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Trans-Tasman CGE Modelling: Some illustrative results from the Joani model

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TRANS-TASMAN CGE MODELLING:

Some illustrative results from the Joani model

G Nana, V B Hall and B P Philpott*

CONTENTS

Abstract

A two country multi-sectoral computable general equilibrium model for New Zealand and Australia is developed and applied to explore issues concerning the effects of the CER-induced tariff reductions and related topics. A comparison with a similar short-run exercise conducted in 1988 records minimal gains from a 1990 starting position as data shows little remaining protection to be removed. The removal of all protection arrangements with respect to imports from outside the CER region results in over 1% extra GDP in the short run. However, this figure is doubled in both countries in the longer run as further gains from the re-allocation of capital resources amongst the sectors within each country are experienced. In interpreting the model results the critical nature of the assumptions incorporated within the model closure is discussed. Alternative assumptions addressing questions of inter-country capital mobility as well as exchange rate determination are examined.

Key words: CGE modelling, trans-Tasman CER, protection

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I Introduction

This paper presents new results from the *Joani* computable general equilibrium (CGE) model of the New Zealand and Australian economies and can be viewed as both updating and extending the trans-Tasman Closer Economic Relations (CER)[1] modelling exercise of Philpott & Nana (1988). In that 1988 report the *Joani* model, constructed from the existing *Joanna* and *Orani* single country models, was described[2] and used to explore the effects of varying tariff regimes. This was based on 1984/85 trade and protection data and the model experiments, therefore, captured a movement from early CER times to a post-CER regime. Also explored were alternative policies as to protection in relation to imports from outside the region.

That research found GDP and consumption gains for both countries arising from the reduction in trade barriers. The gains to New Zealand, however, were larger than those to Australia. The differential in the gains was attributed to two reasons. Firstly, the greater influence of trans-Tasman trade in NZ's total trade, compared to that for Australia, ensured that the CER reduction in protection had a wider impact and secondly, the then higher levels of existing protection in NZ meant that their removal led to a greater cost reduction (ie competitive gain) than that experienced in Australia.

In addition to asking similar questions using the latest available data, this new study extends the analysis to issues relating to protection from non-CER imports along with exploration of longer-run issues concerning factor mobility and exchange rate adjustments.

Updated versions of both the *Joanna* and *Orani* models (with the models' input-output data now being based on the 1986/87 year) have been incorporated, along with new trade and protection data relating to 1990/91 and a new *Joani* model generated. In addition to this new data, the *Gempack* suite of CGE model construction and solution programs[3] was used to convert the model from its previous mainframe residence to one available for use on (sufficiently powerful) PCs and Macintoshs. The use of *Gempack* also allows access to the multi-step and extrapolation solution options, thus reducing the "linearisation" errors inherent in a model (such as these) of the Johansen type. An outline of the model's structure and the economic influences it captures is given in the next section.

In section III, several sets of illustrative results are presented and discussed. Each simulation requires a comparative static interpretation. That is, the model results do not provide forecasts of the respective economies but, rather, they measure changes (in GDP, exports, relative prices, and so on) arising from the policy change or shock under investigation. In this paper the policy changes analysed relate to various import protection regimes and the model measures should be viewed as in addition to those that would occur in the absence of that policy change. Thus the comparison is between two particular economic situations - one a baseline outcome without the shock, the other a scenario where a shock is imposed. The model results reflect the difference between these two outcomes. The model produces measures at both the macro and the sectoral level but, for the sake of brevity and bearing in mind the illustrative nature of the simulations, the presentation and discussion in section III refers, primarily, to the macro picture[4].

Along with examining the effects of updating the database, section III also presents several model simulations addressing the policy options of "CER-only" versus "total free trade" (zero protection). In addition the short-run impacts are contrasted with the long-run aspects and alternative assumptions surrounding exchange rate determination and the country-specific nature of capital resources are explored.

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1 See Lloyd (1991) for an exploration of some of the key empirical economic issues still requiring analysis in the CER area.

2 For a detailed listing of *Joani's* data base and equations see Nana & Philpott (1988).

3 See Codsi & Pearson (1988) and Pearson (1988) for an overview of the *Gempack* package.

4 Details at the sectoral level are available upon request.

II The *Joani* model

This model is based principally on two existing models - viz, *Orani* of Australia and *Joanna* of New Zealand - which have been developed independently by the Impact Project and the RPEP, respectively[5]. These two models are similar in concept and practice[6] - both being working versions of Johansen-type, multi-sectoral, input-output based, computable general equilibrium models. They are designed to simultaneously determine and respond to relative price/cost and resource shifts as well as new demand patterns arising from an economic shock or policy change.

The interfacing of these two models to create *Joani* - one model of the NZ-Australia economic system - is theoretically based on the works of Vincent (1983) and Meagher (1982). Those two papers describe the equation structure of a generalised multi-country, Johansen-type model. The *Joani* model was to the authors' knowledge the first working model, using actual data, based on this structure.

In essence, the interfacing requires separately identifying three sources and destinations for each country's products (namely home, the trans-Tasman CER partner and the rest of the world) as opposed to the two (home and overseas) incorporated in the individual models. Sectors' and consumers' production and consumption decisions can, thus, reflect changes in the relative competitiveness of NZ and Australian goods vis-a-vis each other and, also, with respect to the rest of the world's products.

The interdependencies of the two economies are explicitly incorporated within the model, ensuring the equivalence (at the disaggregated sectoral/commodity level) of NZ exports to Australia to the latter's imports from the former - and vice-versa. Similar equivalence in the prices of trans-Tasman exports and imports ensure the transmission of cost as well as demand influences across the Tasman Sea, in both directions.

The construction of *Joani*, therefore, required substantial data, at a disaggregated level, as to NZ and Australian trade flows. Considerable processing was undertaken to build a database conforming to input-output[7] concepts. In addition, issues concerning sectoral concordance between ASIC and NZSIC[8] and associated commodity classifications had to be settled. For reasons of data and resource availability this *Joani* model has been constructed at the 22 sector level.

