CENTRE of POLICY STUDIES and the IMPACT PROJECT

Incorporating International Capital Ownership into the GTAP Model:

Results for Asia-Pacific Trade Liberalisation

by

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Abstract

In this paper, some major modifications are made to the existing GTAP structure and database to incorporate a long-run closure in which changes in the ownership of capital stocks are determined endogenously and income earned on endowment commodities accrues to the owners of those endowments. This long-run closure assumes that in the long run all economies are growing at a common steady-state rate of growth, determined by the rate of population and technological growth. In order to ensure valid comparative statics the underlying growth rate in the database must equal this steady-state rate of growth. Shocks are imposed to equate the growth rates of capital across regions and thus create a steady-state database. Once the GTAP model and database have been modified, they are then used to simulate the long-run effects of Asia-Pacific trade liberalisation on welfare and gross national product. It is found that the foreign ownership of assets does have a significant effect on the projected outcome of trade liberalisation in the Asia-Pacific region.

1. Introduction

Recent attempts to undertake simple comparative static long-run analysis (Walmsley, 1998 and Francois, MacDonald and Nordstrom, 1996) using the GTAP model have been frustrated by the need to make certain unrealistic assumptions about the mobility of capital and the allocation of income earned on that capital. In the standard GTAP model the existence of foreign ownership is not considered and therefore the region in which an endowment commodity is located is also implicitly the region of ownership and thus the region to which the income earned accrues. The foreign ownership of capital stocks and of other assets, however, is likely to have a significant affect on the projected long-run effects of a policy shock.

In this paper, some major alterations are made to the GTAP model and database in order to incorporate a long-run closure in which both the foreign ownership of capital and land and the existence of foreign labour are considered. These modifications to the GTAP model and database include the incorporation of equations and data to explain or define:

1. the way in which saving is allocated across regions for investment purposes;

2. the accumulation of capital stocks by ownership;

3. the foreign ownership of land;

4. the existence of foreign workers and consequently their effect on the allocation of income across consumption, saving and government spending; and

5. national income in terms of income earned on endowments owned by permanent residents of the region, rather than income earned on endowments located within the region.

This revised GTAP model and database is then used to determine the long-run effects of Asia-Pacific trade liberalisation. The results of this long-run simulation, based on the revised GTAP model, are then compared with a similar long-run simulation based on the standard GTAP model. The risk-adjusted long-run closure developed in Walmsley (1998) is used for the simulation based on the standard GTAP model. In this closure capital is mobile, however, income earned on endowment commodities is assumed to accrue to the region in which the endowment commodity is located, rather than to the region of ownership. The results show that the foreign ownership of capital can significantly affect the long-run results of Asia-Pacific trade liberalisation, particularly for the Asian economies.

The long-run closure developed for the revised GTAP model assumes that in the long run all economies grow at a common steady-state rate of growth. In order to ensure valid comparative statics a steady-state version of the revised GTAP database must be created. The revised GTAP model and the steady-state database are then used to determine the long-run effects of Asia-Pacific trade liberalisation shock. These results are then compared with those obtained above using the revised GTAP model the revised GTAP database.

Following the introduction this paper is divided into six sections. Section 2 provides a brief summary of the changes made to the structural form of the GTAP model to track the ownership of endowment commodities. Section 3 examines the changes made to the standard GTAP database to incorporate the foreign ownership of capital, land and labour. Section 4 outlines the long-run closure used in the revised GTAP model and compares it with that developed for the standard GTAP model in Walmsley (1998). The results of the long-run simulations based on the revised GTAP model and database are then compared with the long-run results obtained using the standard GTAP model. In Section 5 the creation of the steady-state database is discussed and the results analysed. Following this the Asia-Pacific trade liberalisation shock is simulated using the revised GTAP model and this steady-state database. These results are then compared with those obtained in Section 4. Section 6 draws general conclusions obtained from the simulations reported.

Wherever possible new variables and coefficients have been added while attempting to maintain the GTAP conventions established in Hertel and Tsigas (1997)[1]. Changes to these conventions are however, inevitable with such major modifications to the GTAP structure and database. Additional subscripts have been added to define the location of the endowment commodity and the region of permanent residency of the owner. For example, where i $\in$ ENDW_COMM (the set of endowment commodities), (i,r,t) would stand for endowment commodity i, "located" in region r and "owned" by, or in the case of labour, a permanent resident of region t. Additional letters have also been added (e.g. "l" and "p") to the end of coefficient and variable names to distinguish between coefficients and variables which have been divided into the "location of the asset" and "permanent residency of owner" alternatively[2].

2. The Extended GTAP Model Incorporating Ownership

In this section the alterations made to the GTAP model are outlined. The section is divided into four sub-sections. The first sub-section examines the foreign ownership of capital. Included in this first sub-section is an outline of the equations relating to the way in which saving is allocated across regions for investment. The second sub-section examines the foreign ownership of land and labour. The third

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1. Lower case represent deviations from the base case, while upper case represents the actual values or coefficients.

2. For example, the percentage change in capital stocks located in region r and owned by permanent residents of region t is written as kblp(r,t). In some case "p" may be lengthened to "perm". If there is no additional affix the variable has not been changed from the standard GTAP model and therefore the region can be interpreted as the location.

calculates national income in terms of income earned by the permanent residents on endowments owned by them. The final section looks at the existence of foreign labour and the effect of this on the allocation of income across private household consumption, saving and government spending.

2.1   Foreign Ownership of Capital

In incorporating the foreign ownership of capital into the GTAP model a number of changes were made to the equations in the standard GTAP model. A summary of these changes is outlined below.

1.   *Ownership-specific taxes on the rental price of capital*

The inclusion of an ownership-specific tax (tolp("capital",r,t)) on the rental price of capital has the effect of creating an ownership-specific rental price (pslp("capital",r,t)) and current rate of return (rorclp(r,t)). Although this tax exists as a variable in the revised GTAP model, no ownership-specific taxes are present in the initial database.

2.   *The Expected Rate of Return Schedule*

Expected rates of return are related to current rates of return via the expected rate of return schedule illustrated in percentage change form in Equation 1.

$$rorelp(r,t) = rorclp(r,t) - \text{ROREFLEX}(r) \times \left[kbgrow(r) - avgrow \right] \qquad \text{Equation 1}$$

The expected rate of return schedule states that if capital stocks in region r are expected to grow faster than the global average growth rate of capital (i.e. kbgrow(r) > avgrow), then the expected rate of return will be lower than the current rate of return, and visa versa.

Both of these rates of return carry two subscripts reflecting possible differences in the ownership-specific taxes, which are applied to both the expected and current rates of return.

3.   *Regional Saving Pools*

In the current GTAP model, the saving of each region is accumulated into a global saving pool from which investment is then allocated across regions. The inclusion of ownership-specific taxes on the rental price of capital and the division of endowment commodities across regions of ownership preclude the use of this global saving/investment pool. Instead regional saving pools for each region of permanent residency are used to determine investment across regions of location and ownership. In this case the saving of permanent residents (qsaveperm(t)) of t must equal the sum across locations r of all investments undertaken by the permanent residents of t (regionalcgds(t)).

$$qsaveperm(t) = regionalcgds(t) + walraslackp(t) \qquad \text{Equation 2}$$

walraslackp(t) is exogenous (and normally set to zero) for all regions except one (namely, ROW). This acts as a check that Walras' Law is satisfied in computations.

4.   *Perceived Risk*

Regional saving is allocated across regional investment such that permanent residents of region t equate their risk-adjusted expected rates of return across regions of asset location. In percentage change form:

$$roreflp(r,t) = rorfp(t) \qquad \text{Equation 3}$$

where: roreflp(r,t) is the percentage change in the expected risk-adjusted rate of return, received by permanent residents of t, on their investments in region r (ROREFREELP(r,t)); and

rorfp(t) is the percentage change in the common value of the risk-adjusted rate of return on all investments undertaken by permanent residents of t (RORFPERM(t)).

