PRODUCTIVITY COMMISSION

The Structure of the FTAP Model

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Abstract

FTAP, a comparative static, computable general equilibrium model of the world economy, was developed from GTAP, with the addition of the structure necessary to support the analysis of services liberalisation. A major component of this liberalisation is the removal of barriers to FDI in the tertiary sector, the various types of which are represented in the FTAP database. Consequently, the FTAP model includes a treatment of foreign direct investment on a bilateral basis.

This paper provides an overview of the FTAP model, drawn largely from the full documentation. It also includes some illustrative simulations.

1 Introduction

The FTAP model is a comparative static, computable general equilibrium model of the world economy that includes a treatment of foreign direct investment on a bilateral basis. The FTAP model was developed from the GTAP model (Hertel 1997), with the addition of the structure necessary to support the analysis of services liberalisation. A major component of this liberalisation is the removal of barriers to FDI in the tertiary sector.

This paper provides an overview of the FTAP model. Full documentation of the theoretical structure of FTAP is available in Hanslow, Phamduc and Verikios (1999). The contents of this paper are very largely drawn from those parts of that document that provide an overview of FTAP.[1]

The development of the FTAP database will be documented in Stone, Strzelecki and Welsh (2000) and Hanslow, Phamduc, Verikios and Welsh (2000). The current database is a 19 region, 3 commodity (primary, secondary and tertiary) representation of the world economy after the full implementation of the Uruguay Round (UR) of trade liberalisation.

Section 2 describes the FTAP model structure. Section 3 describes how barriers to services trade were represented as tax equivalents in FTAP. Section 4 illustrates various features of FTAP using a couple of policy simulations. First, the FTAP welfare decomposition, which is an extension of that used in GTAP, is used to analyse a simulation of full, global liberalisation of the tertiary sector. Second, second-best effects, arising from barriers to services trade, are examined using a simulation of full, global liberalisation of the secondary sector. Section 5 provides some concluding remarks.

[1] The FTAP model is implemented using the GEMPACK software (Harrison and Pearson 1996). The FTAP model documentation, model code, and data files are available at www.pc.gov.au.

2 The structure of FTAP

As noted, the FTAP model is a version of GTAP with foreign direct investment. The treatment of FDI follows closely the pioneering work of Petri (1997). FTAP also incorporates increasing returns to scale and large-group monopolistic competition in all sectors. This follows Francois, McDonald and Nordstrom (1996), among others, who adopted this treatment for manufacturing and resource sectors, and Brown et al. (1996) and Markusen, Rutherford and Tarr (1999), who used similar treatments for services. Finally, FTAP makes provision for capital accumulation and international borrowing and lending. This uses a treatment of international (portfolio) capital mobility developed by McDougall (1993b), and recently incorporated into GTAP by Verikios and Hanslow (1999).

Structure of commodity preferences

FTAP takes the standard GTAP framework as a description of the *location* of economic activity, and then disaggregates this by *ownership*. For example, each industry located in Australia comprises Australian owned firms, along with multinationals owned by each of the other regions in the model. Each of these firm ownership *types* is modelled as making its own independent choice of inputs to production, according to standard GTAP theory, but with the more extensive choice of commodity varieties about to be described. Each firm type has its own sales structure.

On the purchasing side, agents in each economy make choices among the products or services of each firm type, distinguished by both ownership and location, and then among the individual (and symmetric) firms of a given type. Thus, the model recognises the firm-level product differentiation associated with monopolistic competition. Firms choose among intermediate inputs, primary factors (skilled and unskilled labour, capital, land and natural resources), and investment goods, while households and governments choose among final goods and services.

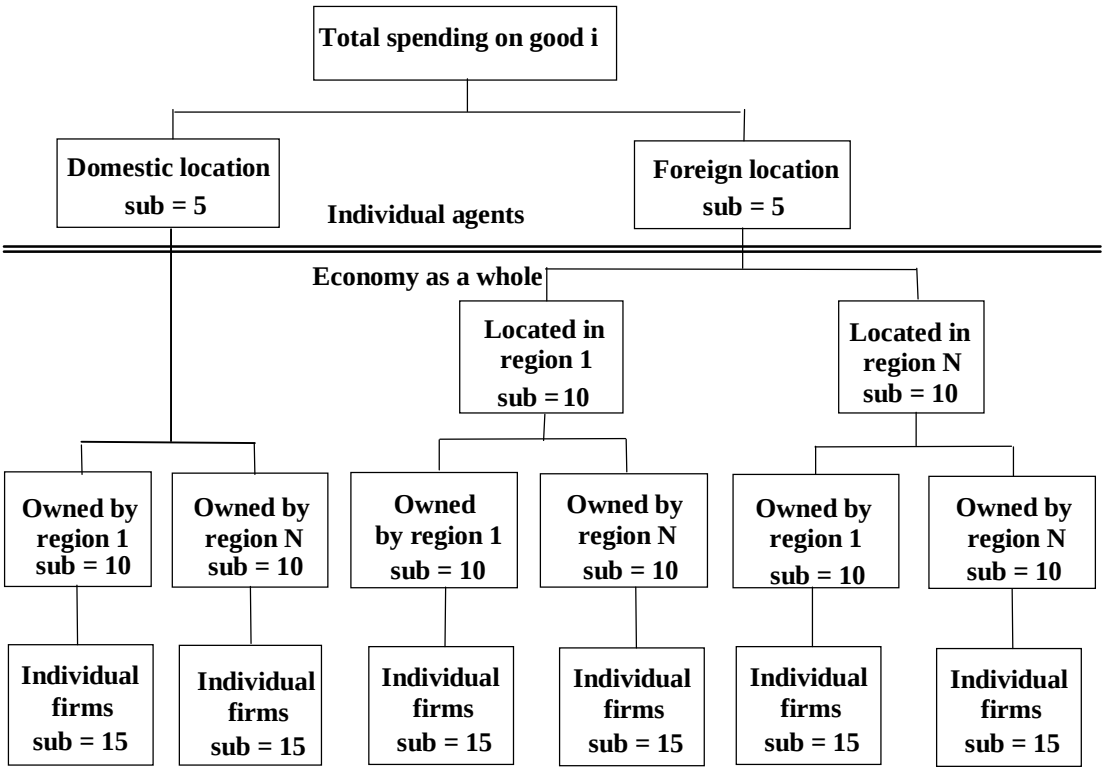
The FTAP choice of commodity varieties in figure 1 builds on the standard GTAP scheme. *Individual agents* are assumed to choose first among products or services from domestic or foreign locations, with a CES elasticity of substitution of 5. The imports of each commodity *for the economy as a whole* are then chosen from among foreign locations with a CES elasticity of substitution of 10. Thus far this is the standard GTAP nesting of domestic/foreign choice.

In FTAP, a choice is then made for the economy as a whole among ownership categories for imports of each commodity from each location, and among ownership categories for domestically-produced commodities, also with a CES elasticity of substitution of 10.

Finally, a choice is made from among the individual firms of a particular ownership and location, with a CES elasticity of substitution of 15.

The choices common to FTAP and GTAP — among domestic and foreign locations — have been parameterised in FTAP using values, 5 and 10, that are roughly twice the standard GTAP Armington elasticities. Two reasons can be given for doubling the standard elasticities. The first is that they enable GTAP to successfully reproduce historical changes in trade patterns (Gehlhar 1997). The second is that higher elasticities accord better with notions of firm level product differentiation.

Figure 1 **FTAP structure of commodity preferences**



With firm-level product differentiation, agents benefit from having more firms to choose among, because it is more likely that they can find a product or service suited to their particular needs. Capitalising on this, Francois, McDonald and Nordstrom (1996) show that the choice among individual firms can be modelled in a conventional model of firm types (not firms) by allowing a productivity improvement whenever the output of a particular firm type (and hence the number of individual firms in it) expands. But because the substitutability among individual firms is assumed here to be very high, the incremental gain from greater variety is not very great and this productivity enhancing effect is not particularly strong. Section 6.7 of Hanslow, Phamduc and Verikios (1999) reproduces the result,

derived in Francois (1998), that the elasticity of productivity with respect to inputs is 1/(15-1) = 0.0714.[2]

The order of the choices, among locations and then among ownership categories, is the opposite of the order adopted by Petri (1997). For example, the current treatment assumes that, from an Australian perspective, a US multinational located in Australia is a closer substitute for an Australian-owned firm than it is for a US firm located in the United States. Petri's treatment assumes that US-owned firms are closer substitutes for each other than for Australian firms, irrespective of location.

There are two reasons for preferring the current treatment.

The first is that Petri's treatment produces a version of FTAP in which multilateral liberalisation of tariffs on manufactured goods produces large economic welfare losses, for most individual economies and for the world as a whole — an uncomfortable result at odds with conventional trade theory. The reason for the result can be seen by considering the choices that Australians would make at the top of Petri's decision tree in the face of a tariff cut. They would choose between an aggregate of the output of Australian firms (irrespective of location) and an aggregate of the output of US firms (irrespective of location). The Australian aggregate would be overwhelmingly dominated by the output of domestically located Australian firms, since 'boomerang' imports from Australian firms located offshore would be minimal. Thus, the Australian aggregate would have a very small proportion of goods attracting a tariff. The US aggregate would include both goods produced by US multinationals located in Australia, and imports from US firms located in the United States. Only the latter would initially attract a tariff. Depending on relative shares, there is no guarantee that the price of the US aggregate would be dominated by the removal of the tariff on imports, rather than by endogenous changes in the cost structure of US multinationals in Australia. Simulations with a model of this structure showed that the price of the US aggregate *rose* relative to the price of the Australian aggregate in the face of a tariff cut, encouraging resources in Australia to move *into* the domestic protected sector as its protection was removed. This led to a deterioration in allocative efficiency and an overall economic welfare loss. The story was repeated in many other regions.

The second reason for preferring the current treatment of FTAP is that, in many instances, it accords better with reality. Firms in a given location, irrespective of ownership, will tailor their services to meet local tastes and requirements, and thus appear to be closer substitutes, as in the present treatment. This is so even when foreign direct investment is 'horizontal' rather than 'vertical', and particularly so for

[2] This section also shows that the elasticity of productivity with respect to *output* is 1/15 = 0.0667. The elasticities with respect to output and inputs differ because of the underlying assumption of increasing returns to scale.

services delivered face to face, where commercial presence (through FDI) is often the only viable means of trade.[3]

Structure of investor preferences

The supply of FDI is determined in FTAP by the same imperfect transformation among types of wealth as in Petri (1997), and is illustrated in figure 2.

Investors in each economy first divide their wealth between 'bonds', real physical capital, and land and natural resources in their country of residence.[4] In FTAP, this choice is governed by a CET semi-elasticity of 1, meaning that a one percentage point increase in the rate of return on real physical capital, for example, would increase the ratio of real physical capital to bond holdings by one per cent.

Investors next choose the industry sector in which they invest (with a CET semi-elasticity of 1.2).

While a bond is a bond irrespective of who issues it (implying perfect international arbitrage of rates of return on bonds), investors in FTAP see capital in different locations as different things. They next choose whether to invest at home or overseas in their chosen sector (with a CET semi-elasticity of 1.3).

Finally, they choose a particular overseas region in which to invest (with a CET semi-elasticity of 1.4).

While the chosen CET parameters at each 'node' of the nesting structure may appear low, the number of nests means that choices at the final level (across destinations of FDI) are actually very flexible. For example, it can be shown that, holding total wealth fixed, but allowing all other adjustments across asset types and locations to take place, the implied semi-elasticity of transformation between foreign destinations can easily reach 20, and be as high as 60.[5] The variation across regions in these implied elasticities comes about because of the different initial shares of assets in various regional portfolios.

The choice of CET parameters at each 'node' was determined partly by this consideration of what they implied for the final elasticities, holding only total wealth constant. They were also chosen so that this version of FTAP gave results that were broadly comparable to GTAPICM[6] with imperfect international mobility

[3] Some Australian examples are provided in Dee and Hanslow (1999).

[4] Bonds can be owned or owed by private households and governments in each region. Equity in productive assets (that is, real physical capital, land and natural resources) can only be owned by private households in each region.

[5] Some examples are provided in appendix F of Hanslow, Phamduc and Verikios (1999).

[6] GTAPICM is a version of GTAP with international mobility of portfolio capital. It is documented in chapter 3 of Hanslow, Phamduc and Verikios (1999), and is applied to an analysis of the Uruguay Round in Verikios and Hanslow (1999).

of portfolio capital, for experiments involving the complete liberalisation of agricultural and manufacturing protection. Imperfect capital mobility was also a feature of the GTAP-based examination of APEC liberalisation by Dee, Geisler and Watts (1996) and Dee, Hardin and Schuele (1998). Thus, these parameters provide a familiar starting point, from which variations could be made in the future.

In one respect, however, the current version of FTAP differs from previous versions of GTAP with imperfect capital mobility. The GTAP variants assumed that capital was perfectly mobile across sectors, whereas FTAP has less than perfect sectoral mobility. Furthermore, the choice of sector is relatively early in the nesting structure, so that the implied elasticities guiding choice of sector, holding only total wealth constant, are relatively low (eg 1.2 in the United States). As a result, FTAP tends to exhibit behaviour where resources move less readily between sectors in a given region, but more readily across regions in a given sector, although the differences are not dramatic. The current treatment is consistent with the idea that the knowledge capital often required to succeed in foreign direct investment, despite the difficulties of language and distance, is likely to be sector-specific.

This imperfect transformation among assets means that rates of return on equity capital can differ by sector, region of ownership and region of location.

Bonds are the difference between total wealth and equity in productive assets — capital, local land and local natural resources — for each region. Each region decides how much to borrow (lend) to finance (supplement) its investment in productive assets. In particular, bonds are a means of financing investment in equity in *aggregate*. The model does not track the financing of FDI in *particular* industries and host regions. This would require a further level at the bottom of the nest determining the debt to equity ratio for particular industries. While such a treatment would be possible, it would seem to add little for the current applications of FTAP.

