INTERPRETATION OF MACROECONOMIC RESULTS FROM A CGE MODEL SUCH AS GTAP

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1. Introduction

There are four basic tasks in model-based analysis:

1. derivation of the model's theoretical structure;

2. calibration;

3. simulation design and solution; and

4. interpretation of results.

This paper deals with the fourth task – interpretation.

Interpretation is concerned with explaining in a logical sequence the projections from a model. At each point in a properly-constructed sequence of explanation, the results are explained by drawing on results that have been explained earlier and/or values in the calibrated database and/or aspects of the underlying theory. Proper interpretation assists in the checking of the model's implementation. It also enhances the credibility of the analysis and provides economic insights that are not obvious from a casual inspection of the results.

The interpretation of results in terms of a logical sequence of connections is not an easy task in itself, and is often made more difficult by a requirement that economists not familiar with details of the model readily understand the interpretation. The objective of this paper is to outline a general strategy for interpreting macroeconomic results from a CGE model such as GTAP.[1] A general strategy is useful because it is available as a starting point and it is often suggestive of more detailed, simulation-specific interpretations.

At the core of our general strategy is a stylised model of the model.[2] Stylised models assist both in identifying the principal theoretical mechanisms that underlie the projections from the full model and in highlighting important elements of the database. They can also be used to conduct sensitivity analysis, indicating the variability of projections from the main model to changes in the data and in other inputs.

The rest of this paper is organised as follows. The general strategy is outlined in Section 2. The stylised macroeconomic model is derived in Section 3. In Section 4, the power of the general

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[1] Our strategy focuses on macroeconomic variables rather than on detailed structural variables such as industry output. Typically, consideration of the macro picture leads to a better understanding of the micro detail. For example, understanding what happens to aggregate private consumption is a key to understanding the response of consumption-oriented industries such as dwelling ownership. Similarly, understanding what happens to the real exchange rate is the key to understanding the response of trade-exposed industries.

[2] Stylised models are used extensively at the Centre of Policy Studies to facilitate "back-of-the-envelope" explanations. A recent example is Dixon and Rimmer (2002, Section 7.2). The usefulness of stylised models and "back-of-the-envelope" explanations is discussed in detail in Dixon, Parmenter and Powell (1984).

strategy is demonstrated with an application to a GTAP simulation of the effects of APEC trade liberalisation. Concluding remarks are in Section 5.

2. A General Strategy

Experience suggests that there are two keys to a good strategy for macroeconomic interpretation. The first is to identify the first point of impact of the exogenous shock. This will generally suggest a way to enter an otherwise closed "loop" of results. The second is to use a stylised model to explain the outcomes for factor quantities and for real factor prices. From these, explanations normally follow for the major components of real GDP from the income and expenditure sides, and for other macroeconomic variables such as the real exchange rate, the GDP deflator and the balance on trade account.

2.1 Identifying first-round impacts

We set out three examples of simulations in which interpretation of the results most naturally begins with the initial points of impact.

The first example is a simulation of the effects of a unilateral cut in one country's tariff protection against imports (the focus of our worked example in Section 4). This reduces the purchasers' price of imported goods relative to the purchasers' price of domestic substitutes, and increases demand for imports at the expense of demand for domestic substitutes. It can also be shown that the tariff cut reduces the real cost of fixed factors[3]. This is the starting point of our detailed investigation in Section 4. Nothing other than the exogenously imposed change, the underlying theory of the model and the data to which the theory is calibrated explains the change in relative demand and the initial reduction in the real cost of the fixed factor.

A second example is a simulation of the impact of a tax on greenhouse gas emissions. Imposition of such a tax has two obvious first-round effects. First it makes greenhouse-gas-intensive products such as coal-generated electricity more expensive relative to cleaner alternatives such as gas-generated electricity. Second it provides a new source of government revenue. Either is an entry point in the eventual macroeconomic interpretation.

The final example is a simulation of an increase in the efficiency of use of all primary factors in an economy. The immediate macroeconomic impact of this is an increase in real GDP. Real GDP increases by the full amount of the cost savings arising from the improved efficiency. Another way to look at it is that the real return to the fixed factor(s) increases because the fixed factor(s) receive all of the benefits of the improved efficiency. These are the entry points in the macroeconomic interpretation of the shock.

2.2 Using a stylised model

The next step in our general methodology is to use a stylised model to explain the outcomes for macroeconomic indicators. Formalised within the stylised model should be aspects of the macro closure adopted in the full model.[4]

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[3] Typical comparative-static closures have one of labour or capital fixed, but not both. For example, in a long-run closure labour is typically fixed and capital is variable. With labour fixed the real wage rate can vary. With Capital variable, the rate of return on capital is fixed.