These risk-adjusted expected rates of return are related to the expected rate of return via an endogenously determined ownership- and location-specific risk premium (rsklp(r,t)).

$$ROREFREELP(r,t) \times roreflp(r,t) = ROREXPLP(r,t) \times rorelp(r,t)$$
$$- RISKLP(r,t) \times rsklp(r,t)$$

Equation 4

The level of perceived risk is assumed to depend on both the location of the investment and the permanent residency of the owner and therefore has two subscripts: r and t respectively.

> Since the risk of which we must take account is the subjective risk, the feeling, that is to say in the mind of the investor, its magnitude very largely depends upon *the amount of relevant information that is easily accessible to him*. What would be risky to any investor principally depends, in fact upon the degree of ignorance respecting the circumstances and prospects of the investment he is considering......(Keynes[3]) (italics added).

Thus investors, from different regions, may have different perceptions about the riskiness of a region. In addition these perceptions of risk may alter at different rates as the investor's share of capital stocks within the region changes or as the region itself grows.

This relationship, labelled the perceived risk schedule, states that the level of risk in each region r perceived by permanent residents of t increases as the proportion of their end-of-period capital stock located in region r and owned by them rises relative to the proportion of global end-of-period capital stock located in region r. This relationship between perceived risk and end-of-period capital stocks is illustrated in Figure 1 and given in Equation 5. The percentage change form of Equation 5 is then incorporated into the revised GTAP model.

Figure 1
Perceived Risk Schedule
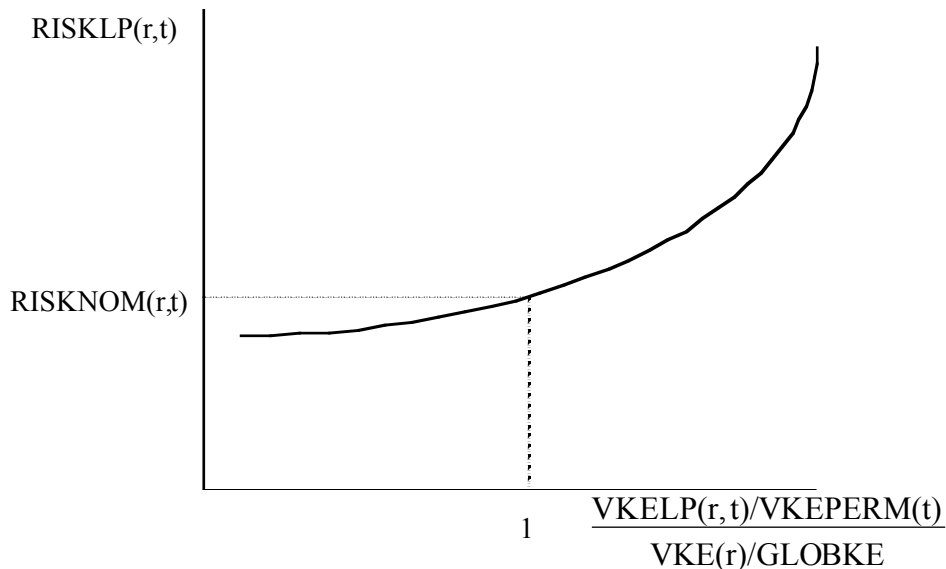
$$RISKLP(r,t) = RISKNOM(r,t) \times \left[\frac{VKELP(r,t)/VKEPERM(t)}{VKE(r)/GLOBKE} \right]^{RISKFLEXLP(r,t)}$$

Equation 5

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3. Quote by Moggridge of Keynes in 1909 cited by Moggridge (1992, p.204).

VKELP(r,t) is the value of end-of-period capital stocks located in region r and owned by permanent residents of region t, which is equal to beginning-of-period capital stocks plus net investment located in region r and owned by permanent residents of t;

VKEPERM(t) is the value of end-of-period capital stocks owned by permanent residents of t;

VKELP(r,t)/VKEPERM(t) is therefore the proportion of the portfolio (i.e. end-of-period capital stocks) of permanent residents of t which are located in region r.

VKE(r) is the value of end-of-period capital stocks located in region r; and

GLOBKE is the value of global end-of-period capital stocks.

VKE(r)/GLOBKE is the proportion of global end-of-period capital stocks (i.e. the proportion of the global portfolio) located in region r.

Hence the ratio, $\dfrac{\text{VKELP(r,t)/VKEPERM(t)}}{\text{VKE(r)/GLOBKE}}$, reflects the specialisation in r of the portfolio of permanent residents of t relative to that in the global portfolio. If this ratio is equal to one then permanent residents of t hold the same proportion of end-of-period capital stocks in region r as the global portfolio. Alternatively if this ratio is greater (less) than one, then permanent residents of t hold a higher (lower) proportion of end-of-period capital stocks in region r than the global portfolio. We would expect a value greater than one in the case of the permanent residents (t) investing in their own region (t), reflecting the empirical observation that people tend to invest first in their own country or region. The latter observation concurs with the quotation from Keynes given above if we assume that relevant information about investment prospects in t is more readily accessible to residents of t than to residents of other regions.

RISKNOM(r,t) is the normalised level of perceived risk. It is that level of risk corresponding to the situation where $\dfrac{\text{VKELP(r,t)/VKEPERM(t)}}{\text{VKE(r)/GLOBKE}}$ is equal to one. These normalised levels of perceived risk give a standard measurement of how risky end-of-period capital located in region r is perceived to be by the permanent residents of region t. By 'standard' here we mean that the riskiness of investments in r as perceived by permanent residents of t is assessed when their exposure to r is equal to the world average exposure.

RISKFLEXLP(r,t) represents how the perceptions of risk by permanent residents of t increase with respect to increasing exposure to region r. That is, if the proportion of their total end-of-period capital stocks devoted to region r by permanent residents of region t rose relative to the global portfolio by 1 percent, then we would expect the level of perceived risk to increase by RISKFLEXLP(r,t) percent. (Note that this slope parameter differs both across regions of permanent residency and across regions of location of physical assets.) In the case of investment by permanent residents in their own region these curves are expected to be relatively flat, reflecting the fact that the permanent residents of a region tend to be better informed about their own economies and hence are more likely to invest heavily there without requiring a higher risk premium.

5. *Capital Stocks*

End-of-period capital stocks located in region r and owned by permanent residents of t are related to beginning-of-period capital stocks via investment (Equation 6) or via the growth rate of capital (Equation 7) located in region r and owned by permanent residents of t.

$$VKELP(r,t) \times kelp(r,t) = REGINVLP(r,t) \times qcgdslp(r,t)$$
$$+ \left[VKBLP(r,t) - VDEPLP(r,t) \right] \times kblp(r,t)$$

Equation 6

$$kelp(r,t) = kblp(r,t) + kbgrowlp(r,t)$$

Equation 7

2.2 The Foreign Ownership of Land and the Existence of Guest Workers

In addition to foreign capital ownership the model also includes the effect on income of the foreign ownership of land and of foreign labour. In the case of land and labour, however the quantities of foreign owned land (qolp("land",r,t)) and foreign labour (qolp("labor",r,t)) within each region are assumed to remain fixed throughout the solution period. Thus no equations have been added to describe the flow of these two endowments between regions.

Total labour (or land) located within a region is then the weighted sum of domestic and foreign labour (or land).

$$qo(i,r) = \sum_{t \in REG} \frac{VOALP(i,r,t)}{VOA(i,r)} \times qolp(i,r,t)$$

Equation 8

where: i = labour and land; and

the ratio coefficient on the right of Equation 8 is the share of the value of labour (wage bill) or land services in region r going to permanent residents of t.

As in the case of capital an ownership-specific tax on the rental price of labour and land (tolp(i,r,t)) has also been included[4]. This has the effect of creating an ownership-specific price (pslp(i,r,t)) for labour and land services.

2.3 National Income

With capital, land and labour divided across regions of location and ownership, national income can be properly defined in terms of income earned on endowments owned by permanent residents of region t.

$$INCOMEP(t) \times yperm(t) = \sum_{s \in REG} \sum_{i \in ENDW} VOALP(i,s,t) \times \left[qolp(i,s,t) + pslp(i,s,t) \right]$$

Equation 9

$$+ \left[TAXES(t) \times tax(t) \right] - \sum_{s \in REG} VDEPLP(s,t) \times \left[kblp(s,t) + pcgds(s) \right]$$

This equation states that the percentage change in income (yperm(t)) earned by the representative permanent resident household of region t is the sum of:

- firstly, labour income earned by all permanent residents of region t, who may be currently residing in region t or in another region r;

- secondly, capital and land income earned by permanent residents of region t on land and capital endowments located in all regions and owned by them; and

- thirdly, tax income earned by the government of the region of permanent residency. In this model taxes are assumed to benefit permanent residents of the region in which the tax is levied, although alternative assumptions could be accommodated.

From this income depreciation is then subtracted to obtain net income.

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4. Note, that although ownership-specific taxes have been included as variables in the equations, no ownership-specific taxes have been included in the database.

2.4   Household Behaviour

The existence of foreign workers also has implications for the equations describing household behaviour, in particular the allocation of income to private household consumption. Permanent residents are assumed to allocate income across private consumption (in the region of temporary residency only), and government consumption and saving (in the region of permanent residency). The most significant change is that private household consumption in region r can be undertaken by permanent residents of region r living in the region or by foreign workers living in region r. An outline of these changes is given below.

1. Rather than there being only one representative household in each region there are now REG representative households for each region representing each of the possible foreign and domestic workers residing (temporarily, in the case of non-permanent residents) within the region.

2. Differential taxes may be levied on the private household consumption of each of these representative households[4]. For example the dual pricing of private consumption goods in China could be incorporated through an additional tax on commodities purchased by foreigners temporarily residing in China. As a result, prices on commodities for private household consumption may have two regional subscripts (r and t) representing the region in which the purchase was made and the permanent residency of the purchaser.

3. Income available for consumption by permanent resident of t temporarily residing in region r depends on the total income of all permanent residents of t. However, temporary residents of region r are assumed to adopt the spending habits of the region of temporary residence. That is, they allocate their income for private expenditure across commodities and domestic and imported sources in the same way as other residents of region r.

3.   The Revised GTAP Database

In the previous section the structural form of the equations (shown in percentage change form) describing the "behaviour" of households by region of permanent residence were discussed; this included saving, consumption and investment behaviour. In this section the calculation of the initial values of the level variables in the database are discussed. We begin with an 11-region by 8-commodity aggregation of the standard GTAP database.

3.1   Foreign Ownership of Capital Stocks

3.1.1   *Data on the Ownership of Capital Stocks*

Data on the ownership of capital stocks located in each region r (VKBLP(r,t)) for the revised GTAP database were estimated using proportions of domestic and foreign ownership of direct foreign capital stocks, for the year 1992, obtained from IMF (1996) and APEC (1995). These proportions were also used to determine initial values in the revised GTAP database for investment (REGINVLP(r,t)), depreciation (VDEPLP(r,t)) and the value of capital services (VOALP("capital", r,t)) by both location and ownership.

Net saving (SAVEPERM(t)) by permanent residents is then equal to the sum across regions of location (r), of gross investment (REGINVLP(r,t)) in region r by permanent residents of t less depreciation (VDEPLP(r,t)) on capital owned by the permanent residents of region t located in region r.

3.1.2   Parameters of Perceived Risk Schedule

Initial values for RISKNOM(r,t) and RISKFLEXLP(r,t) must also be determined such that the perceived risk schedule is also satisfied in the levels. The following observations and assumptions are made:

1. The value of only REG by REG of these variables can be freely determined. The other REG by REG will be determined from Equation 5 in order to ensure that the perceived risk schedule holds in the levels.

2. It is assumed that the initial value of the slope parameter (RISKFLEXLP(r,r)) for the perceived risk schedule of permanent residents of r, investing in region r is equal to 0.01. This value is determined arbitrarily but reflects the belief that this curve is relatively flat for permanent residents investing in their own region.

3. It is assumed that the perceived risk on the first dollar of investment does not vary among residencies of owners for any given investment location. Thus the perceived risk schedules for all investments in r (by permanent residents of r and t) converge to a common value RISKZERO(r) at the y-axis. Note, that this does not imply that the values of RISKZERO(r) are common across locations (r) of assets: if a location is inherently risky, this is appreciated by all potential investors (including those from r).

Given these assumptions values for the two parameters RISKFLEXLP(r,r) and RISKNOM(r,r) are calibrated using the perceived risk schedule.

3.2   The Foreign Ownership of Land and the Existence of Guest Workers

In addition to capital ownership the model also includes the effect on income of foreign ownership of land and foreign labour.

3.2.1   Land

While some data on capital ownership is available, there is no data on the ownership of land in each region. In this paper it is assumed that land within each region is allocated across ownership in the same way as capital. Although some Asian economies do not allow foreigners to own land directly, it is assumed that this does not prohibit foreigners from owning land indirectly through their relationships with the permanent residents of the region. Thus data on the ownership of land located in each region r (VOALP("land",r,t)) for the revised GTAP database were estimated using the proportions of foreign ownership of direct foreign capital stocks.

3.2.2   Labour

In the case of labour by region of temporary and permanent residence, data is available on the overall size of each region's labour force and a limited amount is available on the number of foreign workers in the region. There were a number of problems with obtaining this data, including:

   a) how to define a "temporarily resident" worker;

   b) the need to estimate stocks of foreign workers from data on flows;

   c) insufficient data — in some case only data relating to visas issued could be found;

   d) inconsistency of data between importers and exporters of foreign labour;

   e) insufficient bilateral data on where foreign workers had come from or where they had gone; and

   f) the high levels of illegal foreign workers in some countries.

Based on the limited set of data available, a matrix of the proportions of labour by location and permanent residency was determined. These proportion were then used to determine the share of the wage bill (VOALP("labor",r,t)) in region r paid to permanent residents of region t.

It was assumed that the wage rate received by a foreign worker is the same as that received by a permanent resident. Unfortunately this assumption is not very realistic as many foreign workers, particularly those from the less developed economies, are often paid substantially less than the average permanent resident of the region – both because there is a tendency for them to be employed in unskilled work and because employers in some countries are likely to pay them less for the same work. This allocation could be improved with the division of labour into skilled and unskilled (as is the case in version 4 of the GTAP database).

3.2.3   *Private Expenditure*

Income available for private expenditure by permanent residents of region t (PRIVEXPPERM(t)) is given by the total income remaining after saving and government expenditure have been taken out.

The allocation of private expenditure by permanent residents across regions of temporary residence is then undertaken in two stages.

1. An initial estimate of the private expenditure by permanent residents of region t, temporarily located in region r is determined using the proportions of foreign labour.

2. This initial estimate (from 1 above) is used in the RAS procedure for matrix balancing to ensure that firstly, the sum across regions of permanent residence of private expenditure undertaken in region r by permanent residents of region t is equal to the value of private expenditure in region r given in the GTAP database (PRIVEXP(r)); and secondly, that the sum across regions of temporary residency is equal to the total private expenditure of permanent residents of region t (PRIVEXPPERM(t)).

Private expenditure of permanent residents of t temporarily residing in r is then allocated across commodities, and imported and domestic sources using the consumption shares for the region (r) of temporary residence.

4.   The Long-Run Effects of Asia-Pacific Trade Liberalisation

Section 4 is divided into two parts. In the first sub-section the short- and long-run closures are developed for the revised GTAP model. These closures are based on the standard short-run closure for the GTAP model and the long-run closure developed in Walmsley (1998). In the second sub-section the revised GTAP model and revised GTAP database are then used to simulate the long-run effects of Asia-Pacific trade liberalisation are simulated. The results of this simulation are then compared with those obtained from Walmsley (1998) using a long-run closure for the standard GTAP model and database.

4.1   The Short- and Long-Run Closures for the Revised GTAP Model

The short- and long-run closures developed for the revised GTAP model are similar to those used for the standard GTAP model in Walmsley (1998). Table 1 below depicts the long-run closures for the two models.

Table 1
Long-Run Closures for Standard GTAP Model and Revised GTAP Model

Standard GTAP Model[a]	Revised GTAP Model
to tx tm tms txs	to tx tm tms txs
pop	popperm
psave	psavetot
profitslack incomeslack	profitslack incomeslacklp
endwslack saveslack	endwslack saveslacklp
govslack tradslack	govslack tradslack
ao af afe ava atr	ao af afe ava atr
qo("labor",r) qo("land",r)	qolp("labor",r,t) qolp("land",r,t)
rsk(r)	nomrsk(r,t)
kbgrow(r)	kbgrowlp(r,t)
growavslack	growavslack
	walraslackp("APEC")
	invpropslack (slack in Perceived Risk Schedule)
	tolp tpdlp tmdlp (ownership-specific taxes)
cgdslack(r)	(no longer exists)
growth	(no longer exists)

_____

a. With minor modifications outlined in Walmsley (1998).

In the standard GTAP model the *short run* is defined as that period of time before new investment adds to the total availability of capital for production within regions. In this case investment in each region is determined by allocating global savings to each region in such a way as to equate the *expected* rates of return across regions. In percentage change form:

$$\text{rore}(r) = \text{rorg}$$

Equation 10

In the revised GTAP model, the short run is again defined as that period of time before new investment adds to the total availability of capital for production within regions. In this case however, permanent residents of each region allocate their own regional saving across regions until the ownership-specific risk-adjusted expected rates of return in all regions r equate to a common risk-adjusted expected rate of return. In percentage change form:

$$\text{roreflp}(r,t) = \text{rorfp}(t)$$

Equation 11

Total investment (REGINV(r)) undertaken within a region (r) is therefore the sum across all regions of permanent residency (t) of investments (REGINVLP(r,t)) undertaken in region r by permanent residents of t.

In the *long run* sufficient time has passed for changes in investment to result in changes to regional capital available for production. Thus endogenously determined capital stocks adjust to changes in the demand for capital. In the standard GTAP model, this accumulation effect is determined by setting the current regional rates of return in the period simulated equal to the expected regional rates of return. This accumulation effect reflects the changes in capital stocks necessary for equating rates of return across time.

$$\text{rorc}(r) = \text{rore}(r)$$

Equation 12

In Walmsley (1998) this was achieved by incorporating a new variable − the power of the growth rate of capital (kbgrow(r)) − which is set exogenously equal to zero in the long-run closure.

In the revised GTAP model, capital stocks adjust such that the percentage change in the ownership-specific power of the growth rate of capital (kbgrowlp(r,t)) is equal to zero. If commencing from the steady-state database (discussed below) where investment and capital stocks shares are the same, the percentage change in the power of the total growth rate of capital (kbgrow(r)) located in region r will also equal zero and hence the expected and current rates of return will equate (Equation 13)[5].

$$\text{rorclp(r,t)} = \text{rorelp(r,t)} \qquad \qquad \text{Equation 13}$$

4.2   The Long-Run Effects of Asia-Pacific Trade Liberalisation

In this section the long-run effects of trade liberalisation within the Asia-Pacific region are determined using the revised GTAP model and database outlined in Sections 2 and 3 respectively. These results are then compared with those obtained using the long-run closure developed in Walmsley (1998) for the standard GTAP model.

4.2.1   The Long-Run Effects of Asia-Pacific Trade Liberalisation using the Revised GTAP Model

The long-run results are depicted in Table 2. The results show that in most of the Asia-Pacific economies (North America and Japan excluded) capital stocks, real gross domestic product and gross national product (qgnp(r)) rise. In the Rest of World real gross domestic product and gross national product fall.

For the Asia-Pacific region the liberalisation of trade leads to an increase in demand for commodities and output in APEC countries thus causing demand for capital inputs to rise. In the short run, capital stocks within each region are fixed exogenously, so any increase in demand for the services of capital causes its rental price (and thus the current rate of return) to rise. In the long run, capital stocks are no longer fixed. Any increase in demand for domestic goods will increase the demand for and hence the supply of capital.

In the standard GTAP model the extent to which the supply of capital increases is restricted only by the condition that global investment can be financed by global saving. Thus changes in the supply of capital depend on the equality of all expected (possibly risk-adjusted) rates of return, where risk is fixed exogenously. In the revised GTAP model, this increase in the supply of capital is restricted, not by the equality of global saving and investment, but by the equality of saving and investment by permanent residents of each region. As a result changes in the supply of capital depend on the equality of risk-adjusted expected rates of return across locations for each region of permanent residency, where the risk premia are determined endogenously.

In the case of investments in North America and Japan, higher risk-adjusted expected rates of return available elsewhere in the Asia-Pacific economies mean that investment in North America and Japan is no longer profitable. Hence capital stocks located in North America and Japan fall.

With labour and land constant, the percentage change in gross domestic product depends on the share of capital in gross domestic product multiplied by the percentage change in capital stocks (plus any taxes). Increases (decreases) in capital stocks cause gross domestic product to increase (decrease).

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5. If the growth rates of capital (KBGROWTHLP(r,t)) are not equal across all r and t (as is the case in the revised GTAP database), fixing the percentage change in the ownership-specific power of the growth rates (kbgrowlp(r,t)) to zero does not necessarily leave to the growth rate (KBGROWTH(r)) in region r undisturbed and therefore expected and current rates of return may not equate.

The allocation of capital stocks and investment across ownership depends on the risk premia (rsklp(r,t)), the risk-adjusted expected rate of return (roreflp(r,t)) and the expected rate of return (rorelp(r,t)). The level of risk perceived by investors as applying to their ownership of end-of-period capital stocks located in region r depends on firstly, the extent to which a permanent resident investor's portfolio differs from the average or global portfolio; and secondly, the slope of the perceived risk schedule (RISKFLEXLP(r,t)) (Equation 5).

Table 2
The Long-Run Effects of the Asia-Pacific Trade Liberalisation Shock: Revised GTAP Database

Region[a]	Real GDP (qgdp)	Real GNP (qgnp)	Current Rate of Return (rorclp)	Expected Rate of return (rorelp)	Risk-Adjusted Expected Rate of return (rorefp = roreflp)	Gross Investment (qcgds)	Capital stocks		Welfare (EVPERM)
							kb	kbperm	
NAM	-0.43	-0.49	2.43	2.98	7.41	-1.13	-1.3	-1.43	-23726.36
JPN	0.03	-0.38	4.52	5.1	7.5	-2.72	-2.81	-3.66	29045.97
AUS	1.62	1.63	3.7	4.09	7.61	4.1	3.62	4.27	6258.48
NZL	1.78	3.02	3.88	4.15	7.68	4.75	3.89	8.97	1414.73
CHN_HKG	3.86	2.7	5.34	6.27	7.63	6.27	6.51	1.00	6460.51
SKOR	7.84	2.9	4.06	5.49	8.28	9.11	9.68	-3.02	5607.8
TWN	7.49	4.57	2.53	3.43	8.92	9.82	10.04	-0.29	10697.64
MYS_SGP	11.09	1.01	3.32	4.65	8.23	15.96	16.63	-8.00	1188.15
THA_PHL	35.82	12.48	2.43	3.66	9.66	49.64	50.3	8.31	8537.79
IDN	5.35	0.01	1.68	2.52	9.16	8.29	8.45	-5.08	1.34
ROW	-1.68	-0.82	2.39	2.98	7.4	-3.65	-3.75	-1.97	-70738.31
globalcgds			-0.44						
avgrow[b]			0.064						
ke_tot			-1.92						
walras			0.000000						

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a. All results here represent percentage deviations from control.
b. Although kbgrowlp(r,t) are all set exogenously equal to zero, differences in end-of-period and beginning-of-period capital stock shares in the revised GTAP database mean that avgrow is unlikely to equal zero. In the long-run experiment based on the steady state database avgrow should be much closer to zero as these shares are equal.

Figure 2 demonstrates how the perceived risk schedule can be used to explain the allocation of saving across regions. Investments undertaken by Japanese permanent residents are used for illustrative purposes. The figure is similar to the perceived risk schedule except that the share of end-of-period capital stocks owned by permanent residents (VKELP(r,t)/VKEPERM(t)) is on the x-axis. Curves are shown for Japanese investment in the Rest of World, in other Asia-Pacific economies and in itself. Changes in the share of global capital located in r (r = ROW, Rest of World; r = A, Asia-Pacific other than Japan; r = J, Japan) then appear as changes in the location of the schedules.

There are two important aspects of the perceived risk schedule, which are illustrated by Figure 2; they are:

1. *The growth effect.* Assuming permanent residents do not alter their portfolios (kelp(r,t) = keperm(t)), the risk of investing in region r, as perceived by permanent residents of t, falls with relative increases in the end-of-period capital stocks of the region r (i.e. ke(r) - ke_tot > 0).

Alternatively if the shock has a negative effect on the economy of r so that end-of-period capital stocks there fall relative to global capital stocks, perceived risk associated with assets held in r will tend to rise[6].

2. ***The portfolio effect.*** This shows the effect on risk of a change in the portfolio of the permanent residents of t; that is, a change in end-of-period capital stocks (kelp(r,t)) owned by permanent residents of t and located in region r relative to the total end-of-period capital stocks (keperm(t)) owned by permanent residents of t. This is depicted in Figure 2 as a movement along the curves – increasing exposure of the portfolio to any region r results, ceteris paribus, in an increase in perceived risk.

Figure 2
The Allocation of End-of-Period Capital Stocks across Location owned by Permanent Residents of Japan
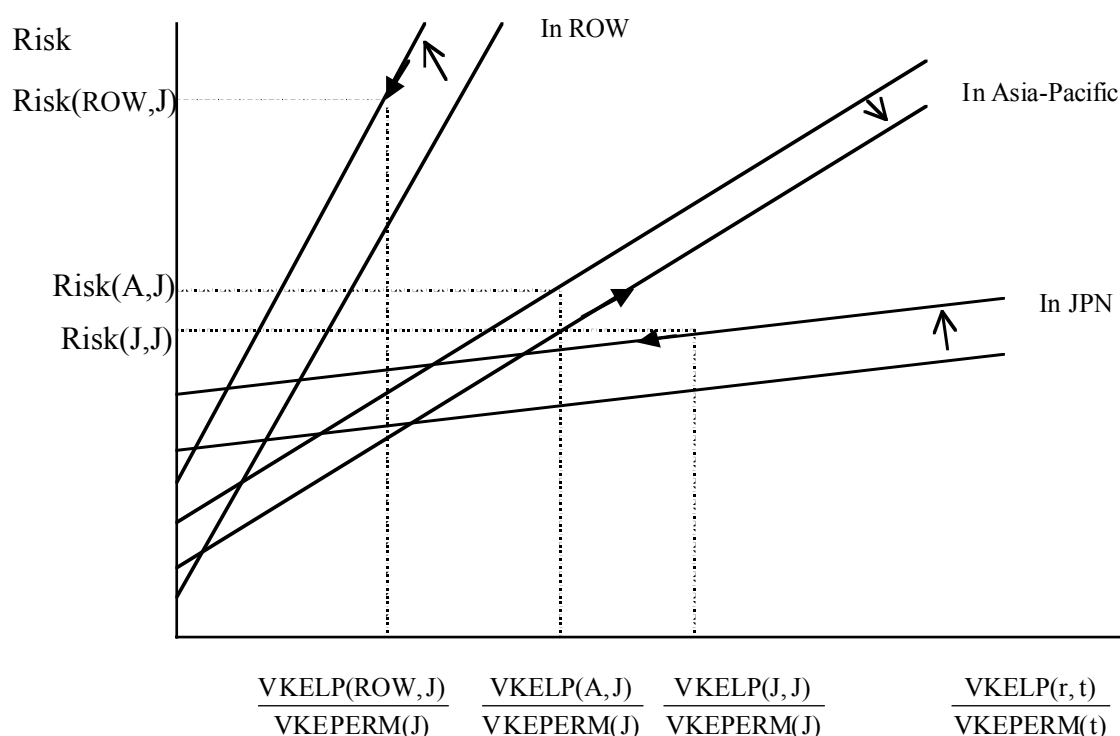
Initially the positive effect of the Asia-Pacific trade liberalisation shock on the end-of-period capital stocks located within the Asia-Pacific economies tends to reduce the perceived risk of the other Asia-Pacific economies, while increasing the perceived risk of the Rest of World (growth effect). Due to the fall in end-of-period capital stocks located in Japan, perceived risk also rises in Japan. As noted above, these changes in risk caused by the 'growth effect' are shown in Figure 2 as shifts in the schedules. In the case of investments "in Asia-Pacific", the schedule moves downwards to the right. Conversely, the "in Japan" and "in ROW" schedules move up to the left.

The reduction in risk (rsklp(r,t)) has the effect of increasing the risk-adjusted expected rates of return (roreflp(r,t): Equation 4) for the other Asia-Pacific economies and lowering them for Japan and the Rest of World. Investment (or end-of-period capital stocks) will flow towards the higher risk-adjusted expected

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6. This can also be related to growth since end-of-period capital stocks depend on the beginning-of-period capital stocks and the growth rate of capital; if an economy is growing faster than average over time, risk will tend to fall over time.

rates of return in the Asia-Pacific (rightward movements along the curve labelled "in Asia-Pacific" in Figure 2) and away from Japan and the Rest of World (leftward movements along the curves labelled "in Japan" and "in ROW" in Figure 2). This will occur until the percentage changes in the risk-adjusted expected rates of return equate across regions for each permanent resident of t (Equation 3).

Overall Asian investors fail to find sufficient funds to take full advantage of the higher risk-adjusted rates of return. With the exception of Thailand-Philippines, the changes in perceived risk are relatively small. For the owners of capital whose permanent residence is in the Asian economies, and who do not have an existing pool of capital stocks from which funds can be drawn, increases in end-of-period capital stocks are restricted to their own economies (where the slope parameter RISKFLEXLP(r,t) is relatively low) and in some cases one or two other countries (usually Thailand-Philippines where the risk has fallen substantially). As a result, ownership of end-of-period capital stocks generally falls or rises only slightly.

Capital stocks owned by permanent residents of t are then a weighted sum across regions r of the capital stocks located in region r and owned by permanent residents of t. With a large weighting on capital stocks located in region r and owned by permanent residents of r we would expect capital stocks owned by the Asia-Pacific (North America and Japan excluded) economies to rise while capital stocks owned by the Rest of World, North America and Japan are expected to fall. This is not always the case, however. In Taiwan, Malaysia and Indonesia the large decreases in investment elsewhere in the world have resulted in overall declines in their ownership of end-of-period capital stocks.

The increase (decrease) in capital stocks owned by the permanent residents of t increases (decreases) income earned and hence real gross national product (qgnp(t)).

In general risk-adjusted rates of return depend inversely on the volume of global saving and investment. In this case global saving decreases (globalcgds) and thus the risk-adjusted expected rates of return are expected to rise. Slight differences in the extent to which they fall are related to the extent to which permanent residents can obtain funds for investing. Hence expected risk-adjusted rates of return tend to rise by less in the Rest-of-World, Japan and North America than in the other Asia-Pacific economies.

4.2.2 A Comparison of the Long-run Effects of Asia-Pacific Trade Liberalisation using the Revised GTAP Model and the Standard GTAP Model

In this section the long-run results of the Asia-Pacific trade liberalisation shock using the revised GTAP model (Table 2) are compared with those obtained in Walmsley (1998) using a risk-adjusted long-run closure for the standard GTAP model (Table 3).

The primary difference between the results obtained in Walmsley (1998) and those obtained using the revised model developed above, is that capital stocks increase much further in the standard GTAP simulations. In the standard GTAP model all income earned on capital stocks located within a region is assumed to accrue to the permanent residents of that region. This income can then be allocated to the production of new capital goods; no concern need be given to the exogenously determined risk premia. In the revised GTAP model, income does not necessarily accrue to the permanent residents of the region in which the income was earned. Instead income will often accrue to foreigners who own the capital. These foreigners will consider carefully the effects on risk before investing more capital into the region. While the level of risk perceived by permanent residents investing in their home region increases only slowly with further investments, investment by permanent residents of other regions may cause risk to increase substantially due to the higher slope parameter of the perceived risk schedule (RISKFLEXLP(r,t)). Thus even though an economy may appear to be a good investment to the permanent residents of that economy, foreigners may not agree.

Table 3
Long-Run Results for APEC Trade Liberalisation: Risk-Adjusted Version of Standard GTAP Model with Standard GTAP treatment of Assets using Standard GTAP Database

Regions[a]	Standard GTAP Database		
	Current Rate of Return (rorc)	Capital Stocks (kb)	Real GDP (qgdp)
NAM	1.82	-0.63	-0.20
JPN	3.08	-0.60	0.92
AUS	2.50	5.52	2.38
NZL	2.56	5.65	2.44
CHN_HKG	3.73	9.12	4.82
SKOR	3.06	14.25	9.96
TWN	1.89	12.52	8.49
MYS_SGP	2.65	20.37	13.18
THA_PHL	1.91	65.81	44.71
IDN	1.42	10.19	6.41
ROW	1.81	-3.17	-1.45
globalcgds	1.07		
roref	4.51		

a. Percentage deviation from control.

5. The Steady-State

5.1 The Creation of the Steady-State Database

In the long-run closure outlined above capital stocks adjust to ensure that the growth rate of capital returns to its pre-simulation value in the GTAP database. That is, the powers of the growth rates of capital are all assumed to be exogenous and the percentage changes in them are set to zero. This is equivalent to an assumption that the shock will not affect the growth rate of capital in the long run. This is only true when discussing the very long run or steady state, where the growth rate of capital is determined by the growth rate of the population and technological growth. It is highly unlikely that an Asia-Pacific trade liberalisation shock will *permanently* affect either the growth rate of the population or technology. Hence the results of this long-run closure represent the move from an initial steady-state position to a new steady-state position in which the effects of the shock are incorporated but where the growth rate of capital has returned to its pre-simulation or steady-state value. It therefore follows that the initial value of growth in the GTAP database should be consistent with this steady-state growth rate of capital. Since the GTAP database is based on a particular year (in this case 1992), it is highly unlikely that the growth rate in the GTAP database is the steady-state growth rate. Therefore there exists an inconsistency between the long-run closure in the GTAP model and the database. This inconsistency is resolved with the creation of a steady-state database. The method used to create this steady-state database is similar to that used in Walmsley (1998).

In order to create a steady-state database, in which growth rates are equal across regions of location and ownership, shocks are imposed on the powers of the growth rates of capital (kbgrowlp(r,t)) by location and ownership. These shocks equate all growth rates to a global average growth rate of capital (3.1881%).

The shocks imposed on the powers of the growth rates of capital, to equate them all to this average power, are provided in Table 4.

Table 4
Shocks to the Powers of the Growth Rates of Capital to the Create Steady-State Database

Permanent Residency of Owner												
Location	NAM	JPN	AUS	NZL	CHN_HKG	SKOR	TWN	MYS_SGP	THA_PHL	IDN	ROW	kbgrow
NAM	1.16	1.68	1.91	2.00	1.98	2.15	2.00	1.95	2.63	2.90	1.58	1.23
JPN	-1.19	-2.12	-0.21	0.65	-1.19	-0.82	-0.89	-0.87	1.69	1.24	-1.42	-2.03
AUS	2.05	1.95	1.35	1.96	2.17	2.48	2.65	2.01	4.16	4.38	1.95	1.49
NZL	2.98	3.14	2.62	2.31	3.04	4.14	3.4	2.74	4.46	4.24	2.93	2.46
CHN_HKG	-3.10	-4.53	-3.24	-1.84	-4.32	-3.37	-3.52	-3.50	-0.13	1.27	-3.88	-4.23
SKOR	-6.81	-7.33	-5.79	-6.29	-6.85	-7.85	-6.59	-6.80	-5.04	-4.45	-7.04	-7.80
TWN	-3.85	-3.85	-3.65	-2.99	-3.96	-3.34	-4.71	-4.06	-3.53	-3.11	-3.73	-4.63
MYS_SGP	-3.64	-3.93	-3.78	-3.39	-3.81	-3.69	-4.00	-4.52	-2.79	-2.56	-3.83	-4.36
THA_PHL	-5.66	-5.71	-5.47	-5.14	-5.81	-5.41	-5.81	-5.90	-5.95	-4.71	-5.53	-5.88
IDN	-5.16	-5.31	-5.33	-4.42	-5.46	-5.43	-5.56	-5.55	-4.80	-5.79	-5.40	-5.66
ROW	0.72	0.90	0.95	1.20	1.39	1.34	1.21	1.03	2.07	1.78	0.53	0.58
kbgrowperm	0.96	-1.64	1.25	2.18	-4.02	-7.52	-4.29	-3.59	-5.79	-5.14	0.54	

The average percentage changes to the power of the growth rates of capital located in region r (final column in Table 4, kbgrow) show that in the non-Asian economies the average shock to the growth rate of capital is positive (reflecting the low growth rates of the non-Asian economies in the revised standard GTAP database), while in the Asian economies the average shock is negative (reflecting higher than average growth rates for the Asian economies in the revised standard GTAP database).

5.2   The Results from the Creation of the Steady-State Database

The results from the creation of the steady-state database are depicted in Table 5. The results show that in those Asian economies where growth rates are reduced, real gross domestic product and gross national product rise. In the non-Asian economies, where growth rates are increased, real gross national product (and in all cases except ROW, gross domestic product) falls.

The reason for this is that the power of the growth rate of capital (kbgrow(r)) located in region r forms a wedge between the expected rate of return (rorelp(r,t)) and the current rate of return (rorclp(r,t)) on capital located in region r and owned by permanent residents of t. The fall (rise) in the power of the growth rate of capital within the Asian (non-Asian) economies therefore causes the current rate of return to fall (rise) relative to the expected rate of return[7]. As a result current rates of return fall in the Asian economies and rise in all non-Asian economies except the Rest of World. In the case of the Rest of World, the small positive shock to the power of the growth rate and the large negative percentage change in the expected rate of return means the current rate of return also falls.

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7. Expected rates of return fall due to a global improvement in saving and investment. This causes the current rates of return to fall significantly in the case of the Asian economies, and rise only slightly in the case of the non-Asian economies.

Falls (rises) in the current rate of return lead to corresponding falls (rises) in the rental price of capital (rentallp(r,t)) relative to the price of capital goods (pcgds(r))[8]. A lower (higher) relative price of capital (rentallp(r,t)) to labour (ps("labor",r)) causes producers to substitute away from (towards) labour inputs and towards (away from) capital inputs within the Asian (non-Asian) economies. With beginning-of-period capital stocks determined endogenously in this long-run closure, capital stocks then increase (decrease) with the increase (decrease) in demand. The increase (decrease) in capital stocks then leads to a corresponding increase (decrease) in gross domestic product.

Table 5
Results from the Creation of a Steady-State Database

Regions[a]	Real GDP (qndp)	Real GNI/ GNP qgnp)	Current Rate of Return (rorclp)[b]	Expected Rate of Return (rorelp)[c]	Risk-adjusted Rate of Return (rorfp = roreflp)	Capital Stocks (kb)	Gross Investment (qcgds)	Owner-ship of Capital Stocks (kbperm)
NAM	-2.21	-16.16	2.93	-8.93	-22.64	-4.61	15.58	-39.9
JPN	27.75	54.16	-31.39	-15.79	-22.93	78.76	37.83	127.63
AUS	-0.85	-16.44	1.39	-12.53	-23.17	-1.74	24.46	-45.47
NZL	-4.53	-25.04	11.27	-12.78	-23.48	-11.16	35.71	-73.73
CHN_HKG	40.38	101.5	-47.88	-19.67	-23.66	132.01	41.95	339.41
SKOR	180.44	347.73	-63.02	-16.68	-24.09	628.58	228.95	1283
TWN	53.15	93.07	-43.87	-9.83	-23.67	170.62	59.48	325.81
MYS_SGP	94.14	205.39	-44.84	-13.88	-23.52	207.95	86.18	456.55
THA_PHL	151.72	181.65	-51.09	-10.3	-24.28	309.17	115.63	603.7
IDN	213.47	201.25	-48.42	-7.65	-23.94	516.22	231.14	739.95
ROW	1.46	-9.19	-3.61	-9	-22.72	3.95	13.28	-23.49
ke_tot				29.83				
avgrow				0.000094				
walras				0.000000				
globalcgds				28.23				

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a. All results here represent percentage deviations from control.
b. rorclp(r,t) are the same for all regions of ownership (t).
c. rorelp(r,t) are the same for all regions of ownership (t).

The allocation of capital stocks and investment across ownership depends on the risk premia (rsklp(r,t)), the risk-adjusted expected rate of return (roreflp(r,t)) and the expected rate of return (rorelp(r,t)) (see Section 4.2.1). Initially the positive effect of the steady-state shock on the end-of-period capital stocks located within the Asian economies tends to reduce the perceived risk of the Asian economies, while increasing the perceived risk of the non-Asian economies ('growth effect'). In the case of the Rest of World, the slight increase in capital stocks located there is less than the global total (i.e. ke("ROW") – ke_tot < 0), therefore (prior to any 'portfolio' adjustments) the perceived risk of investments in the ROW also increases.

Investment (and therefore end-of-period capital stocks) will flow towards the higher risk-adjusted expected rates of return in Asian economies and away from the non-Asian economies. This will occur until the percentage changes in the risk-adjusted expected rates of return equate across regions for each permanent resident of t (Equation 3).

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8. The price of capital goods (pcgds(r)) tends to move with the general price level (pgdp(r)).

Capital stocks owned by permanent residents of t are equal to a weighted sum across regions r of the capital stocks located in region r and owned by permanent residents of t. With a large weighting on capital stocks located in region r and owned by permanent residents of r we would expect capital stocks owned by Asian economies to rise while capital stocks owned by non-Asian economies fall. The increase (decrease) in capital stocks owned by the permanent residents of t increases (decreases) income earned and hence real gross national product (qgnp(t)) in the Asian (non-Asian) economies.

Since a fixed proportion of this income is saved, saving increases (decreases) in the Asian (non-Asian) economies. This increase in saving provides the Asian economies with further funds to allocate to investment across regions. The large increases in investment within the Asian economies eventually causes the expected rate of return in Asia to fall. As the risk-adjusted rates of return in Asia fall, the relatively higher rates of return in the non-Asian economies begin to offset the higher risk. In the Asian economies, where saving has increased, these secondary effects are very important and thus their share of end-of-period capital stocks (kelp(r,t) – keperm(t)) tend to increase for both investments located in other Asian economies and in non-Asian economies ("portfolio effect").

For investments undertaken by the permanent residents of the non-Asian economies the results are more ambiguous. The final change generally depends on the percentage change in the expected rate of return. For example in China where the expected rate of return falls significantly (-19.67 percent), the proportion of end-of-period capital stocks located in China and owned by permanent residents of the non-Asian economies (kelp(r,t) –keperm(t)) tends to decrease. In Taiwan and Indonesia, on the other hand, where the expected rate of return only fell by 9.83 percent and 7.65 percent respectively, the proportion increases.

In the case of own-country investment, the low value of the slope parameter (RISKFLEXLP(t,t)) prevents the perceived risk of own-country investment from falling (or rising) as far as it does for permanent residents of other regions. Thus the extent to which expected rates of return fall is more crucial in determining the resulting change in the portfolio. In the case of the permanent residents of an Asian country investing at home, the large fall in the expected rate of return on investments in their own country makes investment in other regions appear to be more profitable (higher relative risk-adjusted expected rate of return). As a result, although end-of-period capital stocks in one's own region (Asia) increase (kelp(r,t)), the share of end-of-period capital stocks located in one's own region (Asia) actually falls (i.e. kelp(r,r) – keperm(r) < 0).

In the case of non-Asia, the increase in risk is less severe when investing in one's own country. You would expect that this would cause the share (kelp(t,t) – keperm(t)) to increase; however this variable also falls, although only slightly. This would reflect the fact that higher risk-adjusted rates of return are expected elsewhere (e.g. Taiwan and Indonesia where expected rates of return fall by significantly less).

5.3   A Comparison of the Long-Run Results using the Revised GTAP Database and the Steady-State Database

In this section we compare the long-run effects of Asia-Pacific trade liberalisation using the revised GTAP model with both the revised GTAP database (Section 3) and the steady-state database (Section 5.2). The results for the two simulations are depicted in Table 2 and Table 6 respectively.

The results of the two simulations differ with respect to the changes in capital stocks. In most cases capital stocks (kb(r)) by location and capital stocks (kbperm(t)) by ownership increase by more in the long-run simulation based on the steady-state database than they do in the long-run simulation based on the revised GTAP database. The important exceptions to this observation are China-Hong Kong and

South Korea where both capital stocks by location and by ownership fall in percentage change terms relative to the long-run simulation based on the revised GTAP database.

In creating the steady-state database, there was a substantial increase in the total end-of-period capital stocks located in and owned by the Asian economies. This means that the Asian economies have greater access to funds when the steady-state database is used. With more funds to reallocate, capital stocks and hence incomes can be increased further in the long-run Asia-Pacific simulation based on the steady-state database.

In the case of the Industrialised economies, although total capital stocks owned by them falls, their share of capital stocks located in the Asian economies rises as a result of the move to the steady state. As stated above the industrialised economies tend to allocate their saving towards Asia as a result of the Asia-Pacific trade liberalisation shock. The positive changes in capital stocks located in the Asian economies and the larger share associated with these increases leads to a larger increase or smaller fall in total capital stocks owned by the industrialised economies as a result of the trade liberalisation shock.

Table 6
The Long-Run Results of the Asia-Pacific Trade Liberalisation Shock: Using Steady-State Database

Region[a]	Real GDP (qgdp)	Real GNP (qgnp)	Current Rate of Return (rorclp) (= rorelp)	Risk-Adjusted Expected Rate of return (rorelp)	Capital Stocks by Location (kb) (= ke = qcgds)	Capital Stocks by Owner (kbperm) (= keperm = qcgdsperm)	Welfare (EVPERM)
NAM	-0.58	0.27	2.83	8.23	-1.52	0.99	18609.26
JPN	-0.17	0.32	5.11	8.17	-2.76	-0.14	49617.37
AUS	1.69	1.79	4.05	8.51	4.02	7.55	8055.79
NZL	2.12	1.47	4.15	8.69	4.96	8.62	1400.39
CHN_HKG	2.82	-0.79	6.58	8.35	5.32	-0.75	-4884.00
SKOR	3.76	-8.25	5.16	8.36	3.05	-12.4	-71613.15
TWN	9.39	8.94	2.73	8.37	13.65	10.55	30932.36
MYS_SGP	17.56	5.08	4.3	8.49	26.29	5.05	13389.80
THA_PHL	53.63	29.83	2.93	8.87	73.34	23.09	65795.67
IDN	8.93	7.05	2.02	8.65	13.25	7.41	20959.30
ROW	-1.85	-0.35	2.82	8.17	-4.18	-0.81	-46458.96
globalcgds				-0.5			
avgrow				0.000017			
ke-tot				-0.0014			
walras				0.000001			

a. All results here represent percentage deviations from control.

The percentage changes in ownership of end-of-period capital stocks then determine the percentage change in gross national product. With the exception of South Korea and China, real gross national product increases, relative to the results obtained from the revised GTAP database. In South Korea and China-Hong Kong gross national product falls.

The allocation of end-of-period capital stocks across ownership is similar in the two long-run simulations. In general capital flows towards the Asian economies due to the reduction in risk resulting from the

growth effect. Thus ownership of end-of-period capital stocks tends to increase in one's own economy and within the Asian economies.

In the long-run simulation based on the steady-state database, however, the Asian economies now own a greater share of the world's capital stocks as a result of the move to the steady state. Thus the Asian economies now have more capital to reallocate towards the other Asian economies. Greater income (gross national product) also means they have greater saving. As a result the Asian economies can increase their ownership of capital stocks in the other Asian economies as well as in their own economies. In the long-run simulation based on the revised GTAP database, Asian economies were restricted from making substantial investments in the other Asian economies due to a lack of funds.

The industrialised economies, on the other hand, own a smaller proportion of the world's capital stocks as a result of the move towards the steady state. With reduced funds to reallocate across regions, the industrialised economies may not only restrict the total amount invested in each region, but may also become more particular about which of the Asian economies they invest in. That is, the industrialised economies will allocate their saving only to those Asian economies which exhibit the highest risk-adjusted rates of return as a result of the trade liberalisation shock. China-Hong Kong and South Korea are the two countries which suffer the most as a result of the higher risk-adjusted rate of return, required by the industrialised economies.

6. Conclusions

In this paper, some major alterations have been made to the GTAP model and database in order to incorporate a long-run closure in which capital is determined endogenously and income is defined in terms of income earned on endowment commodities owned, rather than on endowment commodities located in the region. Having made these alterations, the model is then used to simulate the long-run effects of an Asia-Pacific trade liberalisation shock.

In order to redefine income in terms of ownership, several fundamental changes are required to the model and database in order to incorporate the ownership of capital and land and the existence of foreign workers.

Firstly, equations and data relating to the way in which saving is allocated across regions for investment are included. The mechanism used for this allocation must be consistent with both economic theory, that risk-adjusted rates of return should equate across regions, and empirical evidence, that there is a tendency for investors to invest firstly in their home economies. A perceived risk schedule is developed for this purpose. This schedule states that the level of risk perceived by permanent residents of a region t rises as the proportion of their end-of-period capital stocks invested within the region rises relative to the proportion of global end-of-period capital stocks invested in that region. Differences in behaviour can be explained by differences in the rate at which this risk rises. Within one's own region risk rises and falls only slightly as the share of end-of-period capital stocks rises and falls relative to the global share, while risk rises and falls much faster when investing in countries other than one's own.

Secondly, once a mechanism for allocating saving across regional investment has been included, the ownership of investment and hence capital stocks can be determined. With the ownership of capital stocks well established, any rental income earned on this capital can be appropriately included in the income of the owners of the capital. In this way, changes in welfare can be properly ascertained.

In addition to capital ownership the model also includes the effect on income of foreign ownership of land and foreign labour. The quantities of both foreign and domestic labour and land are, however, determined

exogenously, as no equations have been included to describe the flows of these two endowments between regions.

With income now defined in terms of income earned by permanent residents, private expenditure, government expenditure and saving must also be defined in terms of permanent residencies. This has a considerable effect on the treatment of private expenditure as income allocated to private expenditure is then spent in the country of *temporary* residency of the household. This has a flow-through effect onto many of the demand-side equations in the model. Government expenditure and saving are only affected to the extent that they and income are redefined.

Once the equations had been altered to reflect the behaviour of permanent residents, some initial database values for the year 1992 had to be estimated for endowments, investment, saving and private expenditures. This initial database was estimated using proportions of foreign ownership and foreign workers obtained from various statistical sources. Parameters for the allocation of saving and private expenditure were then estimated by ensuring that the new database was consistent with the behavioural equations in the model.

Finally, a long-run closure was incorporated in which capital stocks responded endogenously to a shock in order to ensure that the growth rate of capital did not change and that expected and current rates of return equated within each region. This closure is similar to the one used in Walmsley (1998).

At this stage the revised GTAP model and database were used to simulate the long-run effects of Asia-Pacific trade liberalisation. These results were then compared with those obtained in Walmsley (1998) where a simple risk-adjusted long-run closure was incorporated into the standard GTAP model to determine the long-run effects of Asia-Pacific trade liberalisation. The results show that the foreign ownership of capital can significantly affect the estimates of the long-run results of trade liberalisation within the Asia-Pacific region. In the case of the revised GTAP model, although a shock may cause the demand for capital to increase, the permanent residents of that region may not have sufficient funds to finance the required increase in capital stocks. If the expected risk-adjusted rates of return are considered adequate, foreigners may be willing to fund the production of these new capital goods; however income earned on these capital goods will accrue to them. This has the effect of increasing real gross national product in the investors' regions of permanent residence, whereas real gross national product in the region where the capital is located is only marginally affected, through the indirect effect of the increase in capital stocks on labour income and taxes.

The long-run closure discussed above assumes that eventually all economies grow at a common steady-state rate of growth, determined by the rate of population and technological growth. In order to ensure valid comparative statics the underlying growth rate in the database must equal this steady-state rate of growth. Shocks are imposed to equate the growth rates of capital across regions, thus creating a steady-state database. The steady-state database is created from the revised version of the standard GTAP database.

The steady-state shocks imposed on the revised GTAP database cause growth rates in the Asian economies to decline and those in the industrialised economies to increase. The results of the creation of the steady-state database show an increase in both capital stocks located in and owned by the Asian economies, while the capital stocks located in and owned by the industrialised economies fall. Thus not only do growth rates converge across regions, but the ownership of capital stocks also converges to some extent.

The long-run effects of Asia-Pacific trade liberalisation are then examined using the revised GTAP model and the steady-state database. These were then compared with those obtained using the revised GTAP

model and database; they showed that the use of a steady-state database did significantly affect the results of the Asia-Pacific trade liberalisation shock. These differences stem from the fact that in the steady-state database the Asian (industrialised) economies own a much larger (smaller) share of the world's capital stocks and therefore have access to more (less) financial resources than they had in the revised GTAP database, which represented the current state of the world economy. In both of the long-run simulations the Asian economies relied to a certain extent on foreign investment to finance the increases in capital stocks. In the long-run simulation based on the steady-state database, South Korea and China-Hong Kong were unable to attract the smaller funds of the foreign investors and unlike the other Asian economies this slack could not be filled entirely by their own funds.

7. Bibliography

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