The actual relationships (equations), which simulate the behaviour of economic agents[9] and highlight the linkages between them, that make up the *Joani* model are far too numerous to describe here individually. However, a descriptive outline of the major "blocks" of equations is given below. It should be noted that, although described in general terms, these equations are specified individually at the sectoral and/or commodity level. In addition a schematic outline of the principal relationships captured by the model is given in the appendix.

As is the case for the two individual models, the *Joani* variables are expressed, and solved for, in percentage change form. The model's solution provides a picture of the economy after it has reached a new general equilibrium[10] position following a particular policy change, package or

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5 See Dixon, Parmenter, Sutton & Vincent (1982) and Nana & Philpott (1983).

6 The major difference, in practice, between the two models is one of size - *Joanna* consists of 22 sectors while *Orani* has 112.

7 Input-output concepts require information as to the end-user(s) of the import - the Broad Economic Category (BEC) classification helped here.

8 The respective Standard Industrial Classification for each of Australia and New Zealand.

9 Overall assumptions of profit maximising producers and utility maximising consumers form the basis of the simulation of agents' behaviour.

10 Here, "general equilibrium" implies the clearance of all commodity and factor markets (although the existence of unemployed labour and/or surplus capacity can be incorporated where desired).

set of events. This "picture" is shown as percentage changes in numerous economic variables or indicators - for example, output, consumption, employment, exports, relative prices.

As indicated briefly in the introduction, the model is designed to analyse the pure effects on the economy of a policy change or set of events. Its results do not provide forecasts of the economies but, rather, they measure the changes in the economies (at both the aggregate and sectoral levels) arising from the change or events under investigation. The changes measured by the model, therefore, should be viewed as in addition to those that would occur in the absence of the change under investigation.

Closure

The *Joani* model is a set of simultaneous equations where the number of variables exceeds the number of equations. In all simulations the values of some variables are not determined within the model but are set externally. These variables are termed "exogenous". Information describing the policy change or shock under investigation enters the model by setting exogenous variables at appropriate values. Variables determined within the model are termed "endogenous".

The specification of a variable as either endogenous or exogenous establishes the "environment" within which a model analysis is undertaken and, hence, reflects various assumptions that the modeller has to make to attempt such an analysis. The choice of which variables are exogenously specified in this way is referred to as the "closure" or "environment", in that it contains the (primarily macroeconomic) assumptions under which the shock is simulated. It follows that not only do the correct number of variables have to be specified exogenously, but also that such a group has to make economic sense.

Obviously, variables directly associated with the shock are properly deemed "exogenous" and are set by the user. Other variables placed by the modeller in the exogenous set can be interpreted as being independent of the shock - either being determined by non-economic factors (eg government policy) or by influences not directly captured within the model. These "independent" variables are therefore set at no change, with the interpretation being that their values are not effected by the shock under analysis. It should be remembered, therefore, that any model simulation result reflects:

(1) the effects of the shock,
(2) the relationships incorporated within the model and
(3) the assumptions, implicit in the closure adopted, as to which variables are independent and so not influenced by the shock.

The closure assumptions adopted in this study are detailed at the beginning of section III. Further discussion is also undertaken within section III, where relevant.

Numeraire

Within the *Joani* model there is endogenous determination of relative prices and costs (and the simulation of responses to them) simultaneously with the determination of supply and demand (and, also, the simulation of responses to them). It is important to note, however, that the model does not determine the absolute price level, rather it determines - and responds to - (changes in) prices relative to a "numeraire". This follows from the "standard" Walrasian general equilibrium property that only n-1 of the n market-clearing equations are independent - thus allowing us to determine only n-1 of the prices. The "nth" price is referred to as the "numeraire", and all movements in prices should be interpreted as shifts relative to this numeraire. In the closure set, therefore, at least one "price" variable must be included as exogenous. Note further, that if more than one "price" variable is deemed to be exogenous then the numeraire for that simulation is, implicitly, some "average" of those exogenous price variables.

As a consequence the model is not responsive in real terms to changes in the numeraire - ie it is homogenous of degree zero in real variables and of degree one in prices. In almost all of the simulations presented below, both the Australian and the NZ exchange rates with the rest of the world are set exogenously (as are world prices) and, thus, act as the numeraire in those runs. Thus the model is not concerned with (or responsive to) changes in the world price level (in domestic currency terms) per se, but is crucially responsive to any changes in the level of prices within New Zealand and/or Australia relative to each other and/or relative to the world price level.

Demand for goods & services

(a) Domestic

The demand for each type of commodity, in each country, can be met either by a domestically produced product, one imported from across the Tasman or one imported from another country. The demand for a home-made commodity, therefore, is dependent on its price relative to that of the equivalent products from the other two (imported) sources. Thus there can be substitution towards domestic goods (away from the imported equivalents) in response to any favourable movement in the price of the domestic good. On the other hand, there would be a shift away from home made commodities if the relative price movements favoured one of the imported sources.

Both domestic consumers and producers (the latter in purchasing materials required as inputs for their production activities) are faced with these choices as to the source(s) of their purchases. Such choices are limited by pre-set "substitution elasticities" which reflect either differing tastes and qualities of the good or technological constraints[11].

(b) Imported - from across the Tasman

The same decision procedure determines each country's demand for imports from the other CER partner. The price (to the purchaser) of the trans-Tasman import relative to that of the domestically made product and that of the import from the rest of the world, along with the ease (elasticity) of substitution, are the prime determinants.

(c) Imported - from the rest of the world

Again, the same decision process determines each country's demands from the rest of the world.

(d) Exports - to the CER partner

The amount exported by either country, to the CER partner, is determined by the demand for imports (from across the Tasman) in that other country - (b) above, applies.

(e) Exports - to the rest of the world

Similar decisions as to choice of source(s) are made by "foreign" purchasers to determine the amount exported by New Zealand and Australia to the rest of the world. That is, the purchaser from the rest of the world chooses between NZ-made, Australian-made and "foreign-made" articles responding to movements in their respective export prices, relative to each other. Such choices are subject to commodity-specific substitution elasticities reflecting the varying qualities and characteristics of the goods from the different sources.

