principle of "open regionalism, involving commitment to non-discriminatory liberalization through the process of 'concerted unilateralism' ". There has long been an unresolved issue within APEC as to whether it is satisfactory for this non-discriminatory liberalization to be implemented unconditionally, without reciprocation being required from the rest of the world, or whether it should be conditional on such reciprocation. These two different approaches to "open regionalism" are referred to respectively as "unconditional non-discrimination" and "conditional non-discrimination".

Considerable effort has been expended by a large number of researchers on quantifying the likely effects of the trade liberalization contemplated in APEC's stated objectives. Studies have focused on the overall trade and welfare effects of APEC liberalization, and also on comparing the effects under "unconditional non-discrimination" with those under "conditional non-discrimination". Another focus has been the role within the overall APEC liberalization programme of sectoral liberalization initiatives such as early voluntary sector liberalization (EVSL). Some studies have also considered the effect of liberalization in a single sector such as forestry (Gilbert, 1998) or agriculture and food products (Scollay and Gilbert, 1999b). Because the APEC liberalization programme is potentially so extensive, the use of CGE methods has proved to be most useful in this task.

[1] The membership of APEC currently comprises Australia, Brunei Darussalam, Canada, Chile, China, Hong Kong (China), Indonesia, Japan, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, the Republic of Korea, the Russian Federation, Singapore, Taiwan Province of China, Thailand, the United States and Viet Nam. (*Note:* In APEC, Taiwan Province of China is referred to as Chinese Taipei.)

III. ALTERNATIVE CGE MODELS

CGE models are in essence numerical models based on general equilibrium theory, which are implemented in the form of a computer program. These models have a number of features which make them powerful tools of analysis. Most importantly, they are multisectoral and in many cases multiregional, and the behaviour of economic agents (producers and consumers) is modelled explicitly through utility and profit-maximizing assumptions. In addition, they differ from other multisector tools of analysis in that economy-wide constraints are rigorously enforced (e.g. expansion in one sector can usually occur only at the expense of another, given limited resources). The strength of CGE analysis as a tool of trade analysis lies in its ability to help us understand the linkages between sectors, countries and factors on a global scale. Domestically, the impact of liberalization can be seen in terms of connections throughout the economy in the cost of goods and services used by all producers and consumers of goods and services. Hence, the impact of reducing trade barriers and subsidies can be analysed simultaneously through the reduction in production in previously assisted sectors and increases in efficiency and production in previously unprotected sectors, in addition to possible general equilibrium tax considerations. Moreover, all estimated outcomes are constrained to be consistent with each other.

Starting from some calibrated base, experiments are conducted by *shocking* the initial equilibrium, introducing distortions or removing existing ones, and observing the new equilibrium which results. Distortions in an economic system will generally have repercussions far beyond the sector in which they occur, and where they are wide-ranging, general equilibrium is perhaps the only method which is capable of capturing the relevant feedback and flow-through effects.

The modelling of multi-country trade liberalization is most conveniently based on the GTAP database – a global general equilibrium dataset detailed in Hertel (1997). This database may be used in conjunction with the GTAP CGE model or alternatively with other models such as the MRTS model detailed in Rutherford (1998), which is used for example in Scollay and Gilbert (1999a, 1999b) and in Gilbert, Scollay and Wahl (1999). The basic model chosen may be customized by the researcher to suit the particular purposes of the research. The majority of CGE models assume perfect competition, meaning that all agents take prices given, but they also typically incorporate the *Armington* assumption, meaning that goods from different sources are treated as imperfect substitutes. This allows the models to account for intra-industry trade, or two-way trade in the same product category – a fact observed in the data which are inconsistent with the perfect substitutes assumption of standard trade theory. It also implies that all economies face a downward-sloping demand curve for their exports. Gains from removing trade barriers will generally be larger the closer goods from different sources are to being perfect substitutes, i.e. the larger the Armington elasticities.

Most CGE models are *static*; that is, they consider the role of changes in relative prices in the allocation of goods amongst consumers and resources amongst productive activities, and the consequences for economic efficiency. These models have no explicit time dimension. The results of static simulations are often interpreted as representing how the

economic system in question would have looked if the new policy had been in place in the base year, after all relevant adjustments had taken place. Some CGE models run static simulations from a *projected* future equilibrium. A time element can also be introduced by solving the model sequentially, updating the capital stock to simulate investment and depreciation, the labour stock to simulate population growth, and productivity parameters to simulate advances in technology. Such models are known as *recursive dynamic*. They generate a base growth path to which the experimental growth path can be compared. In these models, however, the behaviour the economic agents is myopic: they optimize in each period, but the inter-temporal allocation of goods and resources will not be optimal in general. Truly *dynamic* models attempt to overcome this by explicitly modelling inter-temporal behaviour. However, owing to the complexities involved, such models tend to be used less widely and tend to be much smaller in scale than the static models.

In addition to the choice between static, recursive dynamic and truly dynamic models, there are a number of other aspects of experimental design which can account for variations in results. These include the aggregation in the model, both for regions and commodities, the initial dataset used, and closure assumptions. The impact of aggregation on the results, particularly those based on the GTAP model, seems to be that models with high levels of aggregation tend to predict large efficiency gains, while more disaggregated models tend to predict larger terms-of-trade effects (see Gelhar and Frandsen (1998) for further discussion). The initial dataset chosen in modelling APEC liberalization typically assumed that full implementation of liberalization required under the Uruguay Round Agreements and the North American Free Trade Agreement had already occurred.

IV. LITERATURE REVIEW

Given the variation in assumptions that can be used in CGE modelling, it is risky to rely on the results of any one study of a particular liberalization initiative. Confidence in the results will tend to increase if the results of a number of studies appear to be broadly consistent with each other, particularly if variations in the results can be readily related to differences in the assumptions underlying the different studies. In the case of APEC, an early survey of CGE analyses is provided by Petri (1997), and a more recent survey by Scollay and Gilbert (1999a) identifies some 25 separate studies, the main features of which are summarized in table 1, and adds a further study. This provides a useful sample for the purpose of assessing what conclusions can safely be drawn from CGE analyses of APEC liberalization.

Welfare gains from liberalization are typically reported as annual gains evaluated at various points in time. In the studies surveyed by Petri (1997), the estimates of the welfare gains from APEC liberalization were in the range of $54 to $519 billion. The welfare gains reported in all the studies that have subsequently become available are within the same range, with most estimates of the overall gain to APEC members of complete liberalization clustering around $60 to $80 billion. There is thus a reassuring degree of consistency among the studies. As a rough indication of order of magnitude, these estimates tend to be equivalent to about 70 per cent of the gains estimated from the Uruguay Round Agreements in comparable studies. In that sense, the potential gains from APEC liberalization identified in the majority of the studies are moderately large.

It is also possible to identify general patterns tending to relate divergence in the results to model structures and experimental design. Thus, models which are dynamic or recursively dynamic (McKibbin, 1996; Lee, Roland-Holst and van der Mensbrugghe, 1997; APEC Economic Committee, 1997a; Anderson et al., 1997, Coyle and Wang 1998a, 1998b; Mai et al., 1998), which use some other methodology to account for the increased capital accumulation and induced productivity increases that result from liberalization, or which account for increased capital mobility (Adams et al., 1997; Dee, Geisler and Watts, 1996; Kawasaki, 1998; Walmsley, 1998), tend to predict larger gains than the more traditional static models (Young and Huff, 1997; APEC Economic Committee, 1997b, Wahl, 1998;, Scollay and Gilbert, 1999a). Similarly, models which account for imperfect competition in some sectors (Dee, Geisler and Watts, 1996; Brown, Deardorff and Stern, 1996; Ballard and Cheong, 1997) have a tendency to produce larger estimates of welfare gains than do perfectly competitive models, all other things being equal. Studies which consider the elimination of a wider range of barriers (tariff and non-tariff barriers, liberalization of services and investment), or which assume reductions in transaction costs due to trade and investment facilitation measures, also produce larger estimates of potential gains, as we might expect.

While all of the studies considered in the APEC-related survey use slightly different regional aggregations, thus making direct comparisons difficult, a number of fairly clear patterns do also emerge from the results regarding the regional distribution of gains from liberalization. The first and possibly most important pattern is that most studies predict wel-

Table 1. Summary of APEC Simulation Model Features and Results

Study	Aggregation (Regions x Commodities)	Model features	Experiments	Welfare impact	Key results
Adams et al. (1997)	11x37	GTAP model (V3), post-NAFTA dataset, normal closure and long-run (mobile capital) closure, static, top-down shocks implemented in MONASH.	APEC liberalization (general), preferential basis.	APEC: $53-203b ROW: -$5-13b	Substantial gains from APEC liberalization in long run with capital internationally mobile (but since asset ownership not tracked may be unreliable for any individual country). Gains smaller without mobile capital but still positive.
Anderson et al. (1997)	15x13	GTAP model (V3), upgraded elasticities of demand for farm and food products, upgraded Armington elasticities (doubled), recursive dynamic.	UR liberalization, APEC liberalization (50% reduction in tariffs beyond UR on MFN basis) + various other scenarios.	APEC: $75b ROW: $6b	Gains from APEC boost UR gains substantially, but magnitude depends heavily on whether or not agriculture is included (if so, 65% higher).
APEC Economic Committee (1997a)	19x14	GTAP model (V3), post-UR dataset, recursive dynamic (2 period) and static.	APEC liberalization (MAPA), MFN basis.	APEC: $17-69b ROW: $0-2b	All APEC members gain, gains proportionately larger for developing economies, welfare gains considerably smaller (some negative) under static simulations.
APEC Economic Committee (1997b)	8x7	GTAP model (V3), no data modifications documented, static.	APEC liberalization (general), preferential, unconditional MFN, conditional MFN with EU/ROW reciprocation, global free trade.	APEC: $52-62b ROW: $38-54b	Preferential liberalization inferior to all other liberalization scenarios, including unconditional MFN, for APEC members as well as world as a whole, global free trade optimal.
Ballard and Cheong (1997)	9x5	Custom model, GTAP database (V3), perfectly and imperfectly competitive versions, static.	APEC liberalization (general), preferential, global liberalization, various subregional groupings.	APEC: $77b ROW: -$7b	Most members gain from APEC FTA, gains larger the more countries included in grouping, gains substantially larger with imperfectly competitive model.
Brown, Deardorff and Stern (1996)	8x29	Michigan model, monopolistic competition in some sectors, static.	Preferential elimination of 1990 tariffs and non-tariff barriers for various APEC subgroups (APEC regions not fully identified).	APEC: $54b ROW: $0.5b	Benefits of liberalization increase with size of bloc, more members included the larger the gains for all members.

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Table 1. Summary of APEC Simulation Model Features and Results (continued)

Study	Aggregation (Regions x Commodities)	Model features	Experiments	Welfare impact	Key results
Coyle and Wang (1998a)	12x12	Custom model based on GTAP database (V3), post-UR, NAFTA, rural-urban migration, recursive dynamic.	APEC liberalization (general), simulations based on MFN and preferential assumptions.	APEC: $272-373b ROW: -$39+70b	MFN liberalization inferior to preferential for APEC members, unless ROW reciprocates. In all cases welfare increases.
Coyle and Wang (1998b)	12x12	As above.	As above.	As above.	As above + agriculture makes substantial contribution to gains (55 to 70 per cent of welfare gains attributable to agricultural liberalization).
Cheong (1997)	6x10	Custom model, GTAP database (V3), perfectly competitive version, static.	APEC liberalization (general), preferential and MFN.	APEC: $67-78b ROW: -$3+4b	MFN superior to preferential.
Dee, Geisler and Watts (1996)	14x37	IC95 model, GTAP database (V3), imperfectly competitive, static.	APEC liberalization (general), MFN basis. MFN excluding agriculture.	APEC: $519b ROW: $43b	Increases in real GDP in all APEC members, larger for small open economies, terms of trade tend to improve for agricultural exporting regions, gains lower when agriculture excluded.
Dee, Hardin and Shuele (1998)	14x37	IC95 model, GTAP database (V3 with some V4 modifications), post-NAFTA/UR dataset with modifications to services protection data, imperfectly competitive, static.	APEC EVSL liberalization (commodity-specific and joint, plus partial food system reform), MFN basis only.	N/A	Need to consider linkages in the production chain to avoid EVSL liberalization leading to welfare losses by creating high external reference prices; removal of export and production subsidies as well as tariff barriers results in much larger gains.
Gilbert (1998)	10x9	GTAP model (V3), static.	APEC EVSL liberalization (forestry only), MFN (conditional and unconditional), preferential, global.	APEC: -$0.3+0.1b ROW: $0.1-0.7b	Preferential liberalization of forestry superior for members to MFN, despite high ratio of intra-APEC trade.

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Table 1. Summary of APEC Simulation Model Features and Results (continued)

Study	Aggregation (Regions x Commodities)	Model features	Experiments	Welfare impact	Key results
Kawasaki (1997)	11x14	GTAP model (V3), post-UR dataset, static, some capital accumulation.	APEC liberalization (general), MFN basis, preferential basis.	APEC: $61-69b ROW: -$4+4b	Under MFN, gains largest for developing countries (slightly lower than UR gains), free-rider problem minimal, MFN superior to FTA, gains much larger with capital accumulation.
Lee and Roland-Holst (1995)	10x10	Custom model, IDE database (Australia and New Zealand not present), endogenous labour supply, static.	APEC liberalization (general), MFN basis, preferential basis.	APEC: $17.5-30b	MFN superior to preferential, all countries gain.
Lee, Roland-Holst and van der Mensbrugghe (1997)	20x27	Custom model based on LINKAGE, modified to use GTAP database (V3), recursive dynamic.	APEC liberalization (general), MFN basis, preferential basis.	APEC: $245-299b ROW: $0-34b	Gains to developing countries largest, unconditional MFN superior to preferential.
Lewis, Robinson and Wang (1995)	7x10	Custom model based on GTAP database (V2), static.	APEC liberalization (general), simulations based on conditional MFN and preferential assumptions (sub-groups).	APEC: $140b ROW: -$0.4b	APEC FTA should be as broad as possible gains larger the more APEC members are included; APEC FTA inferior to global liberalization (but no MFN by APEC covered).
Mai et al. (1998)	15x19	MEGABARE model, custom based on GTAP database (V3), recursive dynamic.	APEC liberalization (general), preferential and MFN basis, global liberalization.	APEC: 0.1-6.4% GDP ROW: -0.1-0.2% GDP	Gains higher for NZ under preferential agreement than MFN.
Martin, Petri and Yanagishima (1994)	19x7	Custom model, no intermediate input-output, some economies of scale, recursive dynamic.	APEC liberalization (general), preferential and MFN (unconditional) basis, various sub-groups.	APEC: $133b ROW: $11b	Benefits of liberalization increase with size of bloc, MFN superior to FTA with APEC liberalization for some (but not all) economies.

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Table 1. Summary of APEC Simulation Model Features and Results (concluded)

Study	Aggregation (Regions x Commodities)	Model features	Experiments	Welfare impact	Key results
McKibbin (1996)	16x6	Asia-Pacific G-Cubed model, capital internationally mobile, rational expectations dynamic.	APEC liberalization (general, tariffs only), MFN basis, preferential basis.	APEC: $32-42b	Countries which gain most are those which lower barriers the most, minimal free rider problem, MFN superior to FTA .
Otsubo (1998)	19x14	GTAP model (V3), post-NAFTA dataset, run static.	APEC liberalization (general, tariffs only), preferential, MFN conditional and unconditional, global liberalization.	APEC: -$86b ROW: -$363b	Large losses to APEC region with preferential, smaller losses with MFN, region gains only under MFN with reciprocation.
Petri (1998)	6x3	Custom model, FDI/trade linkages.	Preferential and MFN liberalization, removal of barriers to FDI.	APEC: $296b ROW: -$35b	Substantial gains from investment liberalization (40% of overall gains).
Scollay and Gilbert (1998)	15x15	MRTS model, GTAP database (V4), post-UR, NAFTA, AFTA dataset, Armington elasticities doubled, static.	APEC liberalization (general), APEC Open Food System, MFN and preferential basis.	APEC: $60-117b ROW: -$13+11b	Preferential agreement marginally superior to MFN, gains from removal of distortions in agricultural trade substantial.
Wahl (1998)	24x22	MRTS model, GTAP database (V3), post-UR dataset, static.	APEC liberalization (general), APEC liberalization (agriculture only), MFN basis, liberalization of non-agricultural sectors only.	APEC: $83b ROW: -$12b	All APEC members gain from APEC liberalization, ROW loses only slightly, approximately 50% of gains attributable to agricultural liberalization.
Walmsley (1998)	11x8	GTAP model (V3), post-NAFTA dataset, long-run (mobile capital) closure, static.	APEC liberalization (general), only using preferential assumption.	APEC: $78-193b ROW: -$7-199b	Results similar to Adams et al. (1997) above (mobile capital methodology same).
Young and Huff (1997)	10x3	GTAP model (V2), post-NAFTA dataset, static.	APEC liberalization (general), conditional and unconditional MFN and preferential basis.	APEC: $48-81b ROW: -$31+17b	Preferential liberalization superior for most APEC members (and overall) to MFN liberalization, unless the ROW reciprocates.

Source: Scollay and Gilbert (1999a).

fare gains for all of the APEC members. In the studies which find welfare losses for some regions, only the North American Free Trade Area (NAFTA) as a region (or Canada and/or Mexico as individual economies, where the NAFTA member economies are separated) is consistently predicted to have lower welfare as a result of APEC liberalization (although by negligible amounts). This may be related to the assumption in most studies that the North American Free Trade Agreement has already been implemented. Since Canada and Mexico trade predominantly with the United States, gains to them from further liberalization in APEC export markets are likely to be relatively small. The Armington structure of most of the models, which implies a degree of monopoly power for all economies, then results in slight terms-of-trade decreases, and hence small welfare losses are possible.

In relation to the interests of developing countries the studies surveyed also demonstrate a relatively consistent pattern. In most of the existing studies, when welfare effects are expressed as a percentage of GDP, the economies which seem to have the most to gain from APEC liberalization are the developing nations of South-East Asia, in particular the members of the Association of South-East Asian Nations (ASEAN), most notably Thailand, the Philippines and Malaysia. Interestingly and also perhaps to a degree ironically in the light of recent experience, models which deal with international capital flows, such as McKibbin (1996) and Petri (1998), also tend to indicate that the largest proportional gains accrue to the South-East Asian economies from increased investment post-APEC liberalization. This is consistent with the general expectation that in a conventional CGE analysis the size of the proportionate welfare gain is positively correlated with the level of protection existing prior to liberalization. Thus the economies of South-East Asia with much higher trade barriers than the more developed APEC economies of the region tend, in many studies, to experience relatively large allocative efficiency gains as a result of their own liberalization. A slightly different picture emerges in Scollay and Gilbert (1999a), with results similar to those of other studies for Thailand and the Philippines, but less optimistic findings for the other ASEAN members, with Indonesia and Malaysia experiencing losses under some scenarios. This may reflect the fact that the Scollay and Gilbert (1999a) study, unlike all other studies, assumes prior implementation of the liberalization programme of the ASEAN Free Trade Area (AFTA) as well as of the Uruguay Round Agreement and the North American Free Trade Agreement.

CGE modelling has also been able to throw useful light on a number of issues which have been of particular interest to APEC policy analysts. One of the areas in which there is a keen interest is the likely effect of APEC on non-members. Fears that non-members, particularly the European Union, might "free ride" on APEC members' liberalization efforts lay behind the strenuous opposition of the United States in particular to the "unconditional non-discrimination" interpretation of "open regionalism" and the corresponding preference for the alternative of "conditional non-discrimination". The evidence from the models suggests that there may be little basis for such fears of "free riding". All of the models surveyed predict near negligible effects on the rest of the world (in proportional terms) – with a fairly even split between positive and negative impacts. The rest of the world tends to fare slightly better in the "open regionalism" simulations than under preferential scenarios (suggesting among other things that a threat by APEC to form itself into a preferential area might carry some weight), but in all cases the welfare effects on the rest of the world are quite moderate.

Given the at times lively debate over "open regionalism" and its interpretation, another "natural" use of CGE analysis has been to compare the welfare effects under the two competing interpretations of "open regionalism" and also to compare both with the approach which APEC has in fact rejected, namely that of forming a preferential free trade

area (FTA) including all APEC members.

Among the three possible scenarios – a preferential APEC FTA, most-favoured-nation (MFN) liberalization without requiring reciprocation (unconditional non-discrimination) and MFN liberalization requiring reciprocation (conditional non-discrimination) – it is reasonable to believe a priori that conditional MFN (with reciprocation) will yield greater welfare benefits for APEC than the other two scenarios, and this expectation is borne out by the surveyed studies. When it comes to a comparison between unconditional MFN and a preferential APEC FTA, it may also be not unreasonable to believe, a priori, that unconditional MFN liberalization will result in higher global welfare, but it is not necessarily clear that it would lead to higher welfare for the APEC members alone.

Petri (1997) and the APEC Economic Committee (1997a) judged that the studies which they surveyed indicate that unconditional MFN liberalization provides the larger gains to APEC members. However, the later survey by Scollay and Gilbert (1999a), covering a greater number of studies, finds that the results are somewhat less clear-cut, with a number of studies finding a preferential FTA delivering higher welfare to APEC members than unconditional MFN.

Not all of the surveyed studies consider liberalization under all three scenarios. Of those that compare an APEC FTA with unconditional MFN, four – Young and Huff (1997), Coyle and Wang (1998a, 1998b) and Gilbert (1998) – find that the overall welfare gains to the APEC region of forming an APEC-wide FTA would exceed those from unconditional MFN liberalization (Gilbert considers only one sector under the EVSL programme, discussed further below). On the other hand, unconditional MFN is found to be superior to an FTA in six studies – by Lee and Roland-Holst (1995), McKibbin (1996), Cheong (1997), Kawasaki (1997), Lee, Roland-Holst and van der Mensbrugghe (1997) and the APEC Economic Committee (1997). However, in all of the studies except Lee and Roland-Holst the difference is marginal (in Lee and Roland-Holst the difference is roughly 40 per cent). Martin, Petri and Yanagishima (1994) finds MFN liberalization superior for some, but not all, APEC member economies. A number of other studies, such as those by Lewis, Robinson and Wang (1995) and Ballard and Cheong (1997), find conditional MFN superior to an FTA, but do not consider unconditional MFN. Perhaps a reasonable overall conclusion to be drawn from the studies is that while confirming that conditional MFN provides benefits superior to those provided by the other two alternatives, they do not provide convincing evidence that APEC as a group is disadvantaged by preferring the unconditional MFN version of "open regionalism" to the formation of a preferential APEC FTA.

The latter conclusion does not, however, necessarily carry over to individual APEC economies. The results in Scollay and Gilbert (1999a), for example, indicate that Australia, New Zealand, Japan, the Republic of Korea, Canada, the United States and other APEC countries (predominantly Taiwan Province of China and Singapore), i.e. the developed APEC members and the newly industrialized economies (NIEs), experience greater welfare gains under a preferential APEC FTA than under unconditional MFN. Indonesia, Malaysia, the Philippines, Thailand, China and Mexico, i.e. the developing APEC economies, are better off under the unconditional MFN arrangement.

A review of the model structures in the different studies does not reveal an obvious explanation for the difference in results comparing the three scenarios. At least in the static models one would expect that differences in results may be related to experimental design (exactly what measures are implemented), aggregation (GTAP results are sensitive to the aggregation used) and closure (e.g. studies that fix the trade balance, such as Young and Huff (1997), tend to predict smaller welfare gains than those where capital is mobile, such as

Kawasaki (1997)). In the case of dynamic models the explanation may be more complex, as the order in which policy changes are sequenced may also have a bearing. More work is needed to find exactly why the results differ.

A further question, and one where the pattern emerging from the model results is more unequivocal, is on the issue of "width". A number of studies consider regional groupings of different sizes (Martin, Petri and Yanagishima, 1994; Lewis, Robinson and Wang, 1995; Brown, Deardorff and Stern, 1996; Ballard and Cheong, 1998). These studies consistently find that the larger the bloc considered, the larger the overall welfare gains are likely to be.

As in most liberalization initiatives, agriculture has been a sensitive issue within APEC. Its inclusion or non-inclusion became a hot issue in the lead-up to the Osaka APEC meetings in 1995, as North-East Asian economies lobbied strenuously to have agriculture excluded from APEC's liberalization programme. This push was eventually countered by adopting "comprehensiveness" as one of the principles of APEC liberalization, thereby acknowledging that no sector should ultimately be excluded. The balancing adoption of the principle of "flexibility", however, left it open to member economies to delay agricultural liberalization well beyond liberalization in other sectors.

A subset of the studies deals with agricultural liberalization in APEC. These are Dee, Geisler and Watts (1996), Anderson et al. (1997), Coyle and Wang (1998b), Wahl (1998), and Scollay and Gilbert (1999a). The results of these are quite consistent, with agricultural liberalization accounting in all cases for between 50 and 70 per cent of the total welfare gains of APEC liberalization (with some variation, depending on whether MFN or preferential liberalization is considered).

Overall CGE modelling of APEC has built up an impressive array of results and has explored a number of issues that have been controversial within APEC. It would seem fair to conclude that there is an impressive degree of consistency in results among the large number of papers dealing with APEC trade liberalization. The one area of significant divergence is on the question of whether APEC members are better off under "open regionalism" understood in the sense of unconditional non-discrimination than they might be by forming themselves into a preferential FTA – a question which is of some importance in conceptual terms even if it is somewhat hypothetical in practice. Even here, however, the extent of the divergence between the results in quantitative terms is not large, as noted above.

V. CGE ESTIMATES OF AGRICULTURAL LIBERALIZATION

The remainder of this paper focuses on the use of CGE techniques to model agricultural trade liberalization, and an attempt to extend conventional CGE analysis to deal with a wider range of related policy concerns. A conventional CGE analysis of the effects of agricultural trade liberalization was elaborated in Scollay and Gilbert (1999b), where such liberalization is simulated as the removal of all import tariffs, export subsidies and production subsidies on all agricultural and food products, using a recursive dynamic model. Since there is no real historical precedent for the removal of production or export taxes under international liberalization agreements, these were left in place. Liberalization is implemented in the simulation as a set of linear reductions in distortion levels over the five-year period 2001-2005. The simulations are performed under the familiar alternative assumptions of unconditional MFN liberalization by the APEC member economies, conditional MFN liberalization with non-members reciprocating, and establishment of an APEC FTA or a preferential agreement.

The results are shown in table 2. They indicate substantial welfare gains for most APEC members, with only Indonesia and Mexico being relatively unaffected, in fact experiencing small welfare losses. China also experiences welfare losses under the preferential

Table 2. Estimated welfare impact of agricultural trade liberalization, equivalent variation basis

Deviation from baseline 2005 ($1995 billion) and percentage of baseline 2005 real GDP

Region	MFN liberalization		Preferential APEC		MFN reciprocating	
	$	%	$	%	$	%
Australia	5.2	1.1	7.5	1.7	8.6	1.9
New Zealand	1.8	2.5	4.7	6.5	7.5	10.3
Japan	40.5	0.7	30.6	0.5	35.7	0.6
Republic of Korea	8.0	0.9	3.3	0.4	6.2	0.7
Indonesia	-0.3	-0.1	-0.4	-0.1	-0.4	-0.1
Malaysia	6.2	3.6	4.0	2.3	11.3	6.5
Philippines	1.7	1.9	1.2	1.3	1.6	1.7
Thailand	11.7	2.8	10.8	2.5	15.4	3.6
China	8.2	0.5	-6.5	-0.4	4.1	0.3
Canada	1.7	0.3	1.4	0.2	2.5	0.4
United States	9.8	0.1	13.4	0.2	29.5	0.3
Mexico	-0.1	0.0	-0.3	-0.1	-0.3	-0.1
Other APEC	11.8	1.3	9.3	1.0	30.6	3.4
Europe	-12.7	-0.1	-10.7	-0.1	24.1	0.2
Rest of world	13.0	0.2	7.7	0.1	16.2	0.3
APEC developing	**47.1**	**1.0**	**21.4**	**0.4**	**68.5**	**1.4**
APEC developed	**59.0**	**0.4**	**57.7**	**0.4**	**83.8**	**0.5**
Total APEC	**106.1**		**79.1**		**152.3**	
Non-APEC	**0.3**	**0.0**	**-3.0**	**0.0**	**40.3**	**0.2**

Source: Scollay and Gilbert (1999b).

scenario. Total welfare gains to APEC members are estimated to be between $79 and $152 billion, roughly two thirds of which accrues to the developing economies. In proportional terms it is New Zealand and the ASEAN economies of Thailand, the Philippines and Malaysia that experience the largest welfare gains. Interestingly, in absolute terms it is one of the countries that is most opposed to liberalization of food and agriculture – Japan – which gains the most. This is no doubt a reflection of the large allocative efficiency gains achieved with the removal of its substantial tariff barriers and domestic support.

The results for Mexico may be explained by the fact that virtually all of the gains to Mexico from agricultural liberalization have already been attained under NAFTA. Moreover, as the United States and Canada liberalize, competition in those markets intensifies. Mexico begins to lose some of its privileged access. The result is a slight welfare decline, although, given the uncertainty surrounding these types of projections, this should probably be interpreted as a zero gain. Similar factors may play some part in explaining the results for Indonesia, but these results essentially remain something of a puzzle, as Scollay and Gilbert (1999b) note.

In the light of the earlier discussion, it is noteworthy that in the results reported in Scollay and Gilbert (1999b) unconditional MFN liberalization, without any requirement for reciprocation by APEC non-members, is superior to a preferential APEC agreement for APEC members overall, and also for non-members. The impact on non-members of unconditional MFN liberalization is also trivial overall. However, conditional MFN liberalization, with reciprocation required from non-members, once again clearly dominates both of the other two strategies. One implication is that APEC need not be unduly dismayed if agricultural trade liberalization turns out to be one of those issues on which progress can realistically be expected only within the context of the World Trade Organization.

When we consider the distribution of welfare gains across the APEC members, one pattern stands out quite clearly. The major food-exporting economies (Australia, New Zealand and the United States) are estimated to gain more under a preferential agreement, while the food-importing countries of the region (most notably Japan, the Republic of Korea, and China, which is expected to become a major food importer in the new century – see appendix 2) are better off under an MFN arrangement. This result is not surprising. With the conclusion of a preferential agreement on food and agriculture, the exporting economies are able to capture a larger share of importing member countries' markets as a result of their preferential access. However, it is the importing countries that bear the burden of trade diversion, which for China implies a welfare loss. In the case of MFN liberalization, the importing countries are able to achieve greater efficiency gains, and trade diversion is eliminated – hence welfare for these countries is higher than under the preferential agreement.

The results from the conventional analysis in Scollay and Gilbert (1999a) highlight a familiar apparent paradox. The APEC member which has most to gain in absolute terms from agricultural trade liberalization – Japan – is in practice the member most adamantly opposed to liberalization. A number of developing economy APEC members also remain at best equivocal about agricultural trade liberalization, notwithstanding the prediction that about two thirds of the total welfare gains will accrue to developing economies.

The explanation of this apparent paradox is also well known, and highlights a major limitation of the type of studies described so far. The overall gains from trade liberalization routinely predicted by standard economic analysis are in fact, of course, net benefits, measuring the extent to which gains exceed losses within the community. While the gains may be confidently predicted to exceed the losses, they are spread widely through the community, whereas the losses are concentrated on

the sector or sectors from which protection is removed. Both the gains and losses tend to be proportional to the extent of the protection being removed. Thus trade liberalization in a heavily protected sector may yield large gains for the economy as a whole, while at the same time causing severe losses of income (and employment) in that sector. In the longer term some of those engaged in the affected sector will respond by leaving it in order to pursue better opportunities elsewhere in the economy, so that the sector itself will decline.

Management of the political implications of these distributional effects is often the biggest challenge confronting Governments in implementing trade liberalization. Sometimes a Government may seek to persuade the community that "the gain is worth the pain", supporting its argument by pointing to the prospect that even those displaced or otherwise adversely affected by liberalization will eventually find themselves better off as they move to occupations and/or sectors with better long-term prospects. Another approach is to partially or wholly compensate those who lose from liberalization. The existence of net welfare gains means that the Government could do this by way of some form of redistribution, and still leave the rest of the community better off. Direct income-support payments would in principle be one way of effecting redistribution, with the additional merit that they do not distort production and consumption decisions. However, these approaches suggested by economic theory have not in practice proved popular among Governments, which have tended to prefer assistance measures that encourage displaced workers to retrain or relocate.

As is well known, the political obstacles to agricultural trade liberalization have tended to be particularly acute. In part this is related to the high levels of protection often found in the agricultural sector, with the result that the expected adverse effects of trade liberalization on agricultural incomes are correspondingly severe, a problem which is further compounded if resources in the agricultural sector are particularly immobile and cannot thus be readily transferred to other sectors with greater economic potential. Another part of the explanation is the way in which cultural, social and political factors tend to combine to encourage the community to accept the view that severe falls in agricultural incomes, together with any associated decline in the rural sector, are outcomes to be resisted. The nexus between agriculture, development and poverty provides a strong reason for caution in many developing countries where agriculture continues to play an important part in development strategies. In many developing economies, furthermore, poverty tends to be heavily concentrated in the rural sector, which also accounts for a large proportion of the population. Thus policies which may lead to further falls in agricultural incomes and perhaps also to an overall contraction of the sector may be particularly difficult to accept.

There was growing recognition among many in the APEC process that a one-dimensional approach focused solely on agricultural trade liberalization does not adequately address some deeply held concerns of the member economies, and will continue to meet with strong resistance. Furthermore, the fact that the reservations concerning liberalization related to issues which in principle should be capable of being addressed through economic and technical cooperation ("Ecotech") clearly pointed to the potential advantage of a more integrated approach embodying both TILF and Ecotech elements. Recognition of this potential was reflected in development of the APEC Food System (AFS) proposal, with the multifaceted objective of creating a "regional food system where:

- Consumers have access to the food they desire at affordable prices;
- The productivity of the food sector is enhanced through region-wide availability of food-related technological advances and through efficient resource use;
- Supply security is improved through co-

operation and interdependence;
- The vitality of rural communities is enhanced through improved infrastructural development and through access to viable non-farm employment and industry" (ABAC, 1998b).

This objective in turn was to be achieved through a multidimensional approach to food and agriculture policy, in which four main elements can be distinguished:

- Rural infrastructure development;
- Dissemination of technological advances in food production and processing;
- Trade and investment liberalization in the food sector;
- Achieving food security.

The rural infrastructure development and technology transfer elements of the AFS proposal are essentially conceived as exercises in "capacity-building", aimed at ensuring that the food sector develops in ways which contribute to the achievement of overall development objectives in APEC economies, and ensuring also that trade and investment liberalization and facilitation in the food sector contribute to those objectives through a wider spread of benefits both between and within economies.

The capacity-building measures envisaged in the AFS proposal thus offer a further angle on dealing with distributional consequences of trade liberalisation in the food sector. By bringing about improvements in the performance of previously protected agricultural sectors, they may partially or perhaps even wholly offset the negative impact of trade liberalization on agricultural incomes, as well as helping to improve the overall performance of the economy. In so doing they may also help to ease the problems of political management of trade liberalization in the food sector.

Quantitative evaluation of a proposal such as the AFS presents a major challenge. There is a lack of well-developed and readily usable techniques for estimating the distributional effects of trade liberalization, let alone for quantifying how the outcomes might be affected by capacity-building measures of the type envisaged in the AFS proposal. Further issues relate to the nature of the measures themselves. The details of these measures have not been clearly articulated, nor, consequently, has it been explained how they might be adequately modelled.

In Gilbert, Scollay and Wahl (1999) an approach is developed whereby CGE analysis can be extended to address one aspect of the problems described in the previous paragraph, by extending the conventional analysis based on the GTAP database to provide information on distributional effects. It is also shown that if capacity-building measures can be defined in such a way that their economic effects can be reliably estimated, then these effects can also be incorporated into the modelling of both welfare and distribution effects. In principle, therefore, the approach taken is capable of analysing an integrated approach such as that taken in the AFS proposal, in terms both of the aggregate welfare effects which are typically the focus of trade policy analysis, and also of the distributional issues which are a more important concern in assessing developmental impacts. A particular merit of this proposed approach to analysing the distributional consequences of trade liberalization and associated policies is that because it involves an extension of existing modelling techniques based on the GTAP database, the results obtained can be made consistent with those from the analysis of trade liberalization in more conventional analyses.

The remainder of this paper is taken up with an outline of this new adaptation of CGE analysis, illustrated by reference to the results obtained for the AFS proposal in Gilbert, Scollay and Wahl (1999). Although the results reported in that paper are specific to APEC and the AFS proposal, the basic approach used clearly has the potential for wider application to trade and development issues.

VI. THE CGE MODEL SPECIFICATIONS

The procedure followed in Gilbert, Scollay and Wahl (1999) is as follows. The first step is to use CGE analysis to produce estimates of the effects of agricultural trade liberalization in isolation. The properties of the GTAP database, supplemented by additional data, are then utilized to produce information on the distribution of those effects. Next, a series of experiments is conducted in which the effects of the rural infrastructure development and technology transfer elements of the AFS proposal are modelled as productivity improvements, introduced through various mechanisms, including transfers of labour between unskilled and skilled categories. Simulations are run to determine how these productivity improvements affect both the overall effects of trade liberalization and more particularly their distribution.

It is important to be clear at the outset what this analysis does and does not do. It does not purport to identify detailed policies or capacity-building measures in the areas of rural infrastructure development and technology transfer, nor to model the actual effects of such policies. Rather, the policies which might be adopted in these areas are represented through arbitrarily chosen but plausible estimates of the effects which one might expect to observe from them. The analysis is thus very much of an exploratory nature. In principle, it would of course be possible to identify particular policies and in future it might also be possible to provide more detailed specifications of the policies and their effects; this, however, is left as something to be developed at a later date. The usual limitations and qualifications attached to CGE analysis are also of course applicable to this analysis: even highly detailed and sophisticated CGE models are no more than simplified and stylized representations of the economy rather than the economy itself, and the results obtained from them are best interpreted as experiments designed to explore the effect of various policy changes and other economic shocks, observing how the model responds to changes designed to represent those policy changes and shocks. Simulations such as those discussed here are perhaps most appropriately regarded as thought experiments with numbers, designed to throw further light on the relatively well documented results from CGE analyses of agricultural trade liberalization, and to explore how those results might be modified by changes in their parameters that might reasonably be expected to follow from the type of capacity-building measures envisaged in the AFS proposal.

It will, of course, take time for the productivity improvements anticipated from those capacity-building measures to materialize, and for their effects to be felt. For the research reported in Gilbert, Scollay and Wahl (1999), therefore, a dynamic version of the basic CGE model was constructed, allowing the behaviour of the economy under the various scenarios being investigated to be tracked over a period of time, in this case up to 2005. Projections of annual growth in the labour force, labour force skill development and productivity were incorporated into the model. The assumptions incorporated into these projections are important, and are discussed in detail in appendix 1. As a special feature the model also provides for mutual interdependence between the accumulation of capital and the year-to-year behaviour of the economy, by making the level of investment depend on the level of income. Thus, for example, if predicted income levels change as a result of trade liberalization or AFS capacity-building measures, this will be reflected in

changes in the level of investment in the economy, which in turn will affect its future growth path.

The existing model and the GTAP database cannot identify changes in the incomes of different categories of households, but do readily generate information on the functional distribution of income. Income distribution effects are therefore explored in terms of changes and divergences in the incomes of different factors of production (skilled and unskilled labour, capital and land). For this purpose the basic model was adapted to treat unskilled agricultural labour as a distinct factor of production which is not interchangeable with urban unskilled labour; skilled labour, on the other hand, is assumed to be mobile across all industries. Upskilling at a predetermined rate is initially allowed for non-agricultural but not for agricultural unskilled labour. A particularly important extension of the basic model is the presentation of labour incomes in the form of estimated wage rates. This is made possible by combining the information on functional distribution of income generated from within the basic model and database with labour force data, including the body count data in Liu et al. (1998).

Apart from this extension, the data used in the simulations, including data on protection levels, come from GTAP-IV, the latest version of the GTAP database. The commodity and regional aggregation structure is indicated in table 3. Income changes and divergences are generated within the model itself, so that they are fully consistent with the data and behavioural assumptions on which the simulations are based, and with the movements predicted in the simulations of other variables in the economy. The distributional impact of the AFS is examined primarily in terms of the effects on agricultural and non-agricultural labour incomes, which do not correspond directly to changes in household incomes, for reasons explained in the preceding paragraph. However, most rural household income comes from factor payments to agricultural labour, and hence the figures presented here are useful as broad indicators of the effects on income in the agricultural sector.

The first step in Gilbert, Scollay and Wahl (1999) was to simulate a baseline scenario, in which no liberalization or capacity-building measures are implemented, but which incorporates chosen assumptions about investment behaviour and about rates of labour force

Table 3. Regional and commodity aggregation

Regions	Commodities
Australia	Paddy rice
New Zealand	Wheat
Japan	Grains
Republic of Korea	Vegetables and fruit
Indonesia	Other non-grain crops
Malaysia	Livestock
Philippines	Forestry
Thailand	Fisheries
China (including Hong Kong)	Processed rice
Canada	Meat products
United States	Dairy products
Mexico	Other food products
Other APEC (Taiwan Province of China, Singapore, Chile)	Light manufactures
Europe	Heavy manufactures
All other countries (ROW)	Services

Source: Gilbert, Scollay and Wahl (1999).

growth, labour force skill development and productivity growth. This baseline scenario served as the point of comparison for the subsequent scenarios in which the effects of liberalization and capacity-building measures are successively incorporated.

From each subsequent simulation two sets of results were reported. The first set comprises the projected changes in welfare in 2005 for each economy as a whole, relative to the baseline scenario, using the equivalent variation measure. The second set of results comprises the changes in the incomes by 2005 of unskilled agricultural workers, unskilled non-agricultural workers, and skilled workers, again relative to the baseline scenario.

As noted above, a particular focus of the research is the outcome for agricultural incomes. For the majority of APEC economies in which agriculture is to some degree protected, trade liberalization in isolation can be expected to have a negative effect on agricultural incomes, relative to the baseline. A key point of interest in the results is therefore the extent to which AFS-style capacity-building measures might lead to an improvement in the outcome for agricultural incomes.

Agricultural trade liberalization is simulated in the same way, and for the same alternative scenarios as in Scollay and Gilbert (1999b), described in the previous section.

After the effects of trade liberalization had been simulated, a further set of simulations was performed to explore the effects of combining trade liberalization with a range of capacity-building measures of the type strongly emphasized in the AFS proposal, implemented over the same period as the liberalization. Three types of measures were considered: measures to facilitate technology transfer from developed to developing APEC economies, improved rural education, and measures to increase the mobility of unskilled labour between agricultural and non-agricultural sectors. The last type of measure could be interpreted in various ways. It could imply encouragement for rural–urban migration if non-agricultural sectors are located principally in metropolitan centres, or on the other hand it might also represent the creation of alternative non-agricultural employment opportunities in rural areas.

As noted above, the detail of how the capacity-building measures are implemented was not specified, and they were represented by means of plausible but arbitrary assumptions as to their effects on key variables in the model. Thus it was assumed that the effect of the improvements in technology transfer envisaged in the AFS proposal would be to increase the rate of technical progress over the implementation period in the agriculture and food-processing sectors of APEC developing economies (defined as those with economies with per capita GDP of less than $5,000). This was represented by a 10 per cent increase in the rates of total factor productivity growth in those sectors.

Two alternative approaches were adopted to modelling the effects of improved rural education. In the first approach, labelled "Rural Education A", the model dynamics were altered by relaxing the initial assumption that upskilling occurs only among non-agricultural unskilled workers. Instead, a situation was considered where the rate of upskilling among rural workers is equal to that among non-agricultural workers in developing economies. This can be interpreted as the effects of an "equal opportunity" rural education policy providing for access to education among agricultural groups equivalent to that available among non-agricultural groups.

In the second approach, labelled "Rural Education B", it was assumed that improved rural education leads to improved use of land by agricultural workers, and this was represented as a 1 per cent rate of labour-augmenting technical progress in agricultural land use in developing economies.

Finally, a simulation was carried out to explore the effects of increasing the mobility of labour between agricultural and non-agri-

cultural production activities. As noted above, this could be interpreted as reflecting measures to create alternative employment opportunities in rural areas, although other interpretations are also possible, such as an increase in rural –urban migration. Shifting between the alternative forms of employment was assumed to take place in response to wage differentials, which of course will tend to drive down wages in the sector where wages are higher, while wages rise in the lower-paying sector. It was assumed that this effect continues until wages for unskilled workers are equalized between the two sectors.

Further explanation and comment on the modelling of capacity-building measures in Gilbert, Scollay and Wahl (1999) are provided in appendix 2.

It is of course likely that in practice more than one type of capacity-building measure will be used simultaneously. For the purposes of the experiment, however, each type of measure was treated separately, and this made it possible to isolate and compare the direction and possible magnitude of the effect which each type of measure might have on economic welfare and factor incomes in the various APEC economies. The information provided in this way may be useful for policy analysis purposes even though the results may consequently be somewhat artificial.

VII. THE SIMULATIONS

In addition to the methodology, the results obtained in Gilbert, Scollay and Wahl (1999) are of some interest as an example of the range of information that can be generated, and the nature of the indications that can be obtained as to the possible impact of an integrated strategy such as that embodied in the AFS proposal. In this section the general nature of these results is outlined and discussed. While results for a range of variables are reported in the study, only those relating to aggregate welfare effects and agricultural labour incomes are emphasized here.

A. Baseline scenario

Essentially the baseline scenario provides an overall projection of the state of the world economy by 2005 in the absence of any further trade liberalization or implementation of AFS capacity-building measures. The results from the baseline scenario thus provide the benchmark against which the results from subsequent simulations are compared. Figure 1 shows the real GDP levels for APEC economies in the projected baseline scenario at 2005, with the actual real GDP statistics from the base 1995 data also shown for comparison.

A key set of results under the baseline scenario are the changes in factor returns, which provide the benchmark for the changes observed under the liberalization and AFS capacity-building scenarios. The changes in the differential between wages of agricultural and non-agricultural unskilled workers under

Figure 1. Real GDP 1995 and projected 2005 ($ billions)

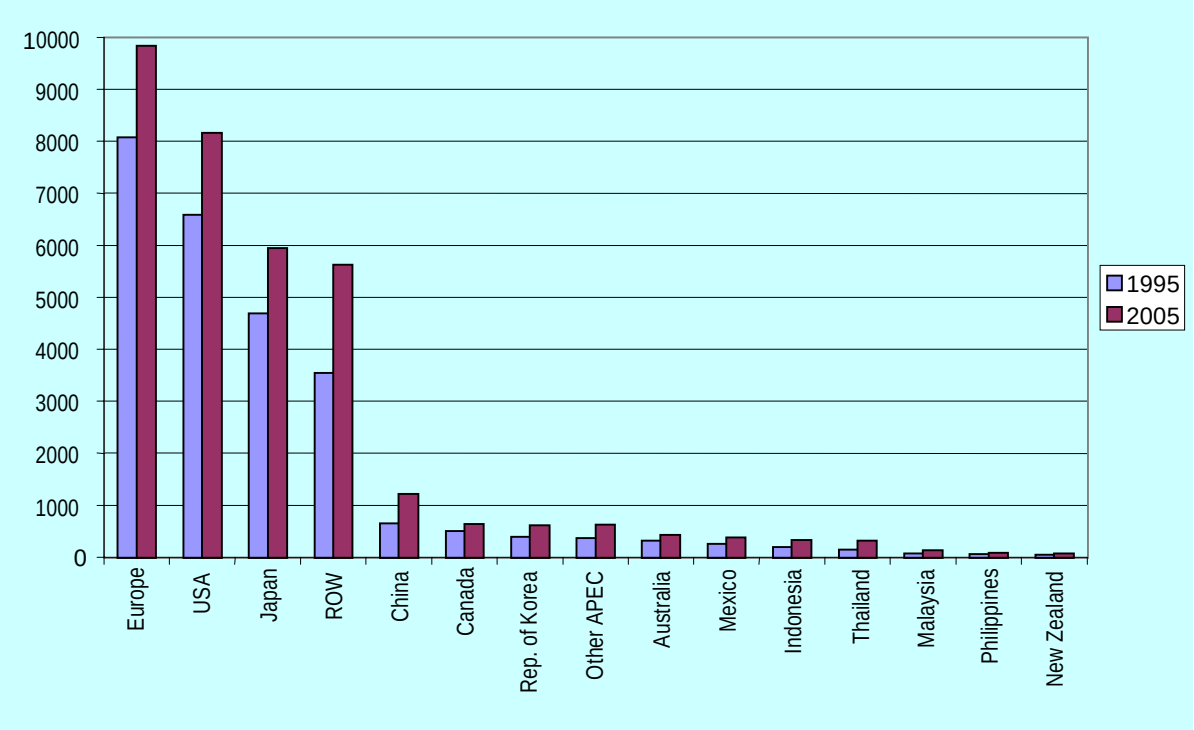
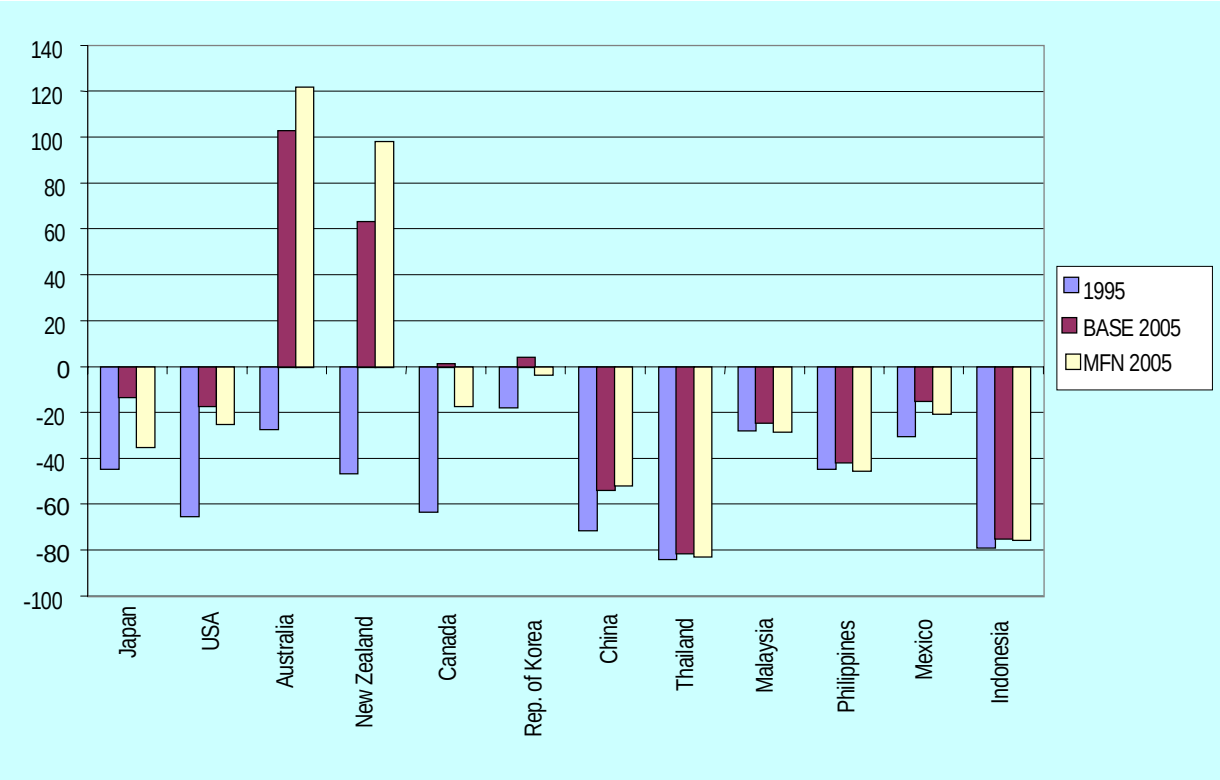


Figure 2. Rural–urban income divergence associated with food sector trade liberalization



the baseline scenario are presented in figure 2, the construction of which is explained in appendix 3. More detailed information can be found in table 4, which also includes projections for returns to skilled labour, capital, land and natural resources.

By comparing the divergence indexes in figure 2 for 1995 with those for the baseline projections for 2005 it can be clearly seen that the model projects an improvement in the wages of unskilled agricultural workers relative to those of unskilled non-agricultural workers.

Table 4. Per unit nominal factor returns: index and dollar values
(Baseline 2005, 1995=1, $000/year)

Region	Agricultural labour		Unskilled labour		Skilled labour		Capital	Land	Natural resources
	Index	$	Index	$	Index	$	index	index	index
Australia	3.5	48.9	1.3	24.1	0.9	36.0	0.9	2.6	1.2
New Zealand	3.7	34.4	1.2	21.1	1.0	24.2	0.9	2.2	1.6
Japan	1.9	34.0	1.2	39.2	0.9	87.4	0.9	1.9	1.8
Republic of Korea	1.8	12.4	1.4	11.9	1.0	27.9	0.9	2.5	2.3
Indonesia	1.6	0.7	1.5	2.8	0.9	5.5	0.9	3.1	1.8
Malaysia	1.7	4.3	1.6	5.7	1.0	9.4	0.8	3.1	1.8
Philippines	1.3	0.7	1.3	1.2	0.9	31.2	1.0	2.9	2.3
Thailand	1.8	0.8	1.7	4.3	1.1	9.4	0.9	2.5	2.4
China	2.5	0.6	1.7	1.3	1.3	2.4	0.9	3.2	2.2
Canada	3.0	25.2	1.1	24.9	1.0	20.7	0.9	3.7	1.2
United States	2.7	28.9	1.1	34.9	0.9	43.5	0.9	3.6	1.1
Mexico	1.5	2.3	1.2	2.7	1.0	6.1	1.0	3.4	1.4

Source: Gilbert, Scollay and Wahl (1999).

In Australia and New Zealand this trend results in agricultural wages rising above non-agricultural wages. In other APEC economies it is reflected in declining wage inequality between agricultural and non-agricultural unskilled workers over the simulation period, although the changes are relatively minor in the ASEAN economies, and in many cases the divergence is and remains substantial. This outcome of the simulations is clearly contrary to the "received wisdom" that disparities between agricultural and non-agricultural incomes are generally widening, but it is consistent with the trend observed over recent decades in some APEC members for which data are available, such as China and the Republic of Korea.

The pattern of changes in factor incomes over time reflects two economic fundamentals, the first being that relatively scarce factors are paid relatively more. Diverging endowment growth rates imply diverging changes in relative scarcity. The second fundamental is that factors which are highly mobile are affected less by shocks to the economy (whether these be growth shocks or the removal of distortions – both of which are present in our baseline) than are factors with more limited mobility. One of the main patterns observed is therefore less change in nominal returns to those factors which are fully mobile (again skilled labour and capital). There are more substantial changes to the incomes of all other factors over time, these changes being larger the less mobile the factors (hence agricultural unskilled labour experiences larger income changes over time than non-agricultural unskilled labour, which is mobile over a much larger sector of most economies).

Some additional comment is called for on the especially large increase in returns to unskilled agricultural labour in Australia and New Zealand, which leads to the differential between agricultural and non-agricultural wages being reversed in those two economies. In fact, the 2005 differential in favour of agricultural labour ends up being larger than the 1995 differential in the opposite direction. This result may partially reflect the favourable impact on agriculture in those two economies of the Uruguay Round outcome, which forms part of the baseline scenario. It is also, however, in part an artefact of the strict assumption being maintained in the baseline scenario that agricultural and non-agricultural unskilled labour are not interchangeable. This is a simplifying assumption which also makes it easier in a later simulation to isolate the effect of allowing for greater labour mobility between the two sectors. However, the outcome to which it gives rise in this case is of course implausible. In practice such a rapid rise in unskilled agricultural wages, and the resulting emergence of such a large differential, would inevitably induce unskilled labour to begin moving out of non-agricultural into agricultural pursuits, and this movement would tend to dampen down the rise in agricultural wages and with it the emerging differential.

B. Food sector trade liberalization

The next step was to simulate of the effects of food sector trade liberalization under the AFS proposal. Table 5 presents the results both in dollar terms and as a percentage of baseline real GDP for 2005 to give an indication of the relative magnitude of the welfare effects. Total APEC gains are estimated to be in the region of $55 to $112 billion, with the largest gains coming under the MFN scenarios. These figures are quite consistent with estimates in existing studies of the impact of agricultural liberalization in APEC countries. All but two APEC economies experience net gains in economic welfare, with the largest gainers projected to be Japan, the United States and China in absolute terms, and New Zealand, Malaysia and Thailand in relative terms. It is noticeable that, expressed as a percentage of baseline 2005 real GDP, the welfare benefits to APEC developing economies are substantially higher under all three liberalization scenarios than the benefits to APEC developed economies. These results are

Table 5. Estimated welfare impact of food sector trade liberalization

Deviation from baseline 2005 ($1995 billion) and percentage of baseline 2005 real GDP

Region	MFN liberalization		Preferential APEC		MFN reciprocating	
	$	%	$	%	$	%
Australia	3.91	0.91	6.00	1.39	6.35	1.47
New Zealand	1.60	2.29	3.82	5.48	5.89	8.44
Japan	34.02	0.57	22.39	0.38	29.72	0.50
Republic of Korea	-1.42	-0.23	-2.24	-0.37	-1.83	-0.30
Indonesia	-0.40	-0.12	-0.38	-0.11	-0.35	-0.10
Malaysia	3.85	2.80	2.41	1.75	8.69	6.33
Philippines	1.66	1.84	1.22	1.35	1.47	1.63
Thailand	6.66	2.09	6.61	2.08	9.67	3.04
China	7.46	0.61	-0.90	-0.07	6.89	0.56
Canada	1.09	0.17	0.86	0.13	1.66	0.26
United States	7.81	0.10	11.64	0.14	25.80	0.32
Mexico	0.60	0.16	0.45	0.12	0.40	0.10
Other APEC	4.44	0.70	3.72	0.59	18.23	2.89
Europe	-11.53	-0.12	-8.51	-0.09	16.47	0.17
Rest of World	9.68	0.17	4.21	0.07	5.51	0.10
APEC developing	**24.27**	**0.78**	**13.13**	**0.42**	**45.00**	**1.44**
APEC developed	**47.01**	**0.30**	**42.47**	**0.27**	**67.59**	**0.43**
APEC total	**71.28**	**0.38**	**55.60**	**0.29**	**112.59**	**0.59**
World	**69.43**	**0.20**	**51.30**	**0.15**	**134.57**	**0.39**

Source: Gilbert, Scollay and Wahl (1999).

similar to those obtained using a slightly different model specification in Scollay and Gilbert (1999).

The estimated effects of the agricultural trade liberalization on labour incomes are presented in figure 2 for the MFN scenario (the preferential and MFN with reciprocation scenario results are similar, and further details are shown in table 6). The effects are presented as percentage changes relative to the baseline scenario. As noted earlier, it would be expected that liberalization would lead to a fall in agricultural incomes in those economies where agriculture has enjoyed significant protection, and we might further infer that the fall in agricultural incomes would be most pronounced in Japan. This expectation is confirmed by the results. The negative impact on agricultural incomes is indeed strongest in Japan, regardless of the form of liberalization. Of course, in Japan the majority of rural households also earn a substantial proportion of their income from off-farm activities, and so the effect on rural households is unlikely to be as extreme as indicated by the projected drop in rural labour incomes.

The results in fact indicate that a decline in agricultural incomes relative to baseline can be expected in most economies as a result of food sector trade liberalization, in particular under scenarios without reciprocation from non-APEC members. A fall relative to baseline does not of course mean that agricultural incomes will fall in absolute terms. Apart from Japan, the other economies in which the fall in agricultural incomes relative to baseline is greatest are the Republic of Korea, Canada and the United States. Since the latter two economies are usually regarded as relatively efficient agricultural producers, this result may come as a surprise. However, both Canada and the United States have relatively high production subsidies in agriculture, even though their trade interventions are relatively

low and removal of this domestic support is included in the liberalization scenario, as noted above. The only clear exceptions to the general trend of a relative decline in returns to agricultural labour are New Zealand, Australia and China, where agricultural labour incomes are projected to rise relative to baseline under all scenarios. Agricultural incomes also rise relative to baseline in the "liberalization with reciprocation" scenario in Indonesia, Malaysia, Thailand and the United States.

The overall pattern from these results can be summarized as follows. In APEC economies we generally expect the divergence between agricultural and non-agricultural wages to decline over time, regardless of whether these economies choose to liberalize their agricultural trade. In Australia and New Zealand the outcome is even more favourable for agricultural wages. However, agricultural trade liberalization, in isolation, is likely to lower agricultural wages relative to where they would otherwise have been in most member economies. These relative falls in agricultural wages are likely to be least severe if APEC liberalization is reciprocated by the rest of the world, and are most severe with unreciprocated MFN liberalization by APEC economies. As noted earlier, this negative impact of liberalization on agricultural incomes represents a political challenge which many APEC economies will need to address properly if they are to implement liberalization and enjoy its attendant overall economic benefits.

C. AFS capacity-building measures

The Gilbert, Scollay and Wahl (1999) study then considers separately the results of the simulations incorporating each of the AFS capacity-building measures being modelled. This allows an examination of how these measures affect overall welfare, and the identification of which measures are likely to be most successful in offsetting the effect of agricultural trade liberalization in causing a decline in agricultural incomes relative to baseline.

Figure 3 shows to what extent and in what direction the introduction of AFS capacity-building measures modifies the

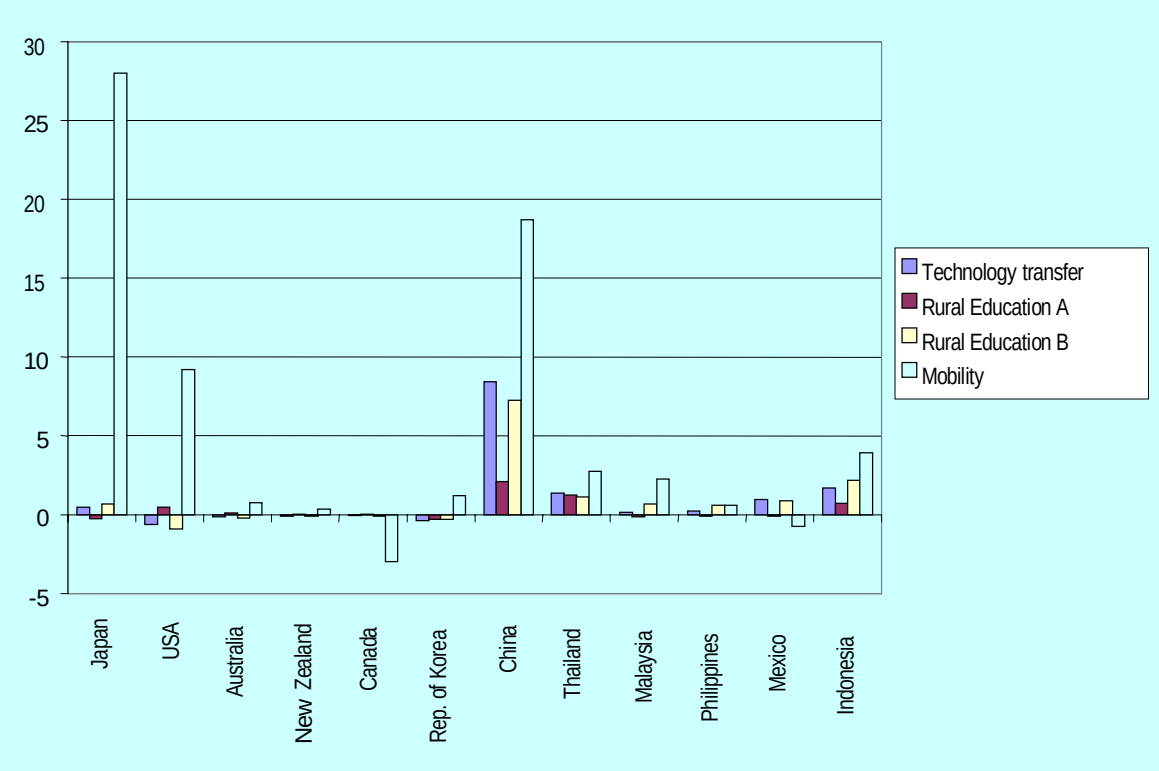
Table 6. Projected nominal factor returns with food sector trade liberalization by 2005
(Percentage change from baseline)

Region	MFN liberalization			Preferential APEC			MFN reciprocating		
	AGL	LAB	SKL	AGL	LAB	SKL	AGL	LAB	SKL
Australia	9.3	0.0	0.2	18.5	0.8	1.0	20.7	2.7	2.9
New Zealand	20.9	-0.5	0.0	59.1	0.5	1.5	72.9	8.9	8.7
Japan	-25.6	-0.4	-0.4	-21.1	-0.1	-0.1	-21.6	1.6	1.6
Republic of Korea	-7.6	-0.2	-0.5	-4.4	-0.1	-0.3	-4.3	1.7	1.5
Indonesia	-2.0	-0.4	-0.4	-0.9	-0.2	-0.2	0.2	1.4	1.5
Malaysia	-3.6	1.6	1.7	1.4	0.9	0.9	12.1	4.1	4.8
Philippines	-6.4	0.2	-0.1	-0.1	-0.3	-0.2	-3.2	1.5	1.5
Thailand	-5.6	1.0	0.9	-1.2	1.1	1.1	1.2	3.2	3.2
China	3.6	-0.6	-0.5	2.4	-0.4	-0.3	7.6	1.1	1.3
Canada	-18.3	-0.3	-0.3	-15.8	0.1	0.0	-10.2	1.9	1.8
United States	-9.8	-0.3	-0.3	-5.8	0.0	0.0	1.6	2.1	2.0
Mexico	-6.9	-0.2	-0.1	-5.2	0.1	0.2	-4.0	1.9	2.0

Source: Gilbert, Scollay and Wahl (1999).

AGL = agricultural (rural) labour.
LAB = unskilled (non-agricultural) labour.
SKL = skilled labour.

Figure 3. Welfare gains associated with capacity-building measures ($ billions)



welfare effects arising from liberalization alone. The welfare changes relative to baseline for each simulation are presented in table 7, which can be compared directly with table 5. Similarly, the impact on divergence between agricultural and non-agricultural incomes is shown in figure 4, while details of changes in nominal factor returns are presented in table 8, which can be compared directly with the first three columns of table 6.

To allow a clearer focus on the effects on agricultural unskilled labour, table 9 extracts the data for this category alone from the more comprehensive data provided in table 8.

1. Technology transfer

The first thing to note about technology transfer is very clearly seen by comparing the welfare results. As might be expected, technology transfer has the clear effect of evening out the discrepancy in the size of gains accruing to APEC developing and developed members. Simulations of this kind can throw some light on the possible magnitude of this effect. The results also show that the total gains expand substantially. Total welfare gains to developed economy members fall only marginally, while those to developing economies rise substantially. Technology transfer is thus shown to play a clear role in ensuring that the benefits of implementing the AFS proposal are spread more evenly among APEC member economies.

In terms of income divergence, figure 4 shows that technology transfer does have the effect of improving agricultural wages relative to liberalization alone in the developing economies, but this positive effect is not strong enough to outweigh the impact of liberalization and restore agricultural wages to baseline levels. The simulations thus indicate that technology transfer, while helpful in evening out gains across APEC economies, is unlikely to provide a complete answer to the impact of liberalization on agricultural wages.

Table 7. Estimated welfare impact of AFS
(MFN basis – Capacity-building scenarios, $ billions)
(Increases compared to MFN basis indicated by figures in bold)

Region	MFN alone	Technology transfer	Rural education A	Rural education B	Mobility
Australia	3.91	3.80	**4.00**	3.72	**4.67**
New Zealand	1.60	1.55	**1.62**	1.55	**1.97**
Japan	34.02	**34.50**	33.80	**34.68**	**62.02**
Republic of Korea	-1.42	-1.79	-1.70	-1.72	**-0.22**
Indonesia	-0.40	**1.30**	**0.34**	**1.77**	**3.55**
Malaysia	3.85	**4.00**	3.72	**4.54**	**6.09**
Philippines	1.66	**1.91**	1.61	**2.25**	**2.24**
Thailand	6.66	**8.04**	**7.91**	**7.78**	**9.42**
China	7.46	**15.90**	**9.58**	**14.72**	**26.15**
Canada	1.09	1.06	**1.13**	1.01	-1.88
United States	7.81	7.20	**8.28**	6.92	**17.03**
Mexico	0.60	**1.56**	0.53	**1.50**	-0.13
Other APEC	4.44	**5.77**	4.03	**5.11**	**5.50**
Europe	-11.53	**-11.32**	-11.67	**-11.11**	**38.56**
ROW	9.68	7.50	7.04	6.52	**21.78**
APEC developing	24.27	**38.48**	**27.72**	**37.67**	**52.82**
APEC developed	47.01	46.32	**47.13**	46.16	**83.59**
APEC total	71.28	**84.80**	**74.85**	**83.83**	**136.41**
World	69.43	**80.98**	**70.22**	**79.24**	**196.75**

Source: Gilbert, Scollay and Wahl (1999).

Figure 4. Rural–urban income divergence associated with capacity-building measures

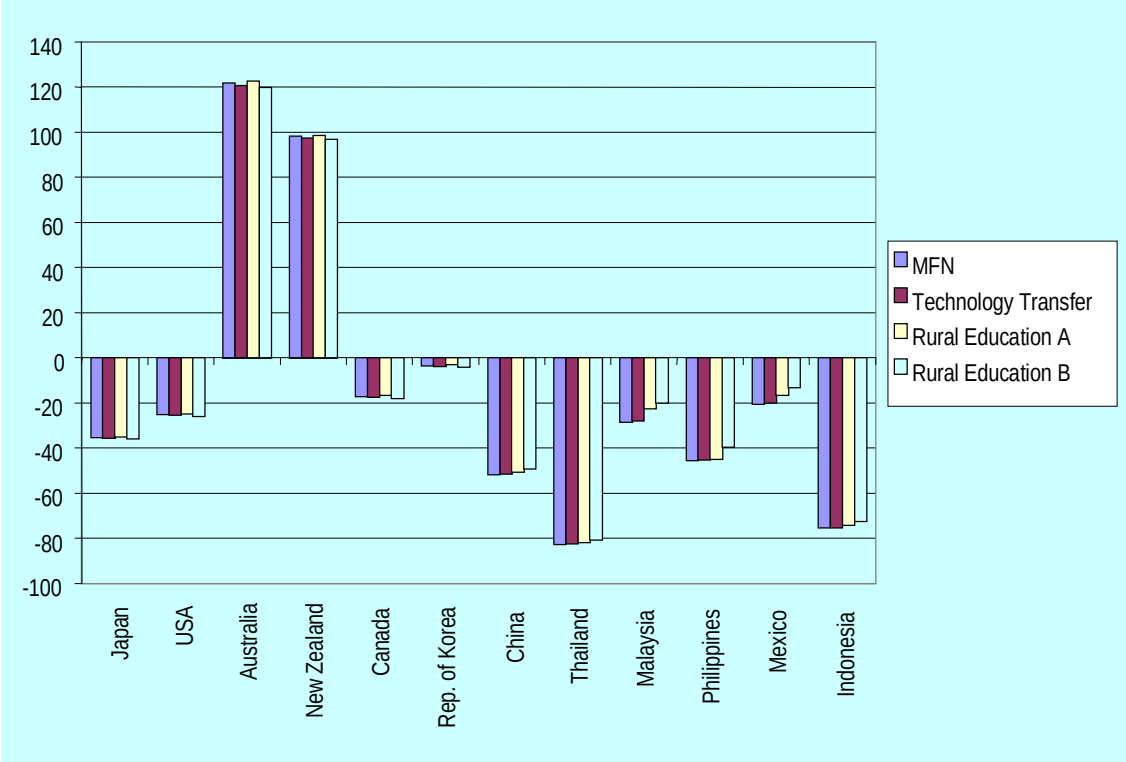


Table 8. Nominal factor returns with MFN food sector liberalization + capacity-building measures
(Percentage change from baseline)

	Technology transfer			Rural education A			Rural education B			Mobility		
	AGL	LAB	SKL	AGL	LAB	SKL	AGL	LAB	SKL	AGL	LAB	SKL
Australia	8.9	0.1	0.2	9.7	0.0	0.1	8.4	0.1	0.2	-48.6	4.3	4.4
New Zealand	20.4	-0.5	0.0	21.2	-0.5	0.0	20.2	-0.4	0.0	-35.0	5.8	6.5
Japan	-25.8	-0.2	-0.2	-25.4	-0.4	-0.5	-26.1	-0.2	-0.2	14.7	-0.6	2.0
Republic of Korea	-7.7	-0.1	-0.4	-7.3	-0.3	-0.5	-8.0	-0.1	-0.3	-4.0	0.0	1.7
Indonesia	-1.1	-0.1	-0.1	2.1	-1.1	-0.3	9.7	-0.1	-0.1	152.2	-39.7	-4.9
Malaysia	-2.6	1.9	2.0	4.0	1.3	1.7	8.5	2.1	2.2	30.5	-1.6	3.9
Philippines	-5.7	0.4	0.1	-5.5	0.1	-0.1	4.2	0.6	0.3	49.3	-16.2	2.7
Thailand	-4.9	1.2	1.2	-1.9	-0.4	0.9	4.9	1.2	1.2	176.7	-47.6	-2.6
China	4.4	-0.4	-0.2	5.6	-1.4	-0.4	9.9	-0.4	-0.1	39.4	-34.4	0.7
Canada	-18.7	-0.3	-0.2	-17.9	-0.4	-0.3	-19.1	-0.2	-0.2	-1.3	-0.5	0.9
United States	-10.1	-0.3	-0.2	-9.4	-0.4	-0.3	-10.6	-0.2	-0.2	20.7	0.0	1.7
Mexico	-6.1	0.0	0.1	-2.5	-0.6	-0.1	2.1	0.1	0.2	9.6	-7.0	1.3

Source: Gilbert, Scollay and Wahl (1999).

AGL = agricultural (rural) labour.
LAB = unskilled (non-agricultural) labour.
SKL = skilled labour.

2. Rural education

Rural education policies are likely to form a key part of any strategy to alleviate rural poverty. Consider first the welfare results for Rural Education A, which corresponds to improved accessibility to education (see appendix 2 for details). By comparing the relevant columns in tables 5 and 7 it can be seen that this improves the overall welfare gains from liberalization for both developed and developing APEC economies, with the additional benefit for developing economies being slightly greater than for developed

Table 9. Comparison of projected returns to unskilled agricultural labour under food sector liberalization + capacity-building measures
(Percentage change from baseline)

		MFN plus			
Region	MFN alone	Tech. transfer	Rural Ed. A	Rural Ed. B	Lab. mobility
Australia	9.3	*8.9*	**9.7**	*8.4*	*-48.6*
New Zealand	20.9	*20.4*	**21.2**	*20.2*	*-35.0*
Japan	-25.6	*-25.8*	-25.4	*-26.1*	**14.7**
Republic of Korea	-7.6	*-7.7*	-7.3	*-8.0*	-4.0
Indonesia	-2.0	-1.1	**2.1**	**9.7**	**152.2**
Malaysia	-3.6	-2.6	**4.0**	**8.5**	**30.5**
Philippines	-6.4	-5.7	-5.5	**4.2**	**49.3**
Thailand	-5.6	-4.9	-1.9	**4.9**	**176.7**
China	3.6	**4.4**	**5.6**	**9.9**	**39.4**
Canada	-18.3	*-18.7*	-17.9	*-19.1*	-1.3
United States	-9.8	*-10.1*	-9.4	*-10.6*	**20.7**
Mexico	-6.9	-6.1	-2.5	**2.1**	**9.6**

Source: Gilbert, Scollay and Wahl (1999).

Note: Figures for "MFN plus" in italics indicate falls relative to MFN liberalization.
Figures for "MFN plus" in bold indicate rises relative both to MFN liberalization and baseline.
Other figures for "MFN plus" indicate rise relative to MFN liberalization only.

economies. However, the incremental welfare changes for developing economies generated in the simulations are somewhat less than those associated with technology transfer.

With respect to the divergence between agricultural and non-agricultural wages, in this experiment the scarcity of agricultural labour is being increased by allowing part of it to enter the skilled labour category. The results are quite encouraging, in that they suggest that the declines relative to baseline in agricultural wages caused by liberalization both in the developing APEC economies and in most developed APEC economies could be substantially offset by improving the access of the agricultural labour force to higher education. In some developing economies, for example Indonesia and Malaysia, such policies would be more than enough to eliminate the negative effects of liberalization on agricultural wages, so that agricultural wages actually rise relative to baseline. In other economies the extent of the fall in agricultural wages relative to baseline falls is sharply reduced.

Rural education policies of type B (involving increasing land productivity – see appendix 2 for further details) have a similar effect in this model. Consider first the welfare results. Like the other policies considered so far, capacity-building measures of this kind have the effect of both expanding the total welfare gains for APEC economies and evening out the gains associated with the AFS across APEC economies. Total gains for developing APEC economies rise sharply, offset only to a minor extent by a slight drop in the welfare gains accruing to developed member economies.

In all developing APEC economies this type of measure also has a strong positive effect on agricultural wages, sufficient to offset the effect of liberalization and ensure that agricultural wages actually rise relative to baseline. It is emphasized that this needs to be interpreted cautiously, however, since returns to land fall substantially relative to baseline under this simulation. Since it is not unreasonable to expect that a considerable proportion of rural household incomes is derived from returns to land, the overall effects on the rural sector are ambiguous. In general, technological improvements biased towards specific agricultural factors are likely to have ambiguous results for agricultural incomes, although society as a whole will benefit. One general policy conclusion can be inferred. If the benefits to society of agricultural productivity improvements are to be shared by rural households, measures to increase the mobility of agricultural labour may well be indispensable in some cases. This is the final issue considered.

3. Enhanced labour mobility

It is not necessary to show in figure 4 the impact on wage divergence generated in the simulation incorporating the assumption of complete labour mobility. Agricultural wages are now constrained to equal non-agricultural wages, and hence income inequality among unskilled workers is eliminated in all APEC economies by definition. In all APEC economies except Australia and New Zealand the impact on agricultural wages is positive, and sufficient to more than offset the negative wage impact of liberalization in all cases except the Republic of Korea and Canada. In Australia and New Zealand, of course, full labour mobility eliminates the wage differential in favour of unskilled agricultural labour.

Welfare gains to APEC overall are also expected to be substantially higher with full factor mobility (figure 3). Compared with the impact of liberalization alone, the economic welfare gains more than double for APEC developing economies and increase by a factor of almost 80 per cent for developed economies.

The policy conclusion suggested by this result is that if wage divergence is considered to be a problem, the most effective solution is to encourage full labour mobility under a flexible wage system. In the context of APEC

developing economies, the set of policies to achieve this will clearly include measures to develop alternative non-agricultural employment opportunities in rural areas. These measures could be combined with education and retraining schemes as discussed above, job-matching systems, or other labour-market efficiency-enhancing measures.

VIII. CONCLUSIONS

The approach developed in Gilbert, Scollay and Wahl (1999) shows some promise as a way of exploring the distributional implications of trade liberalization, and of exploring also the ways in which capacity-building measures may modify the outcome of trade liberalization, both for overall economic welfare and for income distribution. In order to develop practical applications of the approach more detailed specifications of capacity-building measures and ways to measure their impact on productivity will be needed.

However, even the results of the experimental simulations reported here, which as noted earlier are essentially thought experiments with numbers, are quite suggestive. In the APEC context they indicate the potential of appropriately selected capacity-building measures to complement and enhance the benefits of food sector trade liberalization, and to ensure a more even distribution of those benefits both within and between economies. This may not be particularly surprising, but the extended CGE approach appears to have considerable potential for modelling these effects in a single model together with the trade liberalization measures themselves, thereby allowing a range of policy combinations and their implications to be explored and compared. By way of illustration, the results show that if capacity-building measures have the effect on productivity assumed in the simulations, the overall welfare gains to APEC economies as a group are invariably increased, and for each individual economy there is at least one type of capacity-building measure which if combined with food sector trade liberalization will lead to improved levels of economic welfare. The simulations also allow quantitative exploration of the effectiveness of capacity-building measures in helping to even out the distribution of benefits between developed and developing APEC economies.

The ability to model the effect on the wages of unskilled agricultural workers of various combinations of trade liberalization and capacity-building measures is another useful feature. A key policy concern is likely to be the scope under various policy combinations for offsetting the expected negative impact of liberalization on the wages of unskilled agricultural workers. In these simulations all APEC economies can achieve at least a partial offset, and for all APEC economies except Canada and the Republic of Korea the simulations for at least one of the types of capacity-building measures produced a strong enough impact on agricultural unskilled wages to ensure that they rise relative to baseline, thus more than offsetting the impact of liberalization.

The results do also indicate that not all capacity-building measures are likely to be successful in raising agricultural wages, and that selection of appropriate measures will therefore be important. In particular, technological improvements in agriculture can be a two-edged sword. They may need to be accompanied by other policies (income redistribution or mobility enhancement) to ensure that agricultural labour is in fact able to appropriate the benefits of increased productivity. The results provide strong quantitative support for the view that policies to enhance labour mobility, for example by improving the access of the rural unskilled to the education process and/or to alternative employment opportunities, are likely to make the most important contribution to minimizing upheaval in the rural sector, and to maximizing the benefits of liberalization.

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APPENDIXES

Appendix 1
Model details and methodology

The model used in Gilbert, Scollay and Wahl (1999) is a customized version of the multiregional CGE model known as MRT, detailed in Rutherford (1998). The base MRT model is a perfectly competitive, static model of a well-established form. Like virtually all applied trade models, its major departure from the models of neo-classical trade theory is the use of the Armington assumption, differentiating goods by location. This allows the model to explicitly track bilateral trade. GTAP-4 production and modified GTAP-4 Armington elasticities are incorporated into the model, since the standard MRT model uses Cobb-Douglas production functions and Armington elasticities which are invariant across sectors. The values of the Armington elasticities are doubled at both the source-domestic and source-source levels. As in Anderson et al. (1997), this is justified on the ground that the existing Armington elasticities are too small to accurately predict changes in trade shares in backcasting exercises.

A major difference between this model and the others cited above (in particular that used in Scollay and Gilbert 1999b) is that here unskilled agricultural labour is treated as a distinct factor of production, which is mobile between agricultural industries, but is not a substitute for non-agricultural unskilled labour (skilled labour is assumed to be mobile across all industries). This is an extreme assumption, but it facilitates a meaningful discussion about the dichotomy between agricultural and non-agricultural labour incomes (Coyle and Wang (1998a, 1998b) also separate agricultural and urban labour, although their focus is not on factor incomes). Without this assumption agricultural and non-agricultural unskilled labour incomes would equalize, as in the standard specification. The standard specification and this alternative can therefore be regarded as bounds on the potential for divergence between rural and urban unskilled labour incomes. The effect of allowing for complete mobility is considered in the section on enhanced labour mobility (p. 23). Note that the terms "agricultural labour" and "rural labour" are used interchangeably, although there is not a one-to-one correspondence between the two.

Factor returns in the GTAP database are normalized to unity in the base year. It is, however, possible to calculate the actual wage by skilled/unskilled category using the body count data in Liu et al. (1998). These data are supplemented with information on agricultural labour body counts from the 1998 *Japan Statistical Yearbook* in order to obtain consistent measures of the average agricultural wage.

The main driving force behind changes in factor incomes in this type of model is the Stolper–Samuelson effect, whereby an increase (decrease) in the price of a good implies an increase (decrease) in the return to factors used intensively in that good's production. However, the fact that not all factors are perfectly mobile implies that endowment levels will also have an effect on factor incomes, since their existence eliminates the unique correspondence between factor and good prices observed in the Heckscher–Ohlin framework. Diverging growth rates of factors therefore have a substantial effect over time.

The base model is also modified to include a simple recursive-dynamic structure by allowing investment to augment the (depreciated) capital stock at the end of each period, where investment is assumed to be a constant share of income. This approach has a significant advantage over static simulations in that it allows the capture, albeit in somewhat crude form, of the dynamic changes in income that

result from investment expansion with trade liberalization. The recursive-dynamic approach also gives access to tools with which effects of the capacity-building elements in the AFS agenda can be examined. For example, the effect can be observed over time of policies designed to enhance the mobility of unskilled labour, or "upskilling" of rural or urban unskilled labour populations. Also, more generally, by projecting the structure of the world economy at the time when the liberalization is actually likely to occur, a more realistic measure of the potential impact can be obtained.

In describing the dynamic path of the model, exogenous estimates are incorporated of the growth rates in factors of production other than capital, and total factor productivity. Allowance is also made for movement between the unskilled (initially only urban) and skilled labour categories, again based on exogenously specified projections. The assumed growth rates used in the endowment and technology projections for the base year, which are based on a combination of existing projections and historical trends, are detailed in Gilbert, Scollay and Wahl (1999). Labour growth rates are assumed to apply to both agricultural and non-agricultural unskilled labour equally. Changes in endowment ratios over time are the main source of shifting comparative advantage in the model (for example, one expects to see countries with rapidly expanding capital stocks shift production into capital-intensive industry over time).

The inter-period linkage equations differ somewhat from those in many existing recursive-dynamic studies in that existing trend variables are not allowed to remain constant over the simulation period. In particular, the assumption is made that rates of technological progress in developing economies will gradually slow to developed economy levels as their per capita incomes approach developed economy levels. A similar assumption is made with respect to growth rates of the labour stock (in both cases the average parameter in developed economies is taken as the target). While the approach may seem somewhat arbitrary, it is also arbitrary to leave the parameters unchanged regardless of income levels, and this approach captures a widely accepted stylized fact of development. In the case of skilled labour, in all economies the rate of growth in this factor exceeds that of the labour force overall in the base year, implying a degree of upskilling (i.e. movement from the unskilled to the skilled category over time). Keeping this differential in the growth rates constant over time, as some other models do, may seriously distort the model outcomes with respect to factor incomes. In an initial simulation this assumption resulted in several economies having unskilled labour paid more than skilled labour by the end of the 11-year simulation period. While it is possible to think of reasons why this may happen (indeed, this is the case in the original base-year data for Canada, a point noted by Liu et al. 1998), it is a result which seems unlikely to hold in general. The alternative assumption is therefore made that the rate of increase in skilled labour depends in all economies on the relative wage differential between skilled and unskilled labour. As the relative wage approaches one (arbitrarily 1.25 in Canada), the differential between the rates of growth of the two factors approaches zero. The returns remain endogenous, but the assumption has the effect of dampening extreme movements over time, since factor supplies respond to changes in relative returns (whether caused by growth or liberalization shocks) in subsequent periods.

Table 2d in Gilbert, Scollay and Wahl (1999) details the growth rates in real GDP in the base year that the interactions between the changes in endowments and technology improvements imply. Note that, unlike in some other studies, growth rates in this study are determined within the model, since investment is a function of income, and hence will change from year to year in response to shocks to the economy. However, the growth assumptions are neo-classical in form (the dynamic structure is similar to that used in many theoretical neo-classical trade models) and therefore shifts in the growth rate are only temporary – the

economies should eventually return to a steady-state growth path. Note that the growth rates presented in table 2d of Gilbert, Scollay and Wahl (1999) are not the steady-state growth rates. Furthermore, the assumptions underlying growth in the model also imply a gradual convergence of economies to similar growth rates as their incomes reach similar levels.

Finally, the baseline projections account for the implementation of the three major existing trade liberalization agreements which will have an impact on the region – the Uruguay Round Agreements (assuming accession by China and Taiwan Province of China), NAFTA and AFTA. Each of these agreements is assumed to be implemented as a sequence of linear reductions in the appropriate tariff and non-tariff barriers over the assumed implementation period (1995–2000 for the UR Agreements, 1995–2001 for NAFTA and 1995–2008 for AFTA). While a number of previous studies have accounted for the UR Agreements and NAFTA, none (with the exception of Scollay and Gilbert (1999)) has similarly accounted for the AFTA agreement. The figures presented here for welfare and income changes that compare to the baseline thus capture only the impact of additional liberalization by APEC economies.

Appendix 2
Method for simulating capacity-building measures

Technology transfer

Technology transfer is simulated in the model by allowing the rate of technical progress to expand by 10 per cent over the AFS implementation period in APEC developing economies (defined as those economies with per capita GDP of less than $5,000). Total factor productivity parameters are augmented only in the agriculture and food processing sectors. The 10 per cent figure is, of course, entirely arbitrary – no information was available as to what the impact of capacity-building measures on technical progress would be. The simulations are intended only to assist in understanding the likely effect of a temporary increase in productivity growth as developed APEC members transfer their food technology to their developing partners. The costs associated with enabling technology transfer are not accounted for. In a more complete treatment these costs would need to be weighed against the potential benefits.

Rural education

Rural education policies are likely to form a key part of any strategy to alleviate rural poverty. In the model framework in Gilbert, Scollay and Wahl (1999) there are two approaches which can be used to consider the impact of rural education programmes. The first is to alter the model dynamics such that upskilling can take place from both the urban unskilled and the rural unskilled. This could be thought of as emulating policies that increase the availability of education to rural areas (accessibility policies). This is called experiment A, which specifically considers a situation where the rate of upskilling from the rural area is equal to that from the urban area in developing economies (an equal opportunity scenario). The second possible approach to simulating the effect of rural education is to alter the level of factor productivity of the rural sector directly, using biased technical changes as opposed to the Hicks-neutral shocks used in the above section. Care is needed here, however. There is a choice between treating rural education as teaching rural workers how to make better use of land (in which case the productivity of land is improved), and treating it as improving the productivity of agricultural labour in agricultural activities. The choice has important consequences for the returns to rural labour since a biased technical change with fixed factor supplies is like an expansion of the relative quantity of the factor, which will generally cause the relative factor return to decline (as productivity rises less of the factor is required to produce a given level of output, although overall of course incomes are expected to rise). In Gilbert, Scollay and Wahl (1999) education policies are modelled as a land-augmenting technical change. This is called experiment B, which incorporates a 1 per cent rate of labour-augmenting technical progress in agricultural land use in developing economies. Once again, the costs associated with implementing these policies would need to be weighed against the benefits generated in the simulations.

Enhanced labour mobility

Since labour movement between sectors is fundamentally a response to the higher incomes paid in one sector compared with another, it would be possible to allow an endogenously determined rate of inter-sectoral movement in response to changes in relative prices (in much the same way as upskilling is allowed between unskilled and skilled labour categories). Coyle and Wang (1998a, 1998b) use a similar technique which sets the rate of

migration to drive the wage differential to zero over time. In any case, effects would be similar to those observed in the upskilling simulations (experiment A) described above: movement between sectors will tend to drive down wages in one sector and drive them up in another – in other words, the movement between sectors will tend to reduce income divergence. In Gilbert, Scollay and Wahl (1999) these long-run effects of inter-sectoral labour movement are illustrated with reference to another bounding scenario – where agricultural labour and non-agricultural unskilled labour are assumed to be perfect substitutes. This corresponds to perfect intersectoral mobility.

Appendix 3
Interpreting the income-divergence indicator

The CGE model used in Gilbert, Scollay and Wahl (1999) projects the percentage changes associated with various policies on the per-unit incomes of different classes of labour (agricultural unskilled, urban unskilled and skilled). This percentage change is converted to an actual nominal return per unit (in this case thousands of $1,995 per annum, per worker). The data used to make these calculations and the actual nominal incomes projected are detailed in Gilbert, Scollay and Wahl (1999). A summary statistic called the income-divergence indicator is used as a way of presenting the relative movements in rural and urban unskilled labour incomes as indicated in the results.

The income-divergence indicator is calculated by taking the rural unskilled wage as a percentage of the urban unskilled wage, and subtracting 100. This measure allows an indication to be given of the degree and direction of divergence. Negative figures correspond to rural labour being paid less the urban labour, and positive figures the opposite. Zero indicates equality. The greater the divergence of the index from zero, the greater the degree of income inequality.

For example, in figure 2 the index figures for 1995 are shown. These represent the actual degree of divergence in that year. The series labelled "Base 2005" is the projection of the degree of divergence by 2005 under the baseline scenario. The third series, labelled "MFN 2005", is the projection of the degree of divergence by 2005 assuming that the food sector trade liberalization is implemented on an MFN basis, with no concurrent capacity-building measures.

Note that in figure 4 figures are not presented for the final capacity-building scenario – complete mobility between rural and urban unskilled labour. The reason for this is that complete mobility ensures that the incomes are the same, and hence income divergence is eliminated by definition.

It should be noted that the factor income figures are derived from average incomes; hence the projections are for what happens to the divergence of average incomes. In general, the income level of any individual worker will be related to his or her productivity.

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