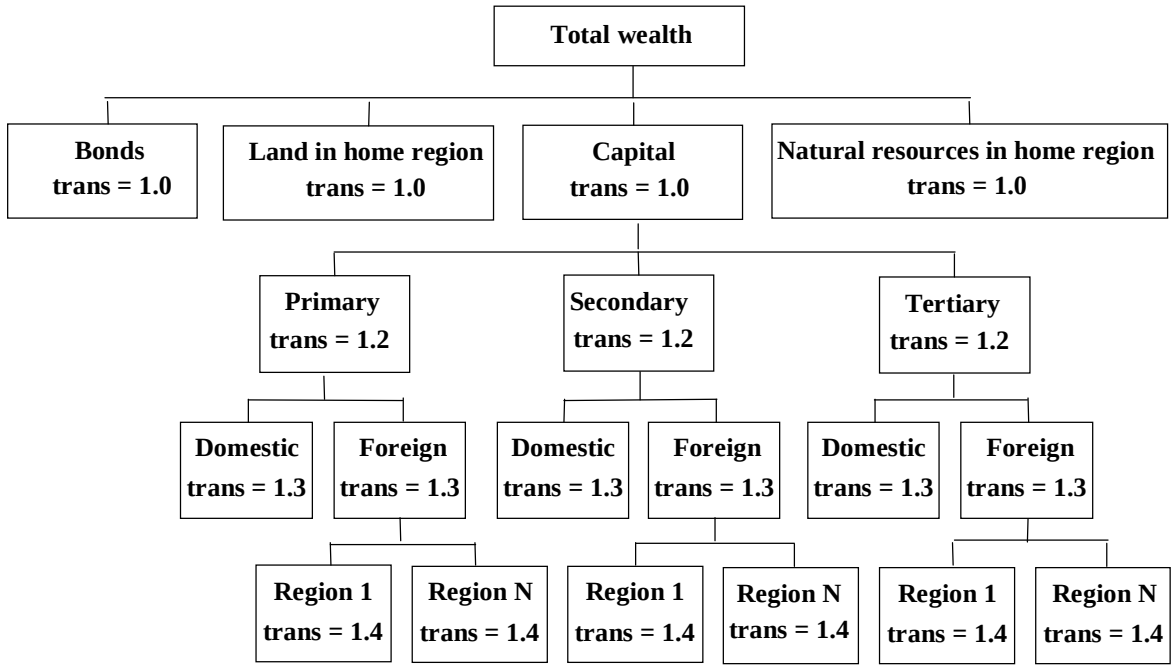
In reality, less than perfect transformation among different forms of wealth can result from a range of factors such as risk aversion and less than perfect information. While such factors are not explicitly modelled in FTAP, they nevertheless provide some justification for adopting the present treatment of asset supply. It is important to note, however, that while the measure of economic welfare in FTAP currently recognises the positive income contribution that FDI can make, it does not account for any non-pecuniary costs associated with risk taking. This is an important qualification to the current results, but could be overcome using techniques outlined in chapter 10 of Hanslow, Phamduc and Verikios (1999).

International capital mobility (ICM)

Petri's model assumed that total wealth in each region was fixed. In FTAP, while regional endowments of land and natural resources are fixed (and held solely by each region's residents), regional capital stocks can accumulate over time, and net

bond holdings of each region can adjust to help finance the accumulation of domestic and foreign capital by each region's investors. Hence, the ICM extension contains modules covering the international allocation of capital, regional wealth accumulation, international stocks of assets and liabilities, and the international allocation of investment. It also adds household and government sector modules that separately identify household and government income and wealth accumulation.

Figure 2 **FTAP asset supply function**



The FTAP treatment of capital mobility and accumulation follows the original treatment of McDougall (1993b), and was also used by Verikios and Hanslow (1999), Dee, Geisler and Watts (1996) and Dee, Hardin and Schuele (1998).

FTAP is a comparative static model, and like most comparative static models, it includes no treatment of time. Household and government wealth in the ICM extension are modelled as the outcome of a wealth accumulation process. This process requires that some treatment of time be introduced to the model. This is done by assuming that all shocks applied to the model represent distinct changes at a certain initial point in time, that is, the initial instant. The database and endogenous variables represent values observed at a certain final point in time, that is, the terminal instant. The simulation period is the period of time between the initial and terminal instants. Certain reasonable assumptions are then made about (i) the shape of the adjustment paths of income and savings, and (ii) the length of the simulation period. These assumptions allow accumulation equations, which

describe how wealth changes over the simulation period in response to exogenous shocks, to be derived.

The movement of bonds between regions requires that they are denominated in a common unit of measurement. It is assumed that lenders are protected against inflation by indexing the value of bonds to a world price index. This assumption also preserves price homogeneity.

With this treatment of capital accumulation, FTAP provides a long-run snapshot of the impact of trade liberalisation, ten years after it has occurred. To the extent that liberalisation leads to changes in regional incomes and savings, this will be reflected in changes to the capital stocks that investors in each region will have been able to accumulate. As noted, investors in each region are not restricted to their own savings pool in order to finance capital investment. They may also issue bonds to help with that investment, but only according to their own preferences about capital versus bond holding, and only according to the willingness of others to accept the additional bonds.

3 Representing barriers to services trade in FTAP

Barriers to services trade are represented in FTAP as tax equivalents, with the rents from these impediments flowing to the appropriate private agents. Although there is the capacity in the model to include such non-tariff barriers in all sectors, they are only implemented in the tertiary sector, based on the work of Kaleeswaran et al. (2000) and Warren (2000) (to be documented in Findlay and Warren 2000) for banking and telecommunications.

Barriers to trade in services have been modelled as tax equivalents that generate rents — a mark-up of price over cost — rather than as things that raise costs above what they might otherwise have been (eg Hertel 1999). This decision was based on the way in which the price impacts of barriers to trade in banking and telecommunications services were measured. Kaleeswaran et al. (2000) measured the effects of trade restrictions on the net interest margins of banks, a direct measure of banks' mark-up of price over cost. Warren (2000) measured the effects of trade restrictions on the quantities of telecommunications services delivered, and these were converted to price impacts using an estimate of the elasticity of demand for telecommunications services. Thus, Warren's estimates did not provide direct evidence of a mark-up of price over cost, but the relative profitability of telecommunications companies in many countries suggests that some element of rent may exist. By contrast, there is evidence that trade restrictions in sectors such as aviation raise costs (Johnson et al. 2000, Tamms 2000). As estimates of the effects of trade barriers in these sectors are incorporated into the model, it will be appropriate to treat some restrictions as cost-raising rather than as rent-creating.

Table 1 **Categorisation of barriers to services trade**

	Restrictions on market access	*Restrictions on national treatment*
Barriers to establishment	'Taxes' on capital	'Taxes' on capital
Barriers to ongoing operation	'Taxes' on output and exports	'Taxes' on output and exports

The General Agreement on Trade in Services (GATS) framework distinguishes four modes of service delivery — via commercial presence, cross border supply, consumption abroad, and the presence of natural persons. Accordingly, the FTAP model distinguishes barriers to establishment from barriers to ongoing operation. This is similar to the distinction between commercial presence and other modes of delivery, since barriers to establishment are a component of the barriers to commercial presence.

Barriers to establishment have been modelled in FTAP as taxes on capital. Barriers to ongoing operation may affect either FDI firms or those supplying via the other modes, and have been modelled as taxes on the output of locally-based firms (either domestic or foreign owned), and taxes on the exports of firms supplying via the other modes, respectively.

The GATS framework also distinguishes restrictions on market access from restrictions on national treatment. The former are restrictions on entry, applying equally to locally-owned or foreign-owned firms. In this sense, they are non-discriminatory restrictions. Restrictions on national treatment mean that foreign owned firms are treated less favourably than domestic firms. These are discriminatory restrictions.

These various kinds of barriers to services trade in FTAP are summarised in table 1. The taxes on capital of foreign-owned firms are higher than those on domestically-owned firms, because they capture restrictions on national treatment as well as market access. The taxes on the output of foreign-owned firms are higher than those on domestically-owned firms, for similar reasons.

The export taxes referred to in table 1 represent barriers to cross-border services trade imposed by importing regions. They are equal to taxes on foreign affiliates' output in the destination regions. The reason for modelling these as taxes in the exporting region, rather than as tariffs in the importing region, is that it allows the rents created by the barriers to be retained in the exporting region.

Because barriers to services trade appear to be significant, and because they are non-tariff barriers, they will generate significant rents. A key issue is whether those rents should be modelled as being retained by incumbent firms, appropriated by governments via taxation, or passed from one country to another by transfer pricing

or other mechanisms. In FTAP, the rents on output have been modelled as accruing to the selling region, and those on capital have been modelled as accruing to the region of ownership, once the government in the region of location has taxed them at its general property income tax rate. Despite this, the asset choices of investors are modelled as being driven by pre-tax rates of return. This is because many economies, in the developed world at least, have primarily destination-based tax systems. For example, if tax credits are granted for taxes paid overseas, investors are ultimately taxed on *all* income at the owning region's tax rate. Although such tax credits have not been modelled explicitly, their effect has been captured by having investors respond to relative pre-tax rates of return. Nevertheless, investor choices are also assumed to be determined by rates of return excluding any abnormal rent component. Investors would like to supply an amount of capital consistent with rates of return including abnormal rents, but are prevented from doing so by barriers to investment. The amount of capital actually supplied is, therefore, that amount that investors would like to supply at rates of return excluding abnormal rents.

Thus a portion of the rent associated with barriers to services trade is assumed to remain in the region of location in the form of property income tax revenue, while the remainder accrues to the region of ownership. Thus liberalisation of services trade could have significant income effects in both home and host regions as these rents are gradually eliminated. Dee and Hanslow (1999) examine how significant these effects are, relative to the allocative efficiency effects and other effects normally associated with trade liberalisation.

4 Some FTAP applications

Full services liberalisation

This entails removing all barriers to services traded conventionally or via commercial presence. In all regions, all tax equivalents representing these barriers are reduced to zero — export taxes (representing barriers in the destination region) for cross-border trade of services, and taxes on capital and output in the tertiary sector for services delivered via commercial presence. Tax-equivalents on both domestic and foreign-owned industries are removed. Dee and Hanslow (1999) provide a discussion of these results. In this section, attention is focused on the usefulness of the FTAP welfare decomposition.

As for GTAP, the FTAP welfare decomposition expresses the equivalent variation (derived from the maximised value of an utility function of real private consumption, government consumption and saving) as a sum of welfare

contributions, representing the various economic changes influencing welfare.[7] The contributions represented in FTAP are listed in the top part of table 2. The contributions listed in the first group (allocative efficiency, endowment, price effects, technical efficiency and marginal utility) also occur in GTAP, but those in the second group are new to FTAP.[8] This latter group measures contributions to welfare from net foreign income flows. Welfare is defined as the maximised value of a Cobb-Douglas utility function of private consumption, government consumption and net savings. Consequently, utility is equal to net national income deflated by a Cobb-Douglas price index of the prices of private consumption, government consumption and net savings. Hence, large foreign income flows also make a significant contribution to welfare.

Appendix B of Hanslow, Phamduc and Verikios (1999) shows how the welfare contribution of each foreign income flow can be split into three effects — a contribution from changes in asset prices, a contribution from changes in rates of return, and a contribution from changes in the real quantity of assets. In table 2, all the asset price effects have been absorbed into the price effect contribution. Thus, in FTAP, there are a few more prices in the price effect contribution than in GTAP, but in both cases what is being measured is the welfare impacts of changes in traded goods prices and asset prices. In GTAP, the price effect contribution consisted of two parts. The first part was a terms of trade welfare contribution (variable CNTtotr in the GEMPACK implementation of GTAP), and was a function of changes in export and import prices. The second part was what might be called an asset price welfare contribution (variable CNTcgdsr), and was a function of changes in the price of savings and the price of creating capital. In FTAP, the latter of these also includes the effects of changes in asset prices of inward and outward FDI capital stocks.

Table 2 also shows welfare contributions associated with changes in rates of return on bonds (interest rate) and net FDI. For the latter, the rate of return contribution is split into two parts. One part is the contribution from changes in the normal rates of return on FDI capital (normal FDI rate of return). The other part comes from changes in impediment rents, where these are considered as a return on FDI capital (impediment rate of return).

The contributions labelled ‘Real bonds’ and ‘FDI capital’ in table 2 are the welfare contributions associated with changes in the real quantity of bonds and net FDI. They are the counterpart, for net foreign assets, of what is called the endowment effect in GTAP (the sum of the GTAP variables CNTendwr and CNTkbr). The

[7] The GTAP welfare decomposition is described in Huff and Hertel (1996.)

[8] Each contribution common to FTAP and GTAP may, of course, have a different formal definition in each model, because of the different model structures. However, each such contribution measures the same type of effect in each model.

GTAP endowment effect is a function of the change in the aggregate quantity of primary factors residing in each region. The FTAP endowment effect is the same as the GTAP endowment effect, but FTAP takes into account the effects of changes in asset ownership, from which extra endowment-type contributions arise.

The characteristics of the three regions shown in table 2 are indicated by the data listed in the second and third parts of the table. Both Japan and the United States have relatively low barriers to establishment and on-going operation for both domestic and foreign-owned tertiary industries, while China has very high barriers, especially on establishment. Japan is a large source of outward FDI, but has relatively little inward FDI. The United States has large quantities of both inward and outward FDI. China has minuscule outward FDI, and not much measured inward FDI (perhaps because of the magnitude of the barriers to establishment), though its inward FDI is comparable in magnitude to Japan's.

Not surprisingly, the allocative efficiency changes arising from services trade liberalisation are very large for China, and much smaller for the other two regions. For the United States, they are in fact slightly negative. The allocative efficiency gains made from removing its low barriers have been eroded by allocative efficiency losses, because of the remaining distortions and economic changes that reinforce the effects of these distortions.

As relatively high barriers to services trade exist in other regions, the two regions with relatively low services trade barriers — Japan and the United States — become relatively less attractive as destinations for investment. Consequently, they receive a negative endowment contribution to welfare as their aggregate capital stocks decrease. Japan redirects domestic investment into outward FDI (as reflected in the positive FDI capital welfare contribution) and even borrows to fund further outward FDI (as reflected in the negative real bond welfare contribution). Likewise, the United States increases outward FDI, but also increases lending to other regions. However, closer examination of the results reveals that private bond holdings in the United States decline, so that the private sector in the United States is borrowing to fund FDI while the government is reducing debt. China, with very high initial barriers to services trade, becomes a much more attractive destination for both domestic and foreign investors. Consequently, it has a large positive endowment contribution to welfare, but the contribution from FDI capital is negative and approximately half the magnitude of the endowment contribution, indicating an increase in foreign ownership of capital residing in China.

The decline in the rate of return on bonds means that the welfare contributions from changes in interest rates are of the opposite sign to the initial bond holdings of each region. Japan initially has a positive quantity of bonds, the United States and China negative quantities. Hence, Japan suffers a negative welfare impact from the decline

in the rate of return on bonds, while the United States and China experience a positive welfare impact from the decline in the bond rate.

Table 2 **Welfare effects from FTAP simulation of tertiary liberalisation, and impediment rates and FDI stocks from FTAP database**
(for selected regions)

	Japan	*USA*	*China*
Simulation results			
Contributions to EV ($US million)			
Allocative efficiency	1,356	-157	48,008
Endowment	-612	-3,820	44,142
Price effects	3,816	-3,150	-3,496
Technical efficiency	-498	-161	12,621
Marginal utility	-1	-2	132
Real bonds	-2,978	1,708	-5,776
Interest rate	-657	45	9,384
FDI capital	5,583	4,114	-23,707
Normal FDI rate of return	8,859	7,511	-12,803
Impediment rate of return	-10,740	-7,896	22,367
Equivalent variation	4,130	-1,809	90,869
Impediment rates in the tertiary sector (per cent)			
Domestic output	3.59	0.07	18.75
Foreign affiliates' output	4.75	1.08	36.4
Domestic capital	0.33	0	123.46
Foreign affiliates' capital	3.01	3.83	250.66
FDI stocks ($US million)			
Outward FDI stocks	337,247	421,755	1,755
Inward FDI stocks	30,354	389,458	26,099

Source: FTAP simulation and database

The welfare contributions from price changes in Japan and the United States are positive and negative, respectively, and are of a sizeable magnitude compared with the overall changes in welfare. The reason why these welfare contributions move in opposite directions is partly because of different terms of trade effects, and partly because of differences in regional trade patterns. Japan experiences a terms of trade improvement because of a heavy dependence on imports from south-east Asian regions, and the decline in prices there from the removal of sizeable barriers to FDI. The United States, on the other hand, does not enjoy decreases in import prices to the same extent as Japan, but experiences a decrease in export prices from the general decrease in world prices from the global removal of barriers. China experiences a large negative contribution to welfare from price changes. This comes

primarily through a large decline in the price received for exports of services, because of the removal of high barriers to FDI in the tertiary sector. Since China's barriers are larger than those in any other region, the general decrease in import prices is insufficient to offset the welfare effects of decreased export prices.

The technical efficiency contributions arise from the endogenous output efficiencies used to represent large group monopolistic competition and the benefits arising from increased varieties. As the *output* of Japan and the United States tends to contract with the relocation of investment to other regions,[9] it is not surprising to see a negative technical efficiency contribution for these regions, but a positive one for China.

A critical factor in determining the overall welfare impacts of services liberalisation is the assumption about who receives the impediment rents. In FTAP, it is assumed that impediment rents in foreign-owned industries accrue mostly to the owning region, with only an income tax contribution going to the region in which the industry resides. This is reflected in the welfare contributions from changes in impediment rents (expressed as rates of return) in table 2. Japan and the United States, which have high outward FDI but low impediments, lose from the reduction in impediment rents in high barrier countries in which they invest, but do not gain from reduced impediment rents flowing to foreign investors. By way of contrast, China has little outward FDI, so does not lose impediment rents from abroad, but gains from reduced impediment rents flowing to foreigners.

However, while removal of services trade barriers causes a reduction in impediment rents, it also causes an increase in normal returns in the tertiary sector. So, for the three regions shown in table 2, the pattern of welfare contributions attributed to normal FDI rates of return is the opposite of the impediment rate of return contributions.

Full secondary liberalisation

This entails removing tariffs on imports of secondary goods for all regions. Dee and Hanslow (1999) provide a discussion of these results. In this section, attention is focused entirely on the effects of barriers to *services* trade on the welfare effects from liberalisation of the *secondary* sector, that is, second-best effects.

Table 3 sets forth the results for secondary liberalisation. Columns (3)-(8) show the welfare effects of retaining the barriers to services trade.

Column (3) is an allocative efficiency welfare contribution that arises from the barriers to establishment and on-going operation that a region imposes upon its own tertiary sectors, both domestic and foreign-owned.

[9] With foreign income flows, output (GDP or NDP) can decrease while income (NNP) increases. This happens in the case of Japan.

Table 3 **Welfare effects of barriers to services trade under secondary liberalisation**

	Equivalent variation	*Contr. tertiary output and capital imped.*	*Contr. tertiary export imped.*	*Total of columns (3) and (4)*	*Relative magnitude of contr. of tertiary imped.*[a]	*Tertiary output*	*Tertiary exports*
	(2)	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	$US million	$US million	$US million	$US million	Per cent	Per cent	Per cent
Australia[b]	-62	38	90	129	68	0.5	16.2
New Zealand[b]	179	22	9	31	15	0.6	7.4
Japan	18,388	224	-390	-166	1	0.0	-10.5
Korea	7,669	90	-303	-213	3	-0.8	-21.8
Indonesia	1,603	208	-24	184	10	0.1	-5.5
Malaysia	1,436	92	-30	62	4	-0.6	-4.4
Philippines	1,119	47	-51	-4	0	-2.3	-10.3
Singapore	2,583	-26	-183	-209	7	-3.8	-8.7
Thailand	1,823	108	11	119	6	0.1	5.1
China	12,400	2,065	8	2,074	14	0.8	3.6
Hong Kong	1,219	2	-903	-901	43	-6.3	-26.3
Taiwan	9,100	210	-155	55	1	-1.3	-31.9
Canada[b]	-914	3	104	107	10	0.6	14.0
USA[b]	2,498	278	480	758	23	0.2	6.1
Mexico[b]	-91	18	13	32	26	0.5	6.8
Chile[b]	29	23	18	41	58	0.7	15.1
Rest of Cairns Group[b]	6,851	96	131	227	3	0.7	23.8
EU[b]	2,781	375	968	1,343	33	0.4	5.9
Rest of World[b]	12,721	691	748	1,439	10	0.6	11.0
World	81,332	4,567	539	5,106	6	0.2	3.4

[a] The numbers in this column are obtained by dividing the absolute value of column (5) by the sum of the absolute values of columns (2) and (5). [b] Secondary output decreases.

Source: FTAP simulation.

Allocative efficiency gains (losses) are obtained from changing the impact on demand and supply decisions of distortions in the economy — both taxes and regulatory restrictions such as barriers to services trade. Distortions drive a wedge between the marginal value of a product to the user, and the price for which the product can be supplied. An improvement in allocative efficiency occurs when a policy change reverses the impact of the distortion, regardless of whether the policy change involves removal of the distortion. The impact of a policy on allocative efficiency is therefore quantified as the product of the price gap induced by the tax — that is, the post-tax price minus the pre-tax price —and the change in the use of the product.

Column (4) is an allocative efficiency contribution to welfare that arises from the barriers on cross-border services trade imposed by each region's trading partners. The restrictions on cross-border trade are quantitative restrictions rather than import tariffs. They therefore restrict the quantity that can be supplied by the exporting region, and so elevate the exporter's domestic market price for services above the world price. These barriers are thus represented as export-tax equivalents in each region, leading to allocative efficiency effects in the exporting region.

Column (5) is the total welfare contribution arising from allocative efficiency effects associated with barriers to services trade, and column (6)[10] attempts to give some measure of how important tertiary sector distortions are for the overall welfare impacts, where the latter is measured by the equivalent variation in column (2).

The quantity changes listed in columns (7)-(8) are of some assistance in understanding columns (3)-(4), respectively. However, there is not a perfect relationship between the signs of corresponding entries, since columns (7)-(8) are totals across both domestic and foreign-owned industries, which face differing distortions. Thus, for example, total output could decrease but changes in the domestic/foreign composition of output could lead to allocative efficiency improvements, as happens for the Philippines.

In all regions where the output of the secondary sector declines, the output of the tertiary sector increases, while the percentage change in tertiary exports is even greater than the percentage change in tertiary output. Both these effects lead to positive contributions to welfare through the allocative efficiency effects associated with tertiary sector distortions. The increase in tertiary output and exports is driven by reallocation of primary factors from the declining secondary sector, and reduced prices of imported secondary goods leading to a cost reduction for the tertiary sector.

In the case of regions with an increase in secondary output, the response of the tertiary sector is not as straightforward. Both increases and decreases in tertiary output and exports occur. Movement of primary factors toward the expanding secondary sector tends to decrease tertiary output, but reduced prices of imported secondary goods tends to assist the tertiary sector. In the case of China, for example, the second effect dominates, since there is a reduction of 22 per cent in the price of imported secondary goods. Changes in the domestic/foreign ownership mix in the tertiary sector also occurs for a few regions, as indicated by a decrease in tertiary output being associated with a positive contribution to welfare from tertiary sector output and capital impediments (column (3)).

[10] Three principles governed the choice of the formula for calculating column (6). First, it should be a proportion. Second, it must be able to accommodate both positive and negative values for the equivalent variations and welfare contributions. Third, it should be conservative in the assessment that it provides of the importance of tertiary sector distortions.

As is evident from table 3, tertiary sector distortions have a very significant impact on welfare for certain regions. In particular, the export impediments often play a role as important as the output and capital impediments, because of the price responsiveness of exports of services.

5 Conclusion

This paper has provided a non-technical overview of the FTAP model. The motivation for creating FTAP was the desire to analyse the effects of the removal of barriers to services trade, and the specification of foreign direct investment in FTAP was chosen to allow the representation of service delivery via commercial presence. Before analysing the removal of barriers to services trade, these barriers first had to be estimated.

The removal of barriers to services trade leads to large global welfare gains and compositional changes in the world economy, and the FTAP welfare decomposition is of assistance in summarising these changes and their contributions to welfare. The existence of large barriers to services trade can have significant implications for the impacts of policies not directly related to the tertiary sector. This is illustrated by considering full global liberalisation of trade in manufactures, where for some regions barriers to services trade — their own and those of their trading partners — make a significant contribution to welfare impacts.

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