[4] Understanding the closure is important in understanding any set of results. For example, in the standard GTAP closure the quantities of all endowed inputs (labour, capital and agricultural land) in each region are exogenous and are typically set to zero. This has

The stylised macroeconomic model developed in Section 3 has a multi-country dimension with each variable and coefficient having a regional index. However, there is no explicit modelling of the linkages between each of the economies arising from trade in goods and services and from international financial flows. Instead, just as in a single-country model, each economy is modelled in isolation, with allowance for exogenous changes in the positions of foreign-demand schedules for exports and foreign-supply schedules for imports as well as for changes in the global rate of return on capital. We adopt the single-country approach for the sake of simplicity. A fully endogenous explanation of trade in goods, services and financial instruments is complex and adds relatively little to the insights that can be gained from a model that excludes them.

3. A Stylised Macroeconomic Model

Equations of the stylised model are shown in Table 1. Equation (1) defines real GDP at market prices in region r ($Y^{MP}(r)$) as the sum of real consumption (C(r)), real investment (I(r)), real government consumption (G(r)) and the net volume of trade (X(r)-M(r)).

Equation (2) is region r's production function. It relates real GDP at factor cost ($Y^{FC}(r)$)[5] to inputs of labour (L(r)) and capital (K(r)), with an allowance for changes in all-factor technical efficiency. A(r) is the technological-change term. An increase in A(r) implies technological deterioration. A decrease implies technological improvement. In writing (2), and elsewhere in the stylised model, we ignore the existence of agricultural land.

The relationship between real GDP at market prices and real GDP at factor cost is given in equation (3). $Y^{TAX}(r)$ is a quantity index, which represents the quantity on which indirect taxes are applied. In other words,

$$Y^{TAX}(r) = \frac{Tax(r)}{T(r) \times P_{GDP}^{FC}(r)},$$

where: Tax(r) is the economy-wide collection of indirect taxes net of subsidies; T(r) is the average *ad valorem* rate of indirect taxes less subsidies; and $P_{GDP}^{FC}(r)$ is the price of GDP at factor cost (assumed to be the price to which T(r) is applied). Note that for the remainder of this paper we assume that import taxes are the only form of indirect taxation imposed in each region. Thus T(r) is taken to be the average *ad valorem* rate of import tariff applied in region r.

Equation (4) is the economy's consumption function, relating the value of private consumption ($P^C(r)C(r)$) to the value of GDP at market prices via the average propensity to consume (Ω). This explanation of private consumption is consistent with GTAP's treatment of the "regional household". Equation (5) explains the value of government consumption. It is analogous to equation (4), with $\Gamma(r)$ being the government's average propensity to consume.

Equation (6) relates the volume of imports to the general level of activity ($Y^{MP}(r)$), to the real exchange rate (RER(r)) and (negatively) to the power of the average rate of tariff, (1+T(r)). An increase in the real exchange rate (a real appreciation) with all else unchanged signals a decline in competitiveness of traded-goods industries in region r and hence an increase in imports.

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strong implications for the determination of real GDP and for relative factor prices. It constrains the GDP response and it forces real factor prices to move together.

[5] GDP at factor cost is the total cost of primary factors. It is equal to GDP at market prices less the value of indirect taxes net of subsidies.

Equation (7) is region r's export equation. Exports are inversely related to the real exchange rate and to $Y_W(r)$, an exogenous variable representing the general level of activity in the countries to which region r sells.

Equation (8) determines economy r's investment, by setting the ratio of investment to capital in the solution year to the exogenous variable $\Phi(r)$.

Equation (9) defines the real exchange rate as the ratio of the price of GDP in the domestic economy (a proxy for local production costs) to the average price of GDP in region r's trading partners ($P_W(r)$), converted to domestic currency via the exchange rate $\Theta(r)$). The exchange rate is expressed as domestic currency per unit of foreign currency.

The price of GDP at market prices is related to the price of GDP at factor cost via equation (10).

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Equation (11) relates the terms of trade (TOT(r)) (i.e., the price of exports relative to the price of imports) negatively to the volume of exports and to the average price of imports paid by region r ($P_W(r)$). $F_{TOT}\{\}$ is a positive increasing function of $X(r)$. Equation (11) is consistent with region r being a small country with respect to imports, but facing a downward-sloping demand curve for its exports.

Equation (12) shows the relationship between the terms of trade and the ratio of the price of private consumption to the price of GDP at market prices. $F_{P_C}\{\}$ is a positive increasing function of TOT(r). Changes in ($P^C(r)/P_{GDP}^{MP}(r)$) will often be associated with changes in the terms of trade. A terms-of-trade improvement reduces the price of total domestic final expenditure (which includes imports but not exports) relative to the market price of output (which includes exports but not imports).[6] Equation (13) explains the ratio of the price of government consumption to the price of GDP in a way that is analogous to the explanation of the price of private consumption relative to the price of GDP in equation (12).

Equation (14) connects relative factor inputs to relative factor prices. $RP_L(r)$ is the real price of labour, defined as the nominal wage rate relative to the price of GDP at factor cost (the price of output). $RP_K(r)$ is the real price of capital, defined as the nominal rental on capital relative to the price of GDP at factor cost. Under (14), an increase in the real price of labour relative to the real price of capital will cause an increase in the capital intensity of the economy. Notice that with perfect competition, the real price of labour is equivalent to the marginal product of labour and that the real price of capital is equivalent to the marginal product of capital.

The relationship between real factor prices is given in equation (15). It is derived from the geometric-average form:

$$P_{GDP}^{FC}(r) = (P_L(r) \times A(r))^{S_L(r)} \times (P_K(r) \times A(r))^{S_K(r)} \qquad (18)[7],$$

where $S_L(r)$ and $S_K(r)$ reflect the shares of labour and capital in the economy ($S_L(r) + S_K(r) = 1$), and $P_L(r)$ and $P_K(r)$ are the nominal wage rate and the nominal rental on capital. To obtain (15),

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[6] Note, that imports of private consumption goods comprise only a fraction of total imports and so not all terms-of-trade changes will lead to changes in the price of private consumption goods relative to the GDP deflator. Moreover, private consumption is only one part of total domestic final expenditure (GNE). Consequently, changes in the price of labour, say, may affect the prices of other GNE components more than the price of private consumption, leading to a change in the price of consumption relative to the GDP deflator even when there has been no change in the terms of trade.

[7] At this point the equation numbering might appear confusing. This is because the equations of the model listed in Table 1 are numbered consecutively and the equations in the text follow on from the number of the final model equation, namely equation number 17.

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divide both sides of (18) by the factor-cost price of GDP, redefine in terms of real prices, then re-arrange.

Equation (16) explains the real price of labour as a function of the real wage rate (RW(r)) (i.e., the nominal wage rate deflated by the price of consumption), the inverse of the terms of trade, and one plus the *ad valorem* rate of indirect taxes less subsidies. In deriving (16), we note that the real price of labour equals:

$$\frac{P_L(r)}{P_{GDP}^{FC}(r)} = \frac{P_L(r)}{P^C(r)} \times \frac{P^C(r)}{P_{GDP}^{MP}(r)} \times \frac{P_{GDP}^{MP}(r)}{P_{GDP}^{FC}(r)} \qquad (19).$$

On the right hand side of (19), $P_L(r)/P^C(r)$ is the real wage rate (RW(r)), $P^C(r)/P_{GDP}^{MP}(r)$ is a function of the inverse of the terms of trade (see equation (12)), and $P_{GDP}^{MP}(r)/P_{GDP}^{FC}(r)$ equals $(1+T(r))$ (see equation (10)).

In deriving (17), note that the real rental price of capital equals:

$$\frac{P_K(r)}{P_{GDP}^{FC}(r)} = \frac{P_K(r)}{P^I(r)} \times \frac{P^I(r)}{P_{GDP}^{MP}(r)} \times \frac{P_{GDP}^{MP}(r)}{P_{GDP}^{FC}(r)} \qquad (20),$$

where $P^I(r)$ is the price of investment. On the right-hand-side of (20), $P_K(r)/P^I(r)$ can be interpreted as the economy's rate of return, ROR(r). The second term, like the corresponding term in (19), responds to changes in the inverse of the terms of trade.[8] The final term is equivalent to $(1+T(r))$.

The linearised percentage-change forms of equations (1) to (17) are given in the second part of Table 1 as equations (1') to (17'). Lower-case letters identify percentage changes in variables written in the corresponding upper-case letters. Coefficients and parameters in the linearised model are given in Table 2. The derivations of the linear forms are generally straightforward but some explanation is necessary.

Equation (6') is an implication of the CES form for domestic/import substitution, with $\sigma_M(r)$ representing the average domestic/import substitution elasticity. Omitting the regional index for sake of brevity, note that the percentage change in $(1+T(r))$ is:

$$\frac{100\Delta T}{(1+T)} = \frac{100\Delta T}{(1+T)} \times \frac{T}{T} = t \times \frac{T}{(1+T)} = t \times \frac{T \times P_{GDP}^{FC} Y_{GDP}^{FC}}{(1+T) \times P_{GDP}^{FC} Y_{GDP}^{FC}} = tS_T \qquad (21),$$

where, as noted in Table 2, $S_T(r)$ is the share of indirect taxes net of subsidies in GDP at market prices.

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In equation (7') and equation (11'), $\sigma_X(r)$ is a negative parameter, representing the price elasticity of world demand for exports. Equation (11') also contains a shift variable, $f_X(r)$, that allows for exogenous shifts in the foreign-currency price of exports in region r.

For equation (12'), notice that from the expenditure side of GDP we can write:

$$p_{gdp}^{mp}(r) = S_C(r) \times p^c(r) + S_G(r) \times p^g(r) + S_I(r) \times p^i(r) + (S_X(r) \times p^x(r) - S_M(r) \times p^m(r)).$$

To obtain (12'), we assume that the prices of private consumption, public consumption and investment move together, i.e.,

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[8] Footnote 6, which relates to consumption goods, applies in an analogous way to investment goods.

$$p^c(r) = p^g(r) = p^i(r),$$

and that trade is initially balanced, i.e.,

$$S_X(r) = S_M(r).$$

Thus,

$$p_{gdp}^{mp}(r) = p^c(r) + S_X(r) \times (p^x(r) - p^m(r)) = p^c(r) + S_X(r) \times tot(r) \qquad (22).$$

In equation (13'), $\eta(r)$ is an exogenous shift variable that allows for changes in the ratio of the price of government consumption to the price of private consumption. Equation (14') is an implication of the CES form for capital/labour substitution:

$$\frac{K(r)}{L(r)} = \left(\frac{P_L(r) \times P_{GDP}^{FC}(r)}{P_K(r) \times P_{GDP}^{FC}(r)} \right)^{\sigma_{KL}(r)} \qquad (23),$$

where $\sigma_{KL}(r)$ is a positive parameter, representing the capital/labour substitution elasticity.

Our starting point for equation (16') is equation (19). Equation (19) implies that the percentage change in real price of labour is the sum of: (a) the percentage change in the real wage rate (rw(r)); (b) the percentage change in the ratio of the consumption price to the market-price GDP deflator; and (c) the percentage change in the ratio of the market-price GDP deflator to the factor-cost GDP deflator. Component (b) is explained by equation (12') and component (c) is explained by equation (10'). The derivation of equation (17') from equation (20) is analogous to the derivation of (16') from (19).

Table 3 lists the variables in the linearised form of the stylised macro model. The number of variables (30) exceeds the number of equations (17) by thirteen. Thus, thirteen variables must be set exogenously. Table 3 shows the exogenous/endogenous status of each variable that has a natural classification. Eleven variables are shown as naturally exogenous; in general, the model cannot explain changes in these variables. The nominal exchange rate is one such variable. It acts as the numeraire, namely, it determines the general price level.[9] This leaves two more variables to be made exogenous. In short-run comparative-static simulations, the capital stock and real wage rate are typically exogenous, allowing the model to determine values for employment and the rate of return on capital. In long-run comparative-static simulations, employment and the rate of return are exogenous, allowing the model to determine values for capital and the real wage rate.

4. Interpretation: GTAP projections of the effects of APEC liberalisation

4.1 GTAP Simulation

The version of GTAP used here is that documented in Hertel (1996) with some additional equations and variables described in Appendix A of Adams, *et al.* (1997). Calibration was based on data from the version 5 database (Dimaranan and McDougall, 2002). The solution software was GEMPACK (Harrison and Pearson, 1996). Table 4 shows the regions distinguished. The industry classification, while not of importance for this study, is shown in Table 5 for the sake of completeness.

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[9] The choice of numeraire is arbitrary. Natural alternatives to the exchange rate as the numeraire are the price of consumption or one of the GDP deflators.

Simulation design

The GTAP simulation involved the removal in each APEC country of all *ad valorem* import tariffs as well as tariff equivalents of bilateral non-tariff barriers on APEC-sourced imports.[10] Import protection between the rest of the world (ROW) and APEC is maintained. Table 6 shows the percentage deviations in the average tariff rate of each region (first row of numbers).

The deviations due to the removal of tariffs were computed under the following assumptions about factor markets and about macro behaviour in regions.

- capital is mobile, moving across regions to equalize disturbances in rates of return generated by the tariff shocks ;
- aggregate employment of labour and of land is fixed in each region;
- government budget balances are slack[11]; and
- in the solution year, investment and capital in each region move together, with the world rate of return adjusting to ensure that the weighted sum of changes in each region's investment equals the change in global savings.

Because of the capital-mobility assumption, we describe our simulation as long run.[12]

Table 7 shows initial values for the coefficients identified in Table 3 derived from the version 5 GTAP database. Table 8 shows results for the 17 variables identified as endogenous (long-run closure) in Table 3. The GTAP projections are shown in the columns labelled "GTAP".

Overview of GTAP projections

As shown in the first row of numbers in Table 8, the real-GDP gains from APEC-trade liberalisation tend to favour regions that are small and open. Examples are Thailand/Philippines (THA/PHL), for which an 18.2 per cent gain in real GDP is projected, and Malaysia/Singapore (MYS/SGP), for which an 8.2 per cent gain is projected. Apart from being small and open, these regions also have high pre-liberalisation levels of protection against imports, especially against imports of investment goods. The regions that gain least in terms of real GDP are the ROW, which does not cut protection and the large APEC economies, North America (NAM) and Japan (JPN).

Projections for changes in the terms of trade as a result of the APEC liberalisation are given in row 10 of Table 8 ("GTAP" column). Here, the liberalisation favours JPN, the agricultural exporting regions such as Australia (AUS) and New Zealand (NZL), and Taiwan (TWN). JPN's terms of trade improves, in part, because of strong increases in NAM demand for Japanese products due to tariff liberalisation. The terms-of-trade increases in AUS and NZL flow from the existence, prior to liberalisation, of large barriers imposed on agricultural and food commodities from these countries. The terms-of-trade increase in TWN stems mainly from strong increases in demand in other APEC regions for imports of other machinery and equipment from TWN. Regions that experience terms-of trade losses as a result of APEC liberalisation do so either because they are

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[10] From now on, whenever we use the term "tariff" we mean both tariffs and tariff equivalents of other trade barriers.

[11] This implies that the deterioration in government budget balances caused by the loss of tariff revenue is not offset by reduced government spending or by increases in other taxes. Most published GTAP applications adopt this assumption. We have done so for convenience, although it is clearly incorrect.

[12] GTAP allows other assumptions than those adopted here with respect to factor markets and macro behaviour. Each set of assumptions describes a closure of the model. The standard GTAP closure is a short-run closure in which each region's endowments of capital, labour and land are held fixed.

agricultural importing regions or because the ROW (where real activity falls because of liberalisation) is over represented as a destination for their exports.

Rows 5 and 6 of Table 8 ("GTAP" columns) show the trade-enhancing effects in each APEC region of tariff reductions. All APEC regions are projected to experience increases in trade volumes, with the largest increases occurring in regions with the highest initial levels of protection.

Rows 2, 3 and 4 of Table 8 ("GTAP" columns) show the impact of liberalisation on the components of real domestic demand. Aggregate real consumption (private plus government) is elevated in all APEC regions other than NAM and JPN. The largest increases are in regions that are projected to experience the largest gains in real GDP.

4.2 More detailed interpretation aided by the stylised model

The overview above is fairly typical of explanations offered in published journal articles of results from a GTAP simulation. Even so, in the context of the APEC liberalisation simulation, the overview leaves many questions unanswered. For example, why did real GDP in NAM fall? What accounts for the changes in factor prices (changes that are so important for income distribution analysis)? Why did NZL gain by more than AUS? What accounts for the large GDP gains in THA/PHL, and for the relatively small GDP gain in Indonesia (IDN)?

Answers to these and to many other questions, are revealed with the aid of the stylised macro model. There are two ways that the stylised model can be used. One is to use individual equations in isolation to understand specific results from the full model. For example, we might use equation (2') to explain outcomes for real GDP at factor cost based on GTAP values for the right-hand coefficients and GTAP-simulated values for right-hand variables. The second way that the stylised model can be used is to employ it as a model in its own right to reproduce the simulation of the primary model using shocks aggregated to a macroeconomic level. Results from the stylised simulation can then be compared with those from the simulation of the primary model, with special attention directed towards significant variations. We adopt this second approach in the discussion below.

Simulation design for the stylised model

The GTAP simulation of the long-run effects of APEC trade liberalisation is reproduced in the stylised macro model by shocking $t(r)$ and variables that are naturally exogenous in the stylised macro model but are naturally endogenous in the GTAP model, namely $y_W(r)$, $y^{TAX}(r)$, $p_W(r)$ and ror(r). The shocks to $t(r)$ are equivalent to the shocks imposed in the GTAP simulation (see Table 6). The shocks to $y_W(r)$ and $y^{TAX}(r)$ were calibrated so that the stylised model reproduced exactly the GTAP projections for the volume of exports ($x(r)$ in the stylised model) and the terms of trade (tot(r) in the stylised model) (see Table 8). $y^{TAX}(r)$ was set equal to the value of m(r), reflecting the fact that imports are the tax base for the taxes that are being removed. The shocks to ror(r) were uniform and set equal to the GTAP outcome for the global rate of return on capital (rorg), 1.28. This is the increase necessary to ensure that the change in global investment matches the change in global savings arising from APEC liberalisation.

Detailed explanation

The projections from the stylised macro model are given in Table 8 in the columns labelled "Stylised". Our explanation of the GTAP projections using the stylised mechanism starts with real

factor prices and the use of factor inputs. It then proceeds to real GDP, to the price of GDP and to the expenditure-side components of real GDP.

Changes in real factor prices

Equation (17') shows that there are three main mechanisms through which tariff cuts can affect the real cost of capital (the nominal cost of capital relative to the GDP deflator at factor cost). The first is via a change in the global rate of return on capital – essentially the rate of return *required* on the global market for capital. The second is via the direct effects of the tariff cuts on the duty-paid prices of imported inputs to investment. The third is via changes in the terms-of-trade that affect the average c.i.f. price of imported capital goods relative to the GDP deflator. In the GTAP simulation, the rate of return on capital increases in all regions by 1.28 per cent, whereas the outcomes for the terms of trade vary across regions. Ultimately, the GTAP-simulated value for rp_k is negative for all regions except NAM, JPN and ROW. In the exceptional cases, the impact of the increase in the required rate of return on the real cost of capital more than offsets the effects of changes in the terms of trade and in tariff rates.

In the GTAP simulation, the regions that experience the largest falls in the real cost of capital are THA/PHL, TWN, and CHINA. The tariff cuts as a share of GDP in these regions are relatively large (see the second row of Table 6) and dominate the influences of other factors on the cost of capital. Table 6 shows that the tariff cuts in MYS/SGP are also large, but the GTAP-projected fall in that region's real capital cost is mild relative to the fall projected for THA/PHL. To understand this result, note that the stylised model's projection for MYS/SGP is relatively close to the GTAP projection, whereas for THA/PHL, TWN and CHINA the stylised macro model underestimates the fall projected by GTAP. This points to compositional effects that are not accounted for in the stylised model. Closer inspection of the GTAP projections shows that the tariff cuts in THA/PHL, TWN and CHINA are more oriented towards investment goods than are the cuts in MYS/SGP. Thus in the most-affected regions the falls in the price of investment relative to the price of GDP (market prices) are much larger than in MYS/SGP. This is why the tariff cuts in the most-affected regions have a stronger influence on the real cost of capital than they do in MYS/SGP.

Equation (15') establishes that there is a strong negative relationship between the real cost of labour and the real cost of capital. The degree of responsiveness is determined by values for the ratio of the share of capital to the share of labour, initial estimates of which can be deduced using data in Table 7 for $S_K(r)$ $S_L(r)$. These show that the responsiveness of the real cost of labour to a one per cent change in the real cost of capital will be greatest in the developing regions such as THA/PHL. In these regions wages are low and so the ratios of capital payments to labour payments are high. In developed regions, the situation is reversed; comparatively high wage rates means that the ratio of capital payments to labour payments is low.

The negative relationship between real factor prices is confirmed by the GTAP results in Table 8. In regions where the real cost of capital declines the real cost of labour rises. The largest rise occurs in THA/PHL, which is projected to experience the largest fall in the real cost of capital and which has a relatively high capital share.

For some regions the stylised macro model fails to account adequately for changes in the real cost of land as projected by GTAP. This is due primarily to the omission of agricultural land. In GTAP, there are two main fixed factors of production in the long-run, labour and land. Thus when the real cost of capital falls, the real cost of labour plus land rises. The distribution of this increase

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in each region between labour and land depends partly on the respective shares of labour and land in GDP. In agriculturally-oriented regions like AUS and NZL, in which land's GDP-share is over 2 per cent, land absorbs a significant portion of the benefit that would otherwise have gone to labour. In these cases, the stylised macro model will tend to overestimate the increase in the real price of labour.

Changes in factor inputs and real GDP at factor cost

Equation (14') shows that at the macroeconomic level a fall in the real cost of capital relative to the real cost of labour causes producers to substitute capital for labour.[13] Accordingly, with employment unchanged in the long-run, capital is created in regions where the real cost of capital falls (see rows 8 and 16 of Table 8) and is destroyed in regions where the real cost of capital rises. THA/PHL experiences the largest increase in capital, followed by CHINA, TWN and SKOR. ROW and NAM experience the largest falls in capital.

Having explained changes in capital stocks we have also explained changes in real GDP (see equation (2')).[14] Figure 1 is a chart of the deviations in real GDP at factor cost as projected by GTAP and as projected by the stylised macro model. This figure illustrates two things: the relativities across regions in factor-cost GDP responses, and the reliability of the stylised model's explanation of deviations in real factor-cost GDP.

Real GDP at factor cost falls in three regions, NAM, JPN and ROW. These falls ultimately reflect projected increases in the real cost of capital in each adversely-affected region arising from the global increase in the rate of return on capital. Liberalisation is projected to increase real GDP in all other regions. The regions that expand least are AUS, NZL and IDN. This is consistent with the relatively small tariff cuts in these regions (see Table 6). Note that NZL gains more than AUS despite a smaller tariff cut because the NZL economy is more capital intensive and thus more responsive in a long-run simulation.

Figure 1 shows that the stylised model underestimates the "true" effects on real factor-cost GDP most significantly for THA/PHL, TWN, AUS and IDN, and overestimates the effects most significantly in CHINA. Underestimation can generally be traced back to an underestimation of the reduction in the real cost of capital. In all of the cases noted above, the error in estimating the impact on the real cost of capital is accounted for by the composition of the tariff shock which is disproportionately weighted towards imported investment goods (see the discussion regarding real factor prices above).

Overestimation of the factor-cost GDP result for CHINA, though, does not stem from an overestimation of the impact on the real price of capital. Indeed, as can be seen in Table 8 the stylised model underestimates the impact on the cost of capital. The key problem here appears to the relationship between the real cost of capital and the real cost of labour. With the stylised model, a 4.2 per cent reduction in the real price of capital translates into a 5.5 per cent increase in the real price of labour. By contrast, in the GTAP simulation a 5.3 per cent increase in the real cost of capital results in only a 3.3 per cent increase in the real price of labour. Again, the omission of land is the main cause of the disagreement. Though the share of land in GDP in CHINA is initially quite

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[13] In a multi-sectoral model, the economy-wide ratio of capital to labour is affected not only by changes in the ratio of aggregate factor prices but also by changes in the sectoral composition of GDP. For example, in the long-run the capital to labour ratio can rise because of changes in the composition of the economy towards capital-intensive industries. Conversely, it can fall with changes in composition away from capital-intensive industries.

[14] Recall that in the long-run simulation employment is fixed and there is no change in industry technologies.

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small, the increase in land rental in CHINA as projected by GTAP is very large (69 per cent), displacing a significant portion of the benefit that otherwise would have gone to labour. The price of Chinese agricultural land rises strongly because of the significant level of pre-liberalisation tariffs imposed on Chinese agricultural imports by other APEC regions.

Changes in real GDP at market prices and in the expenditure-side aggregates of real GDP

Real GDP at market prices is related to real GDP at factor cost by the addition of real indirect taxes net of subsidies (see equation (3)). In the simulation of the stylised macro model we assume that real indirect taxes net of subsidies move with the volume of imports. Accordingly, in the stylised simulation the ratio of real GDP at market prices to real GDP at factor cost (row 1 less row 7 in Table 8) increases in all regions where imports rise. This is consistent with the GTAP projections. Note, though, that the stylised model typically overestimates the increase in GDP-ratio. This is because the stimulation of imports does not reflect the direct impact of tariff cuts only. Some of the stimulation reflects general expansion in final demand and so the percentage increase in import volume will typically overstate the GTAP-projected percentage increase in real indirect taxes net of subsidies.

Figure 1: Long-run deviations in real GDP at factor cost
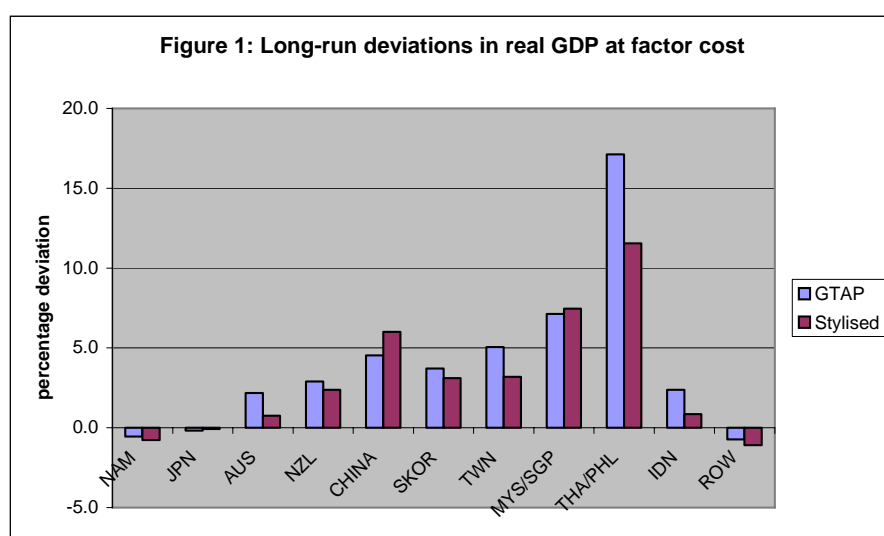
We now turn to the expenditure-side aggregates of real GDP. In the stylised macro model, the change in real private consumption is explained by equation (4'). Assuming no change in the average propensity to consume (Ω), and no change in the ratio of the price of GDP at market prices to the price of private consumption the stylised model would predict that real consumption moves in line with real GDP at market prices. Inspection of the GTAP results shows that this is a reasonable approximation (compare rows 1 and 2 in Table 8). Changes in the ratio of the price of GDP to the price of household consumption, though, are important in some regions (compare row 9 with row 11). In the stylised model, changes in this price ratio are linked to changes in the terms of trade (see equation 12'). According to equation (12'), in regions where the terms of trade improve, the ratio of the price of GDP to the price of consumption increases and allows room for an increase in real consumption. Overall, the stylised model provides an adequate approximation to the impacts on

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private consumption of tariff liberalisation, taking into account errors in the estimation of the percentage change in GDP.

The stylised model's account of changes in real public consumption is less convincing than its account of changes in real private consumption. This is so because in the GTAP simulation the price of public consumption does not move with the price of private consumption, as is assumed in equation (13'). In this case compositional effects are important. Private consumption tends to be oriented towards capital-intensive goods (housing, for example), with a sizeable share of imports in total expenditure. Public consumption on the other hand is oriented towards labour-intensive goods (such as public administration and community services), with only a small share of imports in total expenditure. It follows that in simulations where wage and import-price effects are significant, the price of public expenditure can move quite differently from the price of private consumption. This is certainly the case in the GTAP projections for SKOR.

Investment in both the stylised macro model and GTAP is indexed to capital in long-run simulations. Projections for capital are discussed above.

We turn next to trade volumes. Equation (6') suggests that in the GTAP simulation changes in import volumes reflect three factors: (a) the changes in relative domestic/import prices due to the direct effects of the tariff cuts; (b) changes in domestic demand; and (c) changes in the real exchange rate. In the GTAP simulation, the impact on imports of (a) is unambiguously positive. In most regions, the import-intensive components of demand are investment-related. Thus in most of the APEC regions the effects of (b) reinforce the effects of (a).

The final factor is changes in real exchange rates. In the stylised macro model, the change in real GDP (Y) in each region is determined, in the main, by changes in relative factor prices, and the change in real domestic absorption (C+I+G) in each region reflects the change in real GDP. It follows that the change in net trade volume (X-M) is constrained by the requirement for macroeconomic balance (Y=C+I+G+X-M)). In other words the volume of net trade has to adjust to reconcile changes in real GDP with changes in real domestic absorption. The residual adjustments occur via changes in real exchange rates.[15]

In the simulation of the stylised macro model, the change in real domestic absorption in each region generally exceeds that of real GDP because C and G move with GDP, but I moves with capital. This means that the balance of trade for each APEC region will deteriorate in real terms. The stimuli to import volumes from effects (a) and (b) generate some of the deterioration in each economy. The residual adjustment occurs via changes in real exchange rates. Real appreciation is required in most cases (see row 13 of Table 8). However, in some cases (e.g. THA/PHL) where effects (a) and (b) are very large, real devaluation is necessary. The pattern of devaluation and appreciation suggested by the stylised model is consistent with that projected by GTAP.

5. Conclusion

In this paper we suggest a general strategy for interpretation of macroeconomic projections from a CGE model like GTAP. Central to this strategy is the use of a stylised macro model. Experience suggests that the stylised framework provides a robust method for understanding CGE

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[15] Appreciation of the real exchange rate reduces the competitiveness of traded-goods industries versus foreign substitutes. This leads to fewer exports and to more imports. Conversely, devaluation of the real exchange rate enhances competitiveness, leading to more exports and to fewer imports.

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projections. In this paper, the robustness is put to the test with an analysis of GTