Modelling the effects of implementing the Uruguay Round: A comparison using the GTAP model under alternative treatments of international capital mobility

by George Verikios and Kevin Hanslow, Productivity Commission, Canberra, Australia.*

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1 Introduction

The Uruguay Round (UR) of trade negotiations was a significant first step towards capping the level of protection for agriculture, manufacturing, services and intellectual property to the status quo. It also committed members to significant liberalisation in manufacturing and agriculture. What are the quantitative effects of implementing this agreement? The answer depends, in part, on what is assumed about the movement of inter-regional capital flows. This paper models the effects of completing the implementation of the UR, using the GTAP model of world trade under alternative treatments of international capital mobility. The welfare decomposition which (i) provides an unambiguous indicator of regional welfare, and (ii) decomposes this welfare measure into its contributing parts, is modified to take account of international capital mobility.

Completing the UR implementation is modelled using four scenarios. The first two scenarios apply the standard version 4.1 of GTAP, which allows divergences between regional investment and saving, but forces all existing capital within a region to move only between industries within that region. At first glance, it seems such a treatment of capital movements is likely to ignore some of the important long-run effects of the UR, such as capital moving to regions where returns are highest. This limitation is tested in this paper. The two standard GTAP scenarios are distinguished by the investment allocation mechanism chosen. Global net investment can be allocated between regions in fixed shares, or so as to equalise the expected future rates of return on capital between regions.

The UR is then modelled using version 4.1 of GTAP, modified to allow for quasi-dynamics in regional wealth accumulation. This allows the capital stock to grow, despite the underlying model being comparative static in nature. The treatment of international capital mobility is taken from the SALTER model (see Jomini et al 1994; McDougall 1993). The welfare

* The views expressed in this paper are those of the authors and do not necessarily reflect those of the Productivity Commission.

decomposition is also modified to include income earned from abroad as part of regional welfare.

The modifications allow the user to choose the sources from which any growth in the capital stock is to be funded and, consequently, the degree of capital mobility. Scenario three adopts a closure which forces all capital stock growth in a given region to be funded from savings within that region. This simulates limited (or imperfect) capital mobility. This is similar to the 'endogenous capital, fixed savings rate' treatment in Francois, McDonald and Nordstrom (1995). Scenario four allows regions to fund growth in their capital stock by foreign borrowing. This allows full arbitrage and perfect capital mobility. This is similar to the 'long-run closure with the steady-state database' in Walmsley (1999). Unlike Francois, McDonald and Nordstrom (1995), the modifications made here allow the user to track the change in each region's debt position. It does not, however, allow the user to track changes in the ownership of capital in each region on bilateral basis as in Walmsley (1999).

2 The Models

Standard GTAP

The UR experiment is first conducted with the latest available version of GTAP. This is known as version 4.1 dating from September 1998.[1]

The closure adopted here is the standard one for this version of GTAP. This fixes all technical change variables and all rates of tax and subsidy. Further, it fixes the level of factor endowments in each region, ie. land, skilled labour, unskilled labour, capital and natural resources. Thus, the prices of all factors in each region are free to vary. At the industry level, land is mobile between industries to a limited extent and natural resources are effectively fixed for each industry. Capital and (skilled and unskilled) labour are perfectly mobile between industries within a given region.

GTAP gives the user a choice of two mechanisms for the allocation of investment across regions. One allocates global net investment in fixed shares across regions. The other allocates investment so as to equilibrate expected future rates of return on capital across regions. Allocating net investment in fixed shares leads to more stable investment behaviour.

Importantly, the investment does not come on line in the simulation period, whichever investment allocation mechanism is chosen. Thus, the behaviour of investment can only influence output through changes in the composition of final demand. Productive capacity is unaffected. This characteristic of GTAP is realistic for short-run analysis but is, clearly, unrealistic for long-run analysis.

[1] This version comes with the RunGTAP software available on the GTAP world wide web home page. See http://www.agecon.purdue.edu/gtap/index.htm.

Fixing the capital stock in each region forces regional rental prices of capital to accommodate any changes in the regional demand for capital. Thus, the model predicts that significant global trade reform, such as the UR, will lead to no change in factor intensities between regions. This is unsatisfactory, given GTAP is purpose built for analysing global trade and industry policies, and these policies not only influence the long-run allocation of capital between industries, but also between economies. Large scale structural policies, such as the UR, can also affect the size of the world capital stock (McDougall 1993). The inability of standard GTAP to simulate these effects is significant. Previous work indicates that capital accumulation can dominate the effects of trade liberalisation on output (Baldwin 1992; Francois, McDonald and Nordstrom 1995). Thus, modelling capital accumulation is important when analysing large scale structural policies such as the UR.

GTAP with international capital mobility

The second model with which the UR experiment is conducted is standard GTAP with international capital mobility (ICM). The ICM extension to standard GTAP is taken from GTAP's predecessor, SALTER (see Jomini et al 1994; McDougall 1993).[2] The extensions to the theoretical structure of standard GTAP describe wealth accumulation, and the international allocation of capital and investment. They also spell out government and private household sector accounts, which include international asset ownership and international income payments.

GTAP, like SALTER, is a comparative static model. In introducing wealth accumulation, time cannot be ignored completely in the model. That is, it is assumed that all shocks applied to the model represent discrete changes at a certain initial point in time, while the database and endogenous variables represent values observed at a certain final point in time. The simulation period is the interval between the initial and final points. This differs from a more complete, but not perfect, treatment of time where simulations are projections through time and agents are assumed to have adaptive expectations. This is the approach being taken to implement dynamics in GTAP (McDougall and Ianchovichina 1996). This is also the treatment of time in many other dynamic general equilibrium models, such as MONASH.

Modifications to the GTAP theoretical structure

The ICM extension requires the addition of two sets of assets: bonds and equity in productive assets (land, capital and natural resources) in each region. Bonds can be owned or owed by each region's representative private household and government. Equity in each region's productive assets is owned entirely by the representative private household in that region. The extension also includes income taxes on private households. Income taxes are separated into

[2] This section is largely based on McDougall (1993) and contains only a brief description of the ICM extension and the modifications required to implement it in standard GTAP. McDougall (1993) contains complete documentation of the changes required to the theoretical structure and database to add the ICM extension to a multi-regional comparative static model. It should be consulted by those seeking further detail on the nature of the ICM extension.

taxes on labour and taxes on property income (land, capital, natural resources and interest income from abroad).

The international allocation of capital is determined by international interest parity. Private households are assumed to maximise the rate of return (on all assets) and this imposes parity between the interest rate on bonds, the rate of return on equity and the rate of return on capital in each region. The total value of world stocks of capital, land and natural resources is equal to total net wealth of private households and governments in all regions. This assumes that (i) private household and government net wealth consists of equity in productive assets and net ownership of bonds, (ii) the value of equity in productive assets is equal to the value of the underlying productive assets, and (iii) world net ownership of bonds is zero.

Private household and government wealth is modelled as the outcome of a wealth accumulation process. Private households and governments are assumed to save (or dissave) some predetermined share of their net disposable income. It is also assumed that (i) real income grows at a constant rate through the simulation period, (ii) any change in the saving ratio is concentrated at the beginning of the simulation period, and (iii) changes in relative prices are concentrated at the beginning of the simulation period. The model then takes the policy-induced deviations in income and saving in the final period, uses the above assumptions to deduce the deviation in the entire path of saving between the initial and final periods, and then translates this into a deviation in the final wealth that would have been accumulated by the interim savings.

The international allocation of investment is based on the same parity conditions as the international allocation of capital. To maintain these parity conditions, investment must be allocated across regions and industries so as to equalise time rates of change in rates of return.[3]

Given the comparative static nature of GTAP, wealth accumulation and the international allocation of investment must be of a quasi-dynamic nature. This rules out the imposition of model-consistent expectations, where rates of return expected to be earned in later periods are consistent with actual rates in those periods. Hence, in modelling expected rates of return, all that can be achieved is broad consistency with the behaviour of actual rates of return in the model.

The movement of capital between regions in the ICM extension is facilitated by changes in regional bond holdings (debt). The benefit (cost) to a region buying (selling) bonds is the interest receipts (payments). Interest receipts (payments) now represent an additional source of real income and regional welfare. Hence, the GTAP welfare decomposition is altered by adding an extra term which accounts for this new source of regional welfare. This is further decomposed into the contributions to regional welfare of changes in real bond holdings, changes in interest rates and changes in the asset price of bonds. This decomposition mirrors the treatment of the welfare effects of capital accumulation. The last contribution is summed

[3] This new investment allocation mechanism requires that the original GTAP investment theory be 'turned off'. This is done by endogenising all except one component of the slack variable for investment, ie. cgdslack.

with the existing terms of trade contributions (CNTtotr and CNTcgdsr) to produce a complete terms of trade effect for the ICM extended model.

Modifications to the GTAP database

A variety of additional data are required for the extended model. These include private household and government interest income, income taxes on labour income and property income. An element measuring the world real bond rate is added, which allows asset values to be calculated from property income flows. This is set equal to the world rate of return on capital implied in the GTAP 4 database (McDougall, Elbehri and Truong 1998). The real rate of return on equity for each region is also set equal to the world rate of return on capital implied in the GTAP 4 database. Rates of growth in real private household income and real government receipts for each region (needed to calibrate the quasi-dynamics) are set equal to the average rates of growth in real gross domestic product over the period 1985-1995. The length of the simulation period is set at 10. This is also used to calibrate the quasi-dynamics.

Changes to the existing GTAP 4 database were also required to ensure consistency with the theory added in the ICM extension. The ICM extension models the accumulation of capital and wealth between two long-run equilibrium points. To prevent deviations from long-run equilibrium from distorting investment results, the capital stock was calibrated for long-run equilibrium. That is, it was adjusted so that the implied rates of return between regions were equalised. The regional rates of return were set equal to the world rate of return. This was done by amending the value of the beginning-of-period capital stock in each region.[4]

The GTAP 4 database used in this experiment had negative net savings values for the Philippines and Hong Kong. With negative net savings, the allocation of income between consumption and savings can no longer be regarded as the result of a utility maximising decision.[5] Consequently, the values of net savings for each of these regions was adjusted to be positive by decreasing each region's value of depreciation. For the Philippines, this was done by setting depreciation equal to the lowest depreciation rate in the database used for this experiment. This was 7.08 per cent for Taiwan. For Hong Kong, the above procedure still left negative savings. Therefore, the depreciation rate was set (arbitrarily) equal to half the depreciation rate for Taiwan. Net savings for both regions were increased by the amount that depreciation was reduced, in order to maintain the initial value of GDP and a balanced database.

4 This is the VKB header in the GTAP 4 database. This is one simple method of calibrating the capital stock for long-run equilibrium. A more complex method is that used in Walmsley (1999), where shocks to output are applied to the model so as to achieve equalisation of regional rates of return on capital.

5 For instance, consider total consumption (government and private household spending) as one item. Then, when saving is negative, nominal consumption is equal to a constant proportion of nominal income in the GTAP specification. The income elasticity of consumption is 1, and the uncompensated price elasticity is -1. The compensated price elasticity is thus, by the Slutsky relationship, $-1 + (S^C)*1 > 0$, where S^C is the share of consumption in income, since the share of consumption in income is greater than 1. Thus the allocation of income cannot be the outcome of a utility maximisation decision.

The closure adopted for the simulations with the ICM extended model is one that captures the long-run effects of liberalisation, typically a 10 year period. As such, this usually involves holding the level of employment and technology fixed. Conversely, the real wage and the capital stock are allowed to vary. On the demand side, private household consumption expenditure, government consumption expenditure and total net savings are set equal to fixed nominal shares of net national product (as in GTAP). Income tax rates are determined by holding the government saving ratio (defined as the ratio of government savings to total government revenue) fixed. Investment and the trade balance are endogenous. The modified model allows the user to choose whether growth in the capital stock must be fully financed from domestic savings (imperfect capital mobility), or whether it can be financed from domestic and overseas savings (perfect capital mobility). Both closures are implemented.

3 Aggregation

A 19 region aggregation is used for the simulations. The regions are Australia, New Zealand, Japan, the Republic of South Korea, Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Hong Kong, Taiwan, Canada, the United States, Mexico, Chile, the rest of the Cairns Group (ROC), the European Union (EUN) and the rest of the world (RST). Except for the last three regions, all are stand alone regions in GTAP 4. ROC, EUN and RST are aggregations of existing GTAP 4 regions. ROC includes Colombia, Argentina, Brazil and Uruguay. EUN includes the 15 EU members. All remaining regions are aggregated into RST.

The commodity aggregation used is the complete 50 commodity grouping in GTAP 4. This aggregation breaks down agricultural, mining and manufactured goods to a fine level. Only services are highly aggregated. However, this is unimportant for the purposes of this experiment as the UR is expected to lead to little or no liberalisation in services (Hoekman 1995).

4 Implementing the Uruguay Round

The starting database for the simulations is GTAP 4. This provides a snapshot of bilateral trade and protection for 1995. As such, it reflects partial UR implementation.[6] Simulating the remaining implementation of the UR requires shocking the database to reduce protection to post-UR levels. The UR involved reducing protection by reducing the use of four instruments. These were import tariffs, export subsidies, output subsidies and the export tax equivalents of the Multifibre Agreement (MFA). Calculating the shocks required to simulate the remaining implementation of the UR differed for each instrument.

6 The UR was concluded in 1994 and allows for yearly staged reductions in tariffs, with most final offer rates due to come into effect by January 1, 1999 (McDougall 1997).

Import tariffs

The GTAP 3 database contains data on post-UR rates for import tariffs (McDougall 1997). These rates were compared with the rates in GTAP 4. Where import tariffs were (i) present in both databases and (ii) lower in GTAP 3 than GTAP 4, then the shock was equal to the percentage difference between the powers of the two rates.[7] Table 1 lists the comparable shocks to the average ad valorem tariff rates for 4 major commodity groups in each region. The shocks listed in Table 1 are weighted by the value at market prices of each commodity in total imports from all sources.[8] Table 1 indicates that the highest average shocks were for agricultural, food processing and manufacturing commodities.

Export subsidies

Ingco (1995) estimated the reductions in export subsidies for agriculture and food processing in GTAP 3 needed to achieve the post-UR rates. These were 34 per cent in industrial economies and 24 per cent in developing economies.[9] Where export subsidies were present in GTAP 3, these were reduced by 34 and 24 per cent in industrial and developing economies, respectively. Where export subsidies were present in GTAP 4 and were higher than the adjusted GTAP 3 rates, the shocks applied were the per cent difference between the adjusted GTAP 3 and GTAP 4 powers of the export subsidies. Table 2 lists the comparable shocks to the average ad valorem export subsidies in each region for agricultural and food processing commodities, weighted by the share of each commodity in total exports at domestic (pre-subsidy) prices.

7 The power of the tariff is 1 plus the (ad valorem) rate divided by 100.

8 Market price weights were used so that the commodities with the highest tariffs (and hence higher market price relative to world price) received the highest weights in summarising the shocks.

9 As per the UR agreement, Australia, New Zealand, Japan, Canada, the United States and the European Union were treated as industrial economies. All other regions were treated as developing (GATT Secretariat 1994).

Table 1 **Average reduction in ad valorem tariff rates by region, weighted by the value of imports at market prices**

Region	*Agriculture*	*Mining*	*Food processing*	*Manufacturing*
	%	%	%	%
Australia	-7.4	-0.5	-3.7	-6.9
New Zealand	-0.3	-0.1	-1.6	-0.6
Japan	-12.8	-0.6	-2.5	-2.9
Korea	-8.9	0.0	-2.6	-2.5
Indonesia	0.0	-1.2	-0.5	-2.9
Malaysia	-9.0	-2.8	-6.0	-8.3
Philippines	-12.4	-0.2	-4.3	-7.3
Singapore	-20.3	0.0	-11.6	-0.7
Thailand	-7.5	-0.1	-8.5	-0.4
China	-0.3	-0.9	-0.7	-0.9
Hong Kong	0.0	0.0	0.0	0.0
Taiwan	-0.1	-0.8	-1.9	-8.0
Canada	-1.5	-0.1	-4.6	-2.5
United States	-1.0	-0.3	-5.8	-7.0
Mexico	-3.4	-0.5	-0.2	-0.5
Chile	0.0	0.0	0.0	0.0
Rest of Cairns	-0.3	-4.7	-1.1	-0.5
European Union	-0.8	-0.1	-1.4	-2.5
Rest of World	-4.3	-0.4	-3.1	-1.3

Table 2 **Average reduction in ad valorem export subsidy rates by region, weighted by the value of exports at pre-subsidy prices**

Region	*Agriculture*	*Food processing*
	%	%
Australia	-9.2	-3.8
New Zealand	0.0	0.0
Japan	-0.4	0.0
Korea	0.0	-0.3
Indonesia	-0.1	0.0
Malaysia	0.0	0.0
Philippines	-0.3	-0.7
Singapore	-8.7	0.0
Thailand	0.0	-0.2
China	-0.2	-0.7
Hong Kong	0.0	0.0
Taiwan	0.0	0.0
Canada	-4.5	-1.7
United States	0.0	-2.7
Mexico	0.0	0.0
Chile	-0.3	0.0
Rest of Cairns	-0.1	-6.6
European Union	-0.2	-2.9
Rest of World	0.0	-3.9

Output subsidies

Francois, McDonald and Nordstrom (1995) estimated the reductions in output subsidies for agriculture and food processing in GTAP 3 needed to achieve post-UR rates. These were 20 per cent in industrial economies and 13 per cent in developing economies. Applying these reductions to the initial (ad valorem) output subsidy rates in GTAP 3, where they were present, gives the target post-UR rates used in this paper. Where output subsidies were also present in GTAP 4 and these were higher than the target post-UR rates, then the shock was calculated as the percentage difference between the two powers of the output subsidies. Table 3 summarises the comparable shock to the average ad valorem output subsidies in each region for these commodities, weighted by the share of each commodity in the value of domestic production at agent's (supply) prices.

Table 3 **Average reduction in ad valorem output subsidies by region, weighted by the value of output at agent's (supply) prices**

Region	*Agriculture*	*Food processing*
	%	%
Australia	-14.7	-14.5
New Zealand	-5.8	0.0
Japan	-9.8	0.0
Korea	0.0	0.0
Indonesia	0.0	0.0
Malaysia	0.0	0.0
Philippines	0.0	0.0
Singapore	0.0	0.0
Thailand	0.0	0.0
China	0.0	0.0
Hong Kong	0.0	0.0
Taiwan	0.0	0.0
Canada	-16.8	0.0
United States	-8.2	0.0
Mexico	-6.3	-4.7
Chile	0.0	-1.9
Rest of Cairns	-1.9	0.0
European Union	-7.5	0.0
Rest of World	-10.2	-4.8

Multifibre Agreement

GTAP 4 contains estimated export tax equivalents of the quota restrictions existing under the MFA. These were reduced to zero in accordance with the UR, where it was agreed to completely abolish the MFA. Table 4 summarises the bilateral average export tax rates in GTAP 4 for textiles and wearing apparel, weighted by the value of exports at fob prices.

Table 4 **Average bilateral MFA export tax rates in GTAP 4, weighted by the value of exports at fob prices**

Exporting regions	*Importing regions*			
	Canada	*United States*	*European Union*	*Rest of World*
	%	%	%	%
Korea	2.0	2.0	1.2	0.0
Indonesia	2.3	2.7	0.9	0.0
Malaysia	3.7	3.7	1.4	0.1
Philippines	2.6	2.6	0.9	0.1
Singapore	0.6	0.6	0.2	0.0
Thailand	5.5	6.7	2.1	0.1
China	19.7	20.3	8.0	0.9
Hong Kong	14.8	15.1	5.4	1.6
Taiwan	2.4	2.5	1.2	0.0
Mexico	0.1	0.0	0.1	0.0
Rest of Cairns	0.0	0.1	0.0	0.0
Rest of World	6.9	3.9	1.0	0.2

Source: GTAP 4 database.

4 Results

Standard GTAP

As noted, standard GTAP allows the user two choices for the allocation of investment. One allocates net (of depreciation) investment in fixed shares across regions, the other equalises (expected) future rates of return across regions. Results are usually more stable with the fixed shares mechanism, as regional investment moves in line with global saving, which is typically quite stable (GTAP 1996).

Fixed shares scenario

Table 5 reports the impact of remaining UR liberalisation on six important variables. As expected, the fixed shares investment allocation mechanism causes small, stable changes in investment for all regions. As standard GTAP assumes no international income receipts, all changes in investment must be accommodated by changes in net exports. Increased investment puts upward pressure on domestic prices and this, in turn, causes a real appreciation of the exchange rate. A higher real exchange rate makes exports less competitive and imports more competitive, causing net exports to decrease. But with small, stable changes in investment, the effects on the balance of trade are also quite small. Terms of trade effects, however, do differ significantly between regions. For example, in Australia, New Zealand and Chile, the large terms of trade gains are due to increasing world and regional export prices of most exports, and agricultural exports in particular. All three of these economies are large, efficient agricultural exporters, and the UR involves reductions in output and export subsidies on

agricultural and food processing commodities, putting upward pressure on world prices. In the case of the Philippines, the terms of trade loss is due to decreasing world and regional export prices, particularly for manufactured goods. The UR involves reductions in import tariffs on manufactured goods, putting downward pressure on the world prices of these goods.

Allocating net investment in fixed shares between regions causes large divergences in the expected future rates of return among regions. Some economies experience relatively large increases in expected future rates of return, for example, Australia (7 per cent), Singapore (4.5 per cent), the Philippines (4 per cent), Malaysia (3.5 per cent), and New Zealand and China (1.9 per cent). Other regions experience changes in expected future rates of return that are close to zero or negative. If capital was highly mobile between regions, these values indicate which regions could attract large capital flows and investment. Thus, these rates can be used as a benchmark for indicating which regions will attract the largest capital flows in the later simulations, holding other constraining factors constant.

Table 5 **UR experiment using standard GTAP with fixed shares investment allocation**

Regions	*Balance of trade*	*Terms of trade (tot)*	*Real investment*	*Contribution of tot to EV*	*Contribution of allocative efficiency to EV*	*Equivalent variation (EV)*
	% of GDP	%	%	$USm	$USm	$USm
Australia	0.29	6.48	0.15	4,208	1,428	5,918
NZL	0.19	3.87	0.18	724	36	701
Japan	-0.07	-0.61	0.17	-2,679	4,203	1,374
Korea	-0.13	-0.06	0.25	-118	873	757
Indonesia	0.19	-0.15	0.25	-60	495	457
Malaysia	-0.10	-0.45	0.26	-363	348	17
Philippines	0.09	-2.06	0.27	-633	326	-562
Singapore	0.44	0.92	0.23	1,203	236	1,434
Thailand	0.00	0.73	0.26	509	-22	479
China	0.42	-0.31	0.26	-463	6,912	6,139
HKG	0.17	-0.38	0.34	-425	413	340
Taiwan	0.05	-0.18	0.24	-170	326	270
Canada	-0.01	0.28	0.16	513	487	1,074
US	-0.01	0.46	0.17	3,958	10,840	14,405
Mexico	0.00	-0.60	0.11	-503	76	-340
Chile	0.16	2.06	0.22	379	20	394
ROC	0.00	1.03	0.15	993	546	1,611
EUN	0.00	-0.21	0.13	-5,091	17,661	12,784
RST	0.01	-0.24	0.13	-2,150	5,001	2,767

a The difference between EV and the two contribution to EV terms reported, is the effects of changes in the price of investment and changes in the marginal utility of income. These effects were relatively small and, hence, are not reported.

b The numbers reported for the balance of trade are changes in percentage points, not percentage changes.

The welfare effects are variable. They are dominated by the effects on welfare of the changes in the terms of trade and allocative efficiency.[10] Economies with large terms of trade gains, such as Australia, New Zealand and Chile, receive nearly all their increased welfare from this source. The welfare effects of changes in allocative efficiency are also an important influence on the overall welfare effects. This is especially the case for those economies that are large in absolute terms and/or experience the largest reductions in protection, for example, Australia, Japan, China, the United States and the European Union.

Rates of return scenario

The alternative investment allocation mechanism in GTAP operates so as to equalise the expected future rates of return between regions. This allocation mechanism is meant to represent the international capital market in short-run equilibrium — capital moves between regions so as to equalise (expected) rates of return, but this is not fast enough to affect physical capital stocks within the simulation period (GTAP 1996). Thus, this investment mechanism can be interpreted as mimicking a high degree of capital mobility between regions.

The size of changes in the expected future rates of return have been observed from the fixed shares scenario. The economies with relatively large increases in expected returns were Australia (7 per cent), Singapore (4.5 per cent), the Philippines (4 per cent), Malaysia (3.5 per cent), and New Zealand and China (1.9 per cent). Table 6 shows that, by and large, it is these economies that experience the largest increases in investment in the second scenario. The differences in investment outcomes between regions are also quite large, compared with the fixed shares scenario.

Those economies that experience higher investment in the second scenario also run larger balance of trade deficits, as all divergences between net savings and investment must be accommodated by changes in net exports. In turn, this allows these economies to improve their terms of trade to a greater extent or to reduce the deterioration in their terms of trade, relative to the fixed shares scenario. The larger improvement in the terms of trade (smaller deterioration) leads to a larger welfare gain (smaller welfare loss) from changes in the terms of trade than under the fixed shares mechanism. Thus, these economies experience smaller overall welfare losses or larger overall welfare gains than in the fixed shares scenario. This includes economies such as Australia, Singapore, the Philippines, Malaysia, New Zealand and China, among others.

[10] Other contributions to changes in welfare come from changes in the price of investment and changes in the marginal utility of income. These effects were relatively small and, hence, are not discussed.

Table 6 **UR experiment using standard GTAP with rates of return investment allocation**

Regions	*Balance of trade*	*Terms of trade (tot)*	*Real investment*	*Contribution of tot to EV*	*Contribution of allocative efficiency to EV*	*Equivalent variation (EV)*
	% of GDP	%	%	$USm	$USm	$USm
Australia	-1.90	8.96	11.28	5,514	2,027	8,259
NZL	-0.49	4.18	3.81	777	87	799
Japan	0.07	-0.95	-0.31	-4,309	4,180	-296
Korea	-0.22	-0.04	0.54	-89	881	780
Indonesia	-0.56	0.41	2.96	245	536	762
Malaysia	-1.47	-0.21	4.32	-155	325	177
Philippines	-1.37	-1.53	7.03	-485	408	-306
Singapore	-1.33	1.03	4.81	1,342	262	1,600
Thailand	0.02	0.79	0.25	545	-17	513
China	-0.17	-0.01	2.16	208	7,604	7,308
HKG	-0.24	-0.31	1.42	-405	408	396
Taiwan	-0.33	-0.07	2.10	-17	373	438
Canada	0.09	0.25	-0.39	448	421	951
US	0.06	0.36	-0.29	3,143	10,270	12,844
Mexico	0.45	-0.78	-3.14	-673	72	-477
Chile	-0.19	2.37	1.79	434	42	469
ROC	-0.08	1.22	0.60	1,177	711	1,977
EUN	0.10	-0.27	-0.40	-6,398	17,259	11,028
RST	-0.01	-0.18	0.23	-1,617	4,948	3,207

a The difference between EV and the two contribution to EV terms reported, is the effects of changes in the price of investment and changes in the marginal utility of income. These effects were relatively small and, hence, are not reported.

b The numbers reported for the balance of trade are changes in percentage points, not percentage changes.

Conversely, those economies that experience lower investment in the second scenario run smaller balance of trade deficits and experience a greater deterioration or smaller improvement in their terms of trade, compared with the first scenario. This leads to smaller welfare gains (larger welfare loss) than in the first scenario. This affects economies such as Japan, Canada, the United States, Mexico and the European Union.

The different behaviour of investment between the two scenarios also causes different welfare gains from changes in allocative efficiency. The allocative efficiency gains for a given region are generally greater, the higher the level of investment in that region. As UR liberalisation involves only reductions in taxes and subsidies, it generally leads to allocative efficiency gains.[11] Reducing import taxes usually increases imports and decreases domestic production of the import competing industries. This improves allocative efficiency as resources are freed up for use in relatively higher social marginal value uses. Similarly, reducing export subsidies usually decreases exports and domestic production of relatively low social marginal value

11 Thailand experiences a negative welfare contribution from the change in allocative efficiency as the biggest increases in domestic output are in the most highly protected industries, for example, wheat, sugar cane and sugar beet, dairy products, sugar, and beverages and tobacco products.

uses. Again, this improves allocative efficiency. Thus, the more an economy decreases its net exports, the more it gains in terms of allocative efficiency.

But higher investment in a given region also leads to a reduction in net exports and a larger balance of trade deficit than would otherwise be the case. Take Australia as an example. Investment increases by more in the second scenario, Australia runs a larger balance of trade deficit and gets a bigger welfare improvement from the change in allocative efficiency. New Zealand, Korea, Indonesia, China experience similar effects. In contrast, investment in Japan is lower in the second scenario, Japan runs a smaller balance of trade deficit (or a larger surplus), and is estimated to have a smaller welfare gain from the change in allocative efficiency. Canada, the United States and the European Union experience similar effects.

GTAP with international capital mobility

The ICM extended model differs from standard GTAP in two fundamental ways. One, private households and governments are able to accumulate wealth and, two, capital is free to move between regions. The user is given the choice, though, of the source of funding for any capital stock growth that will occur in a given region. This choice also determines the degree of inter-regional capital mobility. If the user holds the view that domestic savings and investment move together, and that inter-regional capital mobility is limited (eg. Feldstein and Horioka 1980), then the model can be closed in a way that forces all growth in regional stocks to be funded exclusively from domestic savings. On the other hand, if the user holds the view that the degree of inter-regional capital mobility is quite high, then the model can be closed in a way that allows all regions to fund growth in their capital stocks from domestic *and* overseas savings. In the sections below, both scenarios are implemented.

Imperfect capital mobility scenario

In this scenario, regions are able to accumulate capital, but they are restricted to using only domestic savings for capital stock growth. This is done by holding regional bond to income ratios fixed. This imperfect capital mobility scenario is consistent with the views of Feldstein and Horioka (1980).

Under this setting, investment moves to equalise time rates of change in the rate of return on capital. By comparison, in standard GTAP, investment responds to the level of the rate of return. These two adjustment mechanisms can be reconciled. The time rate of change in the rate of return is a function of the level of the rate of return and what is assumed about the speed of adjustment. Thus, in the ICM extended model, investment is a function of the level of the rate of return and the speed of adjustment. As a result, the behaviour of investment lies

somewhere between that observed in the rates of return scenario and the fixed shares scenario.[12]

Under this scenario, investment is slightly more unstable than in the fixed shares scenario (see Table 7). In general, those economies with large increases in expected rates of return in the fixed shares scenario invest more here than in the fixed shares scenario. They also experience higher growth in their capital stocks compared with other regions. But this growth is constrained, since it can only be funded from domestic savings. Thus, economies with high domestic saving rates are able to expand their capital stocks more quickly than other regions.

Take China as an example. It has the second highest net savings rate (as a percentage of GDP) of all regions in the GTAP 4 database. Consequently, it experiences the second largest increase in the capital stock of any region, despite the increase in its expected future rate of return being relatively low. The larger capital stock increases real income. This also allows increased (negative) holdings of bonds (debt) in absolute terms,[13] remembering that the regional bond to income ratio is being held fixed. Bond holdings also increase in real terms, since the asset price of bonds falls. Combined with a slightly higher rate of return on bonds, real interest payments on debt increase. Thus, the large growth in real bond holdings leads to an adverse welfare effect for China. However, this is more than offset by the large growth in the capital stock, which causes a significant and positive welfare effect from growth in endowments.

The Philippines represents an opposite case. Despite its increase in the expected rate of return being higher than most regions, its very low net savings rate causes the capital stock to decrease slightly. Thus, there are no (sizeable) welfare effects from changes in real bond holdings (debt) or changes in endowments. As in the fixed shares scenario, the welfare effects of changes in the terms of trade and changes in allocative efficiency dominate the Philippines' overall welfare effect.

Economies that have very low or negative changes in expected rates of return, ie. Japan, Canada, and Mexico, invest less under the present scenario than in the fixed shares scenario, despite their moderate saving rates. Thus, allowing some degree of capital mobility (the present scenario) permits the expected rates of return to play a dominant role in determining investment for these economies as well.

[12] In the extended model, the elasticity of investment to the time rate of change in the rate of return varies for each region. The elasticities are calibrated from the database used in the simulations, and are indicative of the elasticities implied in the database.

[13] China is a net debtor in the initial database.

Table 7 **UR experiment using GTAP with imperfect capital mobility**

Regions	*Balance of trade*	*Net income from abroad*	*Real investment*	*Capital stock*	*Contribution of real bonds to EV*	*Contribution of end/ments to EV*	*Equivalent variation (EV)*
	% of GDP	% of GDP	%	%	$USm	$USm	$USm
Australia	0.21	-0.04	2.04	1.98	-1,220	2,168	6,951
NZL	0.19	-0.04	0.76	0.66	-133	127	751
Japan	-0.04	0.01	0.05	-0.01	-17	-172	868
Korea	-0.07	-0.01	0.12	0.05	-12	85	672
Indonesia	0.22	-0.04	0.45	0.31	-71	259	470
Malaysia	0.02	-0.04	0.01	-0.07	19	-24	-47
Philippines	0.13	-0.02	0.09	-0.01	20	-1	-591
Singapore	0.34	0.01	0.84	0.78	19	231	1,529
Thailand	0.05	-0.02	0.09	-0.09	-12	-90	341
China	0.37	-0.10	1.44	1.36	-2,421	3,482	7,160
HKG	0.24	0.01	0.13	-0.02	27	-8	375
Taiwan	0.05	0.01	0.36	0.27	13	225	515
Canada	0.01	0.00	0.13	0.04	0	72	1,091
US	0.00	0.00	0.03	-0.05	11	-1,158	13,249
Mexico	0.00	-0.03	0.35	0.03	7	38	-412
Chile	0.17	-0.06	0.73	0.58	-109	184	460
ROC	0.03	-0.03	0.07	-0.10	-366	-438	736
EUN	-0.01	0.00	0.30	0.25	-107	5,536	16,515
RST	-0.08	0.14	-0.45	-0.52	4,411	-5,989	3,946

a The difference between EV and the two contribution terms reported is the effect of changes in allocative efficiency and changes in the terms of trade. These effects are similar in magnitude to those observed in the previous simulations.

b The numbers reported for the balance of trade and net income from abroad are changes in percentage points, not percentage changes.

Perfect capital mobility scenario

If regional bond to income ratios are allowed to vary, then regions with large increases in their expected rates of return can source other countries' savings to fund growth in their capital stocks. Thus, capital is perfectly mobile and can move to those regions where it can earn the highest return. Under this scenario, economies with large increases in their expected rates of return under the fixed shares scenario, will experience the highest growth in investment and capital stocks as they will no longer be constrained by their domestic savings levels in funding growth in their capital stocks.

Simulating perfect capital mobility leads to more unstable behaviour in investment, similar to that observed in the rate of return scenario (see Table 8). This seems to confirm the assertion that the rate of return scenario accurately mimics a high degree of international capital mobility, though without the capital accumulation effects (GTAP 1996). In the perfect capital mobility scenario, the expected and current rates of return become the dominant forces in determining investment and capital stock growth respectively, with net saving rates playing a more subdued role. Thus, regions with very low net saving rates but relatively large increases

in expected rates of return, such as the Philippines and Hong Kong, experience much higher investment and capital stock growth than when forced to use only their domestic savings to fund capital stock growth (imperfect capital mobility scenario). And those regions with the largest increases in expected rates of return can grow even faster than in imperfect capital mobility scenario, despite having low saving rates, eg. Australia and New Zealand. The dominance of the rate of return effect over the net savings rate effect on investment and capital stock growth is underlined by the case of China. Despite having the second highest net savings rate of all regions, its relatively low increase in the expected rate of return causes its investment and capital stock to grow less quickly than other economies with higher increases in the expected rate of return and much lower saving rates.

Table 8 **UR experiment using GTAP with perfect capital mobility**

Regions	*Balance of trade*	*Net income from abroad*	*Real investment*	*Capital stock*	*Contribution of real bonds to EV*	*Contribution of end/ments to EV*	*Equivalent variation (EV)*
	% of GDP	% of GDP	%	%	$USm	$USm	$USm
Australia	0.78	-0.93	6.08	6.04	-4,536	6,530	6,195
NZL	0.43	-0.41	2.07	2.00	-372	385	735
Japan	-0.06	0.09	-0.33	-0.36	4,527	-6,412	1,547
Korea	-0.03	-0.17	0.64	0.59	-761	1,006	766
Indonesia	0.53	-0.68	1.96	1.87	-1,405	1,532	178
Malaysia	0.30	-1.54	4.37	4.31	-1,549	1,480	-36
Philippines	0.88	-1.22	3.59	3.53	-830	931	-704
Singapore	0.41	-1.49	5.23	5.18	-1,020	1,505	961
Thailand	0.15	-0.15	0.31	0.20	-258	188	366
China	0.40	-0.30	2.36	2.31	-4,618	5,888	7,981
HKG	0.71	-0.90	1.93	1.83	-896	903	111
Taiwan	0.15	-0.30	1.44	1.38	-836	1,161	417
Canada	-0.04	0.09	-0.20	-0.25	507	-486	1,186
US	-0.03	0.05	-0.22	-0.27	3,798	-5,834	14,156
Mexico	-0.43	0.49	-0.75	-0.96	1,390	-1,409	-187
Chile	0.21	-0.10	0.85	0.75	-160	239	459
ROC	0.07	-0.07	0.18	0.08	-965	354	851
EUN	-0.07	0.11	-0.30	-0.33	8,910	-7,505	17,948
RST	0.04	-0.02	0.08	0.03	-750	295	2,608

a The difference between EV and the two contribution terms reported is the effect of changes in allocative efficiency and changes in the terms of trade. These effects are similar in magnitude to those observed in the previous simulations.

b The numbers reported for the balance of trade and net income from abroad are changes in percentage points; not percentage changes.

The welfare effects of changes in real bond holdings and endowments in the perfect capital mobility scenario are similar to those observed in the imperfect capital mobility scenario. The differences are influenced by how much more quickly or slowly capital stocks grow in a given region. If capital stocks grow more quickly under perfect capital mobility (compared with imperfect mobility), then the welfare effects of changes in real bond holdings and endowments

tend to dominate the overall welfare effect for a given region, as is the case for Australia, New Zealand, Malaysia, the Philippines and Singapore. Compared with the imperfect capital mobility scenario, these economies all experience a larger increase in their endowments, which leads to larger welfare gains from changes in endowments. At the same time, they experience larger welfare losses from increased debt. The welfare gains from increased endowments usually outweigh the welfare losses from increased debt.

In the perfect capital mobility scenario, economies that fund other regions' capital stock growth reduce their debt and capital stocks relative to the imperfect capital mobility scenario. Consequently, these economies get larger welfare gains from reduced debt and larger welfare losses from reduced endowments, with the endowment effects usually dominating the debt effects. These economies include Japan, the United States, Mexico and the European Union.

5 Concluding Remarks

The GTAP model is a comparative static model that gives the user a choice of two quite different investment allocation mechanisms. One allocates investment between regions using fixed shares of global net investment. Thus, the effects on investment are fairly predictable and stable. This is considered an equilibrium in which capital is fairly immobile. The other mechanism equalises expected future rates of return on capital between regions. This gives less stable results for investment. It is considered appropriate if the user wishes to treat capital as fairly mobile internationally (GTAP 1996). In both cases there are no capital reallocation effects. Are these assertions about the different investment allocation mechanisms accurate with respect to the behaviour of investment and capital accumulation?

A rigorous method of testing these assertions is to impose wealth accumulation and capital accumulation on the model, while maintaining the underlying comparative static nature. Further, an important structural policy shock that usually leads to large capital accumulation effects is also required to test the newly-imposed quasi-dynamic effects within GTAP. An appropriate policy shock for this purpose is the remaining implementation of the UR. This shock is implemented with the two scenarios described above. It is also implemented with imperfect capital mobility and perfect capital mobility, where wealth and capital accumulation have been added to standard GTAP.

By and large, the simulations confirm that the two alternative investment allocation mechanisms available with standard GTAP accurately mimic the investment effects with imperfect and perfect capital mobility when wealth and capital accumulation are added to the model. Importantly, though, the significant welfare effects of changes in the capital stock and bonds (debt) are ignored. In the imperfect capital mobility scenario, investment behaviour is almost as stable as it is in the fixed shares scenario. However, the effect of differential savings rates is ignored under standard GTAP, and the simulations indicate that these effects can be important and significant for certain regions. China is a case in point. China's net savings rate (as percentage of GDP) is around 32 per cent in the GTAP 4 database. In the imperfect capital

mobility scenario, China is able to use its high savings rates to exploit the relatively modest increase in the expected rate of return on its capital stock. This allows its capital stock to grow, and its investment to grow more quickly than in the fixed shares scenario. The story is similar for Singapore.

The ICM extended model can also be modified to indicate the welfare effects of changes in bond holdings (debt) and endowments. In the case of China under imperfect capital mobility, these effects can be important and significant. This is also the case under perfect capital mobility. This cannot be done with the original GTAP model. Thus, the extended model provides a more complete treatment of the benefits and costs to an economy from changes in the stock of capital and debt.

In the case of the UR, the original model and the ICM extended model give broadly similar regional welfare effects. However, the extended model can indicate explicitly the sources of welfare gains and losses from changes in debt and capital stocks. Hence, an economy such as Japan, which decreases its debt to fund capital stock growth in other regions, gains from the increased interest income from holding more bonds. This is despite the fact that its own capital stock shrinks in the process, although the negative welfare effect from this reduction in productive capacity more than offsets the welfare gain from decreased debt.

Simulating a large-scale structural policy shock, such as the remainder of the UR, using a model that allows for wealth and capital accumulation effects, predicts that the welfare effects of allowing capital stocks to grow are significant and important. This result is not new and has been confirmed by others (see Baldwin 1992; Francois, McDonald and Nordstrom 1995). Allowing regional capital stocks to grow provides a mechanism for capital to move to those regions and industries where the rate of return is highest, and to move out of those regions and industries where returns are lowest. The extended model presented here facilitates this movement of capital in a way that allows the regional welfare indicators to fully reflect the benefits (higher capital stocks and output) and costs (higher debt and interest payments) of attracting capital to a given region. The model does not, however, allow tracking of the location and ownership of the newly acquired capital in each region on a bilateral basis (see Walmsley 1999). Adding this feature to the extended model presented here is the next phase in a research project at the Productivity Commission which is concerned with modelling the effects of liberalising trade in services and foreign direct investment.

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