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11 The elasticity of substitution between goods from the 3 sources was set at 2.0 for New Zealand and at the weighted average of those in the constituent *Orani* sectors for Australia.

(f) Household consumer demand

Household consumption expenditure is determined within the model, for each country, as functions of total household income in the respective country. Income is, in turn, dependent primarily on wage rates and employment, as well as profit rates and the amount of capital employed.

Own and cross price, and income elasticities of demand ensure that the allocation of consumption expenditure between the various commodities is responsive to changes in the relative prices of those commodities and to changes in incomes, in each country. In addition to these choices, affecting the composition of the consumption basket, are the decisions as to the source(s) of the goods as described above.

(g) Other final demand

Government consumption and aggregate investment expenditure in real terms, in each country, are exogenous to the model.

Demand for factors of production

(a) Labour

Within each country, each sector's demand for labour depends on its level of activity (as determined within the model by the demands for its output) and the sector's response to changes in the price of labour relative to the price of capital, as allowed for within the sector's production technology. The responsiveness of each sector to relative factor price changes depends on the ease of substitution between the factors[12] and the relative importance (share) of the relevant factor in the sector's total requirements of primary factors.

(d) Capital

Similar influences determine each sector's demand for capital. In addition, there is an aggregate capital stock constraint in each country, within which all the competing sectoral demands for capital (within each country) must be met.

As regards additions to the capital stock, real investment is allocated by the model across sectors so as to equate the "expected" rates of return, in each country. These expected rates of return are determined within the model and are dependent on the rental price of capital, the purchase/construction price of new capital goods and the amount of capital being employed in that sector. Investment expenditure in government social services and new house construction, however, are set exogenously in both countries as such rate of return criteria are inappropriate in these cases.

Price of goods & services

(a) Domestic output

The (change in the) price of each sector's gross output, in each country, is determined by the (changes in the) prices of inputs required to produce that output. These are the prices of both material inputs (being other domestic sector's outputs as well as items imported, from the trans-Tasman partner and/or other countries) and factor inputs (labour and capital).

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12 The elasticity of substitution between the factors capital and labour was set at 0.5, in both countries for the short-run simulations reported below, and 1.0 in the longer-run simulations.

Note that the user cost, or rental price, of capital (relative to that in other sectors) changes, reflecting the relative demand for that sector's output and, hence, its ability to attract (or retain) capital resources (within each country's overall capital constraint).

(b) Exports

Similarly, the price of the inputs required to produce the respective export commodity determine its producer price. After allowing for (changes in) any export subsidy/tax the export price of each commodity is obtained.

(c) Imports

The price of items imported into each country is dependent on the export price of the relevant commodity in its country of origin, inter-country transport costs and the price of foreign exchange (ie the exchange rate). Given this c.i.f. price, the purchaser's price of the imports is obtained by allowing for tariffs (and the tariff-equivalents of other protection measures) imposed by each country. Remember, however, that it is changes in price that are relevant to the model, and so it is changes in tariffs and tariff-equivalents that are simulated in the results presented below.

Note, further, that the export prices of goods produced in the rest of the world are exogenous and assumed unchanged.

Price of factors

(a) Labour

If total labour demand, in each country, is assumed to be independent of the policy or changes being modelled then it becomes exogenous, in which case the price of labour becomes determined within the model so as to satisfy these aggregate labour market constraints. On the other hand, if the (real or money) price of labour, in each country, was thought to be independent of the change being modelled then wage rates (real or money) become exogenous, in which case the total labour demand in each country would be determined within the model.

(b) Capital

As mentioned above, the rental price of capital in each sector moves in response to the strength of demand for the sector's output relative to that for other sectors, in each country.

Exchange rates

There are four exchange rates explicitly identified within the model, two for each country - ie one in relation to the rest of the world's currency, and another in relation to the trans-Tasman partner's currency. These can be denoted (where the variables are expressed in percentage change form) as :

ϕ^n_r = the NZ \$'s exchange rate with the rest of the world currency,

ϕ^a_r = the Australian \$'s exchange rate with the rest of the world currency,

ϕ^n_a = the NZ \$'s exchange rate with the Australian \$, and

ϕ^a_n = the Australian \$'s exchange rate with the NZ \$.

Of course, the latter two exchange rates can be determined via the relationships ensuring consistency in the cross-rates, thus:

$$\phi^n_a = \phi^n_r - \phi^a_r$$

and $$\phi^a_n = \phi^a_r - \phi^n_r$$

As to the remaining two exchange rates, however, we are restricted by the absence in the model of a financial/monetary sector. In particular, as financial capital flows are not explicitly modelled there are no behavioural functions explaining exchange rate movements. Therefore, the two independent exchange rates in the model are either:

(1) exogenously specified by the user; or
(2) endogenously determined by the model dependent indirectly on the assumptions implicit in the "closure" selected and the overall general equilibrium implications of the shock under investigation.

All these price, cost and demand responses - given the various own and cross price, income and substitution elasticities - occur simultaneously to produce the model's general equilibrium solution. Such a model solution provides results for changes in numerous economic variables and indicators including output, employment, relative prices, exports and imports, for both countries, at the aggregate and the sectoral levels.

III Illustrative empirical results[13]

Exogenous assumptions

In this section the results of several model simulations are presented and discussed. It is appropriate to reiterate the provisos expressed during the introduction to this paper - namely that these results are of an indicative nature and, further, that the model is designed for comparative static analyses so that the results should not be interpreted as forecasts but, rather, as illustrating the effects of the shocks alone, *ceteris paribus*. In this context, it is imperative to bear in mind the variables held fixed, by assumption; or, in the model jargon, the "environment" within which the analysis is undertaken. Relevant variables deemed exogenous (unless stated otherwise) are:

1) nominal exchange rates
2) rest of world prices
3) real world income - in that this influences the position of world demand curves
4) real government consumption expenditure in each country
5) real aggregate private investment expenditure in each country
6) the real aggregate stock of capital resources in each country
7) real (consumer) wage rates in each country
8) real trans-Tasman transport margins

The assumption concerning exchange rates does not assume a fixed exchange rate regime; rather, that nominal exchange rates are determined by factors external to the model. Hence, the experiment is undertaken assuming that the trade policy changes being modelled have no influence on these "external factors". It should be stressed, though, that the real exchange rate in each country is determined endogenously within the model. Note that an alternative closure concerning the exchange rate nexus is explored as an analysis of the sensitivity of the model findings (see #146 below).

Similarly, placing each country's aggregate capital stock and private investment on the exogenous list implies that the levels of these variables are determined by influences external to

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13 As mentioned in the introduction, the presentation and discussion below concentrates primarily on the macro picture. Sectoral details are available on request.

the model. To do justice in attempting to capture these influences would require, at the least, a fully-fledged inter-temporal dynamic model with, perhaps, monetary sector relationships as well. This, of course, re-emphasises the comparative-static nature of this current analysis. In #145 an alternative closure concerning these investment/capital stock issues is explored.

For some of the simulations both short and long-run results are provided. In the short run individual sectors are unable to alter their level of capital stock, and thus can only adjust output by changing their employment of labour, with the excess planned demand/supply for capital being reflected in varying sector-specific rates of return on the fixed capital available. The long run, however, allows capital to be reallocated amongst sectors, thus ensuring equality in the sectoral rates of return, subject to the aggregate constraint in each country described above.

New data

Results from the first set of simulations are presented in Table 1 below. The first three columns of numbers (labelled CER) represent the effects of removing all protection on intra-CER trade (that is, imports from the CER partner), while leaving unchanged tariff and other protective measures where those relate to imports from outside the region. The first of these columns lists the results of an equivalent simulation from the previous study[14] in order to provide an indication of the importance of the new data base. The final two columns show the results from the removal of all existing protection on imports from both the CER partner and from the rest of the world.

Table 1 (% changes resulting from shock)	CER(1988) short run CER2	CER short run #150	CER long run #140	Tot fr. trade short run #151	Tot fr. trade long run #141
NEW ZEALAND					
Real GDP	0.7	0.1	0.2	1.1	2.2
Consumption	1.4	0.2	0.3	2.7	3.7
Exports	1.3	0.4	0.6	3.2	5.6
Imports	1.8	0.6	0.6	5.3	6.0
Labour employment	0.9	0.2	0.3	1.5	3.2
ΔBoP: with AUS ($m)	171.8	30.5	29.8	-32.0	-76.3
(%GDP)	0.6	0.1	0.1	-0.1	-0.1
with rest of world ($m)	-179.2	-27.6	-15.3	-495.9	-309.5
(%GDP)	-0.6	-0.1	0.0	-0.9	-0.6
Consumer prices	0.6	0.1	0.0	-2.6	-3.5
Current rate of return	n.a.	n.a.	0.5	n.a.	5.9
AUSTRALIA					
Real GDP	0.1	0.0	0.1	1.2	2.3
Consumption	0.2	0.1	0.1	2.1	3.0
Exports	0.7	0.2	0.3	7.4	10.7
Imports	0.6	0.2	0.2	6.8	6.5
Labour employment	0.1	0.1	0.1	1.2	2.7
ΔBoP: with NZL ($m)	-93.3	-42.7	-42.8	24.1	65.3
(%GDP)	-0.1	0.0	0.0	0.0	0.0
with rest of world ($m)	89.3	24.4	42.0	-859.6	-143.7
(%GDP)	0.1	0.0	0.0	-0.3	-0.1
Consumer prices	-0.2	0.0	0.0	-4.5	-5.3
Current rate of return	n.a.	n.a.	0.1	n.a.	6.9

14 From Philpott and Nana (1988). It should be noted that due to refinements of the model's structure this simulation is closely related, but is not exactly comparable, to the new simulations.

It is apparent from a comparison of the first three columns that given the 1990/91 starting point - whereby the majority of the CER program has already been implemented - the further modelling of CER tariff removal is now somewhat redundant and/or uninteresting. There remain marginal benefits to both countries but these pale into insignificance compared to the gains recorded in the 1988 study which indicated nearly 0.7% extra onto New Zealand's GDP in the short term alone. Examination of the detailed results of these two simulations does reveal some "diversion" of trade towards the CER partner away from the rest of the world similar to previous findings but, again, the magnitudes are noticeably smaller.

Hence the adoption of a new starting position (1990/91), along with the new data inherent therein, indicates that implementation of CER (as defined here in terms of trans-Tasman free trade) is already reflected in the model's base data, with only minimal protection remaining to be removed. The impacts recorded by Philpott & Nana (1988) illustrated the movement from an early-CER to a post-CER regime. Of more interest now, therefore, are possible post-CER arrangements and their effects.

"Total free trade" versus "CER-only"

The adoption of total free trade by both countries simultaneously is reflected in the last two columns of Table 1 above. Comparing simulation #151 with #150 shows that the short-run effects of removing all protection from imports are of substantially greater magnitude than for the CER-only position. GDP gains to both countries of greater than one percent and over two percent extra (private) consumption are recorded. The larger proportionate increases in consumption expenditure result from, in part, the assumed constancy of the other components of GDE (investment and public consumption) and are consistent with the increased incomes (in total) flowing to households arising from the increased employment of labour. The latter increase in employment reflects the increased demand for labour resources resulting from the higher overall activity in response to the policy shock. This increased demand is satisfied through a quantity adjustment, remembering that a price adjustment is ruled out given the assumption, incorporated in the closure, of no change in real wage rates.

The overall cost reductions arising from this policy are reflected through the changes in consumer prices in each country, showing Australia benefiting comparatively more than New Zealand. This is essentially a result of the fact that currently existing protection levels are greater there than in NZ, and hence lead (see Table 2, below) to a larger initial fall in import prices when protection is removed.

These cost reductions are also reflected in the trading outcomes of each country. Export volumes from both CER partners increase as their respective products become more price-competitive in world markets. Conversely, however, there is a shift amongst domestic purchasers' to imported items, as they are now relatively cheaper than the domestically-sourced equivalent. It is this large shift to imports that is responsible for the deterioration in the trade balances of both countries. As a percentage of GDP, though, this impact is noticeably greater for New Zealand. Within these aggregate export and import numbers, however, are differences between intra-CER flows and those relating to trade with countries outside the region. These differences can be seen in the results listed in Table 2 below which breaks down these aggregate numbers into their respective components[15].

From these numbers it can be seen that the policy to remove all protection leads to a large relative shift away from trans-Tasman trade in favour of trade with the rest of the world. This, of course, can be reconciled with the relative price shifts resulting from the change. For example, the slight increase in total exports in the CER-only situation consists of an increase in exports destined for Australia of over 4% but a fall in those going to the rest of the world of half a percent, which concurs with the relative price advantage that NZ commodities gain when

15 As mentioned in the outline of the model, the trans-Tasman imports and exports are linked at the commodity-specific level which, when combined using different weights (accentuated by data collation inaccuracies) explain the variances at the aggregate level.

Australia removes protection on goods coming from NZ. Such an advantage is, of course, not available to NZ goods going to other destinations.

The removal of all protection, though, brings the more pervasive effect of an economy-wide reduction in costs; as indicated by the results for consumer prices which are now 2.6% lower in NZ and 4.5% lower in Australia. This improves the price competitiveness of both countries in the world market and overwhelmingly dominates the changes in intra-CER competitiveness reflected in the CER-only situation. The result for both countries is increased exports to the rest of the world.

NZ exports to Australia, on the other hand, suffer from the latter's shift away from both domestically-made and NZ-made goods towards those from the rest of the world. In contrast, Australian exports to NZ manage a slight increase, despite a similar shift within NZ towards goods from outside the region. This is reflected in the results for the purchasers' prices of imports from the two sources. In NZ, the reductions of 5.7% and 8.3% lead to a smaller relative shift (towards the rest of world's goods) than in Australia where the gap between declines of 5% and 10.5% leads to the aforementioned fall in NZ exports to Australia.

Such a contrast, compounded by the fact that CER trade is nearly five times more important to New Zealand than it is to Australia, is further reflected in the stark differences in the outcome

Table 2 (% changes resulting from shock) * = exogenous	CER short run #150	CER long run #140	Tot free trade short run #151	Tot free trade long run #141
NEW ZEALAND				
Exports to AUS : volume	4.4	4.5	-1.3	-1.1
: price	0.1	0.1	-2.3	-3.1
: value	4.5	4.5	-3.6	-4.2
Exports to rest : volume	-0.5	-0.3	4.2	7.1
: price	0.1	0.1	-2.0	-2.9
: value	-0.3	-0.2	2.2	4.2
Total exports : volume	0.4	0.6	3.2	5.6
Imports from AUS : volume	3.4	3.5	1.6	3.3
: purchasers' price	-1.8	-1.8	-5.7	-6.4
: cif value	3.4	3.5	-2.4	-1.4
Imports from rest : volume	-0.1	-0.1	6.3	6.7
: purchasers' price	0.0*	0.0*	-8.3	-8.4
: cif value	-0.1	-0.1	6.3	6.7
Total imports : volume	0.6	0.6	5.3	6.0
AUSTRALIA				
Exports to NZL : volume	3.6	3.6	1.6	3.2
: price	0.0	0.0	-4.4	-5.2
: value	3.6	3.6	-2.8	-1.9
Exports to rest : volume	0.0	0.1	7.8	11.2
: price	0.0	0.0	-3.0	-4.7
: value	0.0	0.1	4.8	6.5
Total exports : volume	0.2	0.3	7.4	10.7
Imports from NZL : volume	5.2	5.3	-1.4	-1.6
: purchasers' price	-2.6	-2.6	-5.0	-5.6
: cif value	5.3	5.3	-3.8	-4.5
Imports from rest : volume	0.0	-0.1	7.1	6.9
: purchasers' price	0.0*	0.0*	-10.5	-10.5
: cif value	0.0	-0.1	7.1	6.9
Total imports : volume	0.2	0.2	6.8	6.5

for each country's balance of payments (BoP) situation[16]. A deterioration for NZ equivalent to one percent of GDP compares with a worsening for Australia of just over a quarter of a percent of GDP.

Thus the movement from "CER-only" to "zero protection covering all trade" yields a sizeable gain to GDP for both countries but heightens the distinction between trade diversion and creation. Noticeably in the case of NZ, the element of diversion is enough to yield a non-trivial deterioration in overall trading performance. Although these conclusions are based on the short-run results, that is comparing #151 with #150, similar findings follow from a comparison of the respective long-run simulations, that is #141 with #140. There are, however, appreciable differences in magnitudes between the long-run and the short-run scenarios.

The longer run

Turning to the effects in the longer term, the easing of the constraint on the availability of capital allows "competitive" sectors to expand output by attracting additional productive resources rather than by using existing capital units more intensively. Thus the expansionary forces engendered by the tariff reductions are not hindered in the long run by steeply rising marginal cost curves. Hence, comparing the two free trade simulations (#141 with #151), it is clear that the gains are greater for both countries when they can enjoy the benefits from the re-allocation of capital towards more favourable sectors.

Such an improvement in the recorded outcome over the longer term is not only evident from the macro expenditure aggregates, but also from the effects on prices and/or costs within each country. In the short term the immobile nature of capital restrained the overall reduction in costs - the cost of imports declined but the cost of capital rose. This influence on prices and costs is muted in the longer term as demands for capital are satisfied by re-allocation from other sectors rather than rationing through higher prices to enforce short-run market clearing. It should be noted that there still remains an element of this cost effect due to the overall aggregate constraint on capital within each country.

A reflection of these effects can be gleaned from the movements in consumer prices, which decline by nearly one percentage point more than in the short run, for both countries. These cost implications have repercussions for the trading patterns of the two countries. Again there are several conflicting influences which occur simultaneously, which add up to the overall outcome as presented.

In general, lower costs in the long run further enhance each country's export performance with respect to the rest of the world. Imports from the rest of the world are subject to two counteracting forces when shifting from the short run to the long run. Firstly, each country's domestically-produced item is now more competitive with the equivalent item from outside the region - the substitution effect. Secondly, however, the overall rise in activity in the long run yields a greater aggregate demand for imports - the income effect. In NZ's case this leads to a slight rise in the long run in non-CER imports over the short-run result - that is, the income effect dominates. On the other hand, the substitution effect dominates in Australia.

Likewise for trans-Tasman trade, there is a substitution and an income effect. The income effect is unambiguously larger in the long run than in the short run for both countries as overall activity is greater. The direction of the substitution effect is not as clear-cut, however, as there are varying influences at the sectoral and commodity level which are masked by the aggregate numbers.

As to the effects on the BoP, each country improves its position in the long run when compared to the short-term outcome, a direct result of their increased competitiveness from the reduced pressure on costs arising from the sectoral re-allocation of capital resources. The net result for

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16 In the model's base, imports from NZ account for just 4.4% of total imports into Australia, while imports from Australia account for 20.7% of NZ's total imports.

trans-Tasman trade shows a worsening in NZ's BoP or, the other side of the coin, an improvement in Australia's BoP.

Overall, therefore, there appears to be clear long-run gains to real activity and competitiveness levels for both countries when moving to a position of zero protection on all imports. Remember that this is from a "post-CER" 1990 starting point. The intra-CER trade patterns, however, highlight possible tensions and the negative BoP effects, particularly for NZ, are sufficiently large not to ignore.

Alternative assumptions

In Table 3 below the outcome of three further model simulations are listed, with #141 described above being repeated for ease of comparison. These simulations explore separate questions; firstly relating to an "intermediate" external protection policy option (#143), secondly an alternative closure assumption regarding the mobility of capital (#145) while, thirdly, the exchange rate assumption is addressed (#146).

i) 15% maximum tariff

The first two simulations here (ie #143 versus #141), contrast the option of both countries imposing a maximum tariff of 15% on items coming into the CER region (while those currently under 15% remain unchanged) with the overall zero protection option. Such a policy would result in a milder gain to GDP and consumption in both countries compared with the zero protection option. This can be traced to the relative price shift induced by the tariff reductions which in this scenario result in consumer prices declining about half a percent in NZ and one percent in Australia. These reductions are noticeably smaller than in the total free trade simulation.

This route, on the other hand, would yield a more favourable impact on each country's BoP situation. Again, various conflicting influences are at work. The aforementioned relative price movements imply a smaller improvement in competitiveness and hence smaller increase in exports to the rest of the world. The substitution effect amongst each country's imports is, again, muddled. In contrast to the total free trade situation, domestic prices have not fallen as much and so one would expect a relative shift to imported items. However, the price of imports from outside the region has also not declined as much, due to the smaller tariff cut. The net effect of these two influences would be determined at the individual commodity level. The income effect, though, in both countries is more muted here as the policy-induced expansion is much smaller. This translates into lower demand for imports with the outcome for the BoP as mentioned.

This option, therefore, may appear to be an attractive intermediate position. But such a policy would leave similar commodities facing unequal tariff levels depending on whether they enter the region through NZ or Australia. Given intra-CER free trade, such a policy would require stringent policing of "domestic-content" criteria, otherwise such tariff inequalities would be open to exploitation.

ii) Capital mobile across the Tasman

The second alternative simulation explores the issue of the determination of aggregate real investment and capital. In #145 each country's aggregate investment and capital stock constraints are relaxed, allowing each to move towards the country with the more favourable rate of return response. There remains, however, an overall CER-aggregate capital and investment constraint. As is shown by the results, the consequence of dropping the assumption of country-specific capital and investment would be a movement of resources towards Australia. This stems directly from the results for each country's rate of return in the country-specific simulation #141. There the rate of return in Australia responded more favourably to the policy shock than did that in NZ, with this being a reflection of the relative demands for capital (and, hence, investment) within each country.

Table 3 (% changes resulting from shock) * = exogenous	Tot free trade c'try-spec K exog exch #141	15% max c'try-spec K exog exch #143	Tot free trade mobile K exog exch #145	Tot free trade c'try-spec K endog exch #146
NEW ZEALAND				
Real GDP	2.2	0.5	1.3	1.7
Consumption	3.7	0.8	2.8	2.9
Investment	0.0*	0.0*	-2.4	0.0*
Labour employment	3.2	0.7	2.4	2.5
Capital stock	0.0*	0.0*	-0.8	0.0*
Exports	5.6	1.2	4.5	4.0
Imports	6.0	1.3	5.2	4.3
BoP change: with AUS ($m)	-76.3	-33.8	-59.5	0.0*
(%GDP)	-0.1	-0.1	-0.1	0.0
with rest of world ($m)	-309.5	-17.9	-311.6	-569.7
(%GDP)	-0.6	0.0	-0.6	-1.0
Exchange rate : with AUS	0.0	0.0	0.0	3.0
: with rest	0.0*	0.0*	0.0*	4.7
Consumer prices	-3.5	-0.6	-3.2	0.0*
Current rate of return	5.9	1.0	6.7	4.3
AUSTRALIA				
Real GDP	2.3	0.5	2.4	2.5
Consumption	3.0	0.7	3.1	3.2
Investment	0.0*	0.0*	0.4	0.0*
Labour employment	2.7	0.6	2.8	2.9
Capital stock	0.0*	0.0*	0.1	0.0*
Exports	10.7	2.2	10.8	11.4
Imports	6.5	1.3	6.6	7.0
BoP change: with NZL ($m)	65.3	9.5	54.6	-26.2
(%GDP)	0.0	0.0	0.0	0.0
with rest of world ($m)	-143.7	-15.2	-132.6	187.8
(%GDP)	-0.1	0.0	0.0	0.1
Exchange rate : with NZL	0.0	0.0	0.0	-3.1
: with rest	0.0*	0.0*	0.0*	1.7
Consumer prices	-5.3	-1.1	-5.3	-3.3
Current rate of return	6.9	0.8	6.7	7.3

It is appropriate to make clear just what this closure assumption postulates. By allowing the model to determine the allocation of capital and investment between (as well as within) the two countries, there is an implicit assumption that the policy shock (that is, the move to zero protection) has no influence on the relative rate of return on capital between NZ and Australia, nor on the total amount of capital available to the CER region as a whole. Thus the two rates of return move in tandem in this simulation. By contrast, the previous experiment was undertaken assuming that the move to zero protection had no impact on the aggregate amount of capital available in each individual country.

Removing the rigid assumption of country-specific capital can be seen as a way of introducing a semi-dynamic element within the model. Nevertheless, the shortcomings of handling inherently dynamic relationships within a comparative static exercise remain - and, hence, it is crucial to note the limitations of the model results. That is, they indicate the changes arising from the shock alone, given the closure assumptions adopted. In this instance, the assumption of no change in the trans-Tasman relative rates of return is central.

iii) Exchange rate endogenisation

The final alternative experiment presented attempts to endogenise the determination of (nominal) exchange rates. The two independent exchange rates (those with the rest of the world) have in the runs so far been set exogenously at no change in response to the policy change. As a direct consequence, the cross-exchange rate between the two CER partners remained unchanged as well.

In order to endogenise these, an alternative environment needs to be developed. Rather than assuming that NZ's and Australia's exchange rates with the rest of the world are not influenced by the shock (as in #141), another option could be to assume that NZ consumer prices are not influenced by the shock. Then, in order to endogenise Australia's exchange rate with the rest of the world a constraint of no change in the trans-Tasman BoP is imposed. The outcome for these exchange rates would, by definition, determine the change in the trans-Tasman cross exchange rate.

In #141, specifically, it can be seen that there is a NZ consumer price response of -3.5% and a movement in the trans-Tasman BoP against NZ of approximately 0.1% of NZ's GDP. In order to negate these responses to the policy shock, NZ's exchange rate would need to depreciate by 4.7% and Australia's by 1.7% with respect to the rest of the world, as is shown in the results for #146. It follows that the Australian currency would appreciate by 3% with respect to the NZ currency.

These movements can be reconciled with the assumptions embodied in the new closure. To counter the fall in NZ consumer prices caused by the removal of all protection the NZ exchange rate needs to depreciate, making import prices higher than they would otherwise have been. There also needs to be a depreciation against the Australian currency, making NZ goods more competitive in Australia, *cet par*, so as to rectify the trans-Tasman BoP situation. It should be noted that NZ consumer prices acts as the numeraire in this simulation - thus all price movements recorded by the model in this experiment need to be interpreted as being relative to the overall level of consumer prices in NZ.

The overall result of such a simulation sees the gains to GDP and consumption in NZ more muted than in the unchanged exchange rate scenario, while the gains experienced in Australia are marginally greater. Again, there are numerous offsetting influences which cause this outcome. The depreciation of the NZ exchange rate assists NZ products vis-a-vis Australian commodities but the related subdued price and cost response within NZ means there is a relative shift towards items from outside the region. Hence NZ's trade with the rest of the world suffers, leading overall to a smaller increase in aggregate exports (when compared to #141) and reflected by the large deterioration in the BoP situation. On the Australian side, the less favourable position when competing with NZ-made goods is countered by a more favourable outlook - assisted by the depreciation - with respect to the rest of the world. The relative importance to Australia of external trade over intra-CER trade leads to its overall performance being slightly improved.

While allowing nominal exchange rates to respond in this manner to the policy shock, it should be clear that the crucial factor determining the model's outcome is the response of the real exchange rate. This is a feature of such a model, which is primarily concerned with resource allocation in response to relative price movements. Hence the focus throughout the discussions on changes in relative competitiveness and its pivotal role. Or, put another way, it is real goods and factor markets and/or relative price-based changes, and not monetary changes, which are driving the endogenous nominal exchange rate.

IV Conclusions

Bearing in mind the illustrative nature of these results, the *Joani* model shows the effects of extending CER to the bi-lateral removal of protection on imports from outside the region to be

generally beneficial, in terms of output, employment and consumption. Unlike the previous study (Philpott and Nana,1988), however, these benefits are skewed to be relatively in favour of Australia. This finding follows from the starting point adopted of 1990, whereby the existing levels of protection are much higher in Australia than NZ so that their removal leads to larger cost reductions in the former compared to the latter. Similar to that previous study, and accentuated in the case of NZ, there is an uneven distribution of these improvements amongst the numerous components of GDP and, in particular, between the trans-Tasman and the external trade flows.

The longer-run consequences are not surprisingly of a greater magnitude than in the short run as re-allocation of resources allows the competitive improvements to be further exploited. The interpretation of these results requires careful analysis of the "closure" under which they have been simulated, with one of the features of the model being the ease with which the "closure" can be adjusted to incorporate different assumptions. Variables set exogenously at no change are then interpreted as being independent of the shock, with the consequent endogenous results showing the changes caused by the shock. Hence an extension of the long-run scenario allowing capital to be mobile, not only between sectors, but also between the two countries, shows the responses of the removal of all protection given the assumption that the relativity (between NZ and Australia) in the rates of return on capital remain unchanged by this shock. Despite the movement of capital resources away from NZ in this scenario, benefits to both countries are still recorded although their distribution is slanted more towards Australia.

On the negative side, in most of the longer-run alternatives investigated the BoP positions of both countries deteriorated following the adoption of a zero protection policy. This effect was marked in NZ's case where the magnitudes were of the order of a half to one percent of the nation's GDP. This was mitigated if the zero protection policy was replaced with an intermediate option of a 15% maximum tariff on imports from outside the region. Where each country's exchange rates were endogenised subject to no change to consumer prices in NZ and the trans-Tasman BoP, NZ's competitiveness with the rest of the world was eroded by more than the gain vis-a-vis Australia. This accentuated the BoP deterioration experienced by NZ.

It should be remembered that these findings were presented as indicative results from the model. The explicit identification and quantification of influences, reactions and relationships is the strength of the modelling approach adopted here. Furthermore, this approach also facilitates the analysis of assumptions which may otherwise remain implicit.

The above results have helped clarify the agenda for future development of the *Joani* modelling program and applications. Of a critical, but very difficult, nature is the whole investment/capital nexus and the requirement to model, in some form, dynamic relationships in a satisfactory manner. A not unrelated, and also very challenging, matter is the determination of the exchange rate, as significant progress on this avenue properly awaits the introduction of satisfactory financial capital routines and monetary relationships.

More immediate advancement could be made at the disaggregated industry level, where improved data would enable a better reconciliation of the detailed sectoral results with the aggregate outcome. This would also assist in the treatment of commodity and industry-specific investigations on the impacts of protection policy changes. Other possible model applications are numerous, with an exploration of aspects of the labour market in this two-country context an attractive subject. The influence of trans-Tasman migration would be particularly relevant in this case, and ideally suited to analysis using the *Joani* model. Further studies could include an examination of trans-Tasman transport costs and their impact on commodity trade.

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APPENDIX - schematic outline of *Joani*

Equations (for each country)

Note i) all equations and variables are specified at the individual sector and/or commodity level, unless
ii) *italics* signifies aggregate or economy-wide variable, while
iii) outline signifies equivalent variable relating to CER partner's economy.
iv) d = domestic, c = CER partner, and r = rest of world

Demands for goods

Intermediate	$A = f_a(Q)$
	$A_d = f_{ad}(A, P_d, P_c, P_r, \sigma)$
	$A_c = f_{ac}(A, P_d, P_c, P_r, \sigma)$
	$A_r = f_{ar}(A, P_d, P_c, P_r, \sigma)$
Consumption	$C = f_{cy}(Y)$
	$C = f_c(C, \varepsilon)$
	$C_d = f_{cd}(C, P_d, P_c, P_r, \sigma, \eta)$
	$C_c = f_{cc}(C, P_d, P_c, P_r, \sigma, \eta)$
	$C_r = f_{cr}(C, P_d, P_c, P_r, \sigma, \eta)$
Investment	$I = f_i(P_k, P_d, R)$
	$I = \Sigma I$
	$I_d = f_{id}(I, P_d, P_c, P_r, \sigma)$
	$I_c = f_{ic}(I, P_d, P_c, P_r, \sigma)$
	$I_r = f_{ir}(I, P_d, P_c, P_r, \sigma)$
Other final demands	$O_d = f_{od}(O, P_d, P_c, P_r, \sigma)$
	$O_c = f_{oc}(O, P_d, P_c, P_r, \sigma)$
	$O_r = f_{or}(O, P_d, P_c, P_r, \sigma)$
Exports	$E_c = A_c + C_c + I_c + O_c$
	$E_r = f_e(P_d, P_c, P_w, \phi_r, \lambda, \sigma_e)$

Demands for factors

Labour	$L = f_l(Q, P_k, P_l, \sigma_f)$
Capital	$K = f_k(Q, P_k, P_l, \sigma_f)$

Price formation

Domestic goods	$P_d = f_p(P_c, P_r, P_l, P_k)$
Imported goods	$P_c = \phi_c P_d (1+T_c)$
	$P_r = \phi_r P_w (1+T_r)$
Factors	$P_l = b P_l$
	$P_k = f_{pk}(I, K, K, P_d)$

Market clearing

Domestic goods	$Q = A_d + C_d + I_d + O_d + E_c + E_r$
Imported goods	$M_c = A_c + C_c + I_c + O_c$
	$M_r = A_r + C_r + I_r + O_r$
Factors	$L = \Sigma L$
	$\Sigma K = K$

Other

Household income	$Y = f_y(P_l L, P_k K)$
Exchange rate	$\phi_c = \phi_r / \phi_r$
Trade BoP	$B_c = \Sigma (E_c P_d) - \Sigma (M_c \phi_c \mathbb{P}_d)$
	$B_r = \Sigma (E_r P_d) - \Sigma (M_r \phi_r P_w)$
GDP	$GDP = C + I + O + \Sigma (E_c + E_r) - \Sigma (M_c + M_r)$

Variables (for each country)

Q	Real gross output
A	Demand for intermediate inputs
A_d	Demand for intermediate inputs produced domestically
A_c	Demand for intermediate inputs imported from CER partner
A_r	Demand for intermediate inputs imported from rest of world
C	Demand for consumption commodities
C_d	Demand for consumption commodities produced domestically
C_c	Demand for consumption commodities imported from CER partner
C_r	Demand for consumption commodities imported from rest of world
I	Demand for investment goods
I_d	Demand for investment goods produced domestically
I_c	Demand for investment goods imported from CER partner
I_r	Demand for investment goods imported from rest of world
O_d	Demand for goods for other final demand produced domestically
O_c	Demand for goods for other final demand imported from CER partner
O_r	Demand for goods for other final demand imported from rest of world
E_c	Demand for export commodities to go to CER partner
E_r	Demand for export commodities to go to rest of world
M_c	Imports from CER partner
M_r	Imports from rest of world
L	Demand for labour
K	Demand for capital

C	Aggregate consumption expenditure
I	Aggregate investment expenditure
O	Other final demand expenditure
B_c	Trade balance of payments with CER partner
B_c	Trade balance of payments with rest of world
GDP	Real GDP
Y	Total household income
R	Economy-wide rate of return on capital
L	Total labour employed
K	Aggregate capital stock
P_d	Price of domestically produced good
P_c	Purchasers' price of imported good from CER partner
P_r	Purchasers' price of imported good from rest of world
T_c	Tariff equivalent on imported good from CER partner
T_r	Tariff equivalent on imported good from rest of world
ϕ_c	Exchange rate with CER partner ($domestic/$CER)
ϕ_r	Exchange rate with rest of world ($domestic/$world)
P_l	Price of labour
P_k	Price of capital
P_l	Economy-wide price of labour

Parameters (for each country)

b	sectoral relativities in price of labour
σ	substitution elasticity between goods from different sources of supply
σ_f	elasticity of substitution between capital and labour in production
ε	elasticity of consumption commodity demand with respect to total consumer expenditure
η	price elasticity of consumption commodity demand

Items common to both countries

P_w	World price of competing commodities
λ	rest of world export elasticity of demand
σ_e	elasticity of substitution in exports between CER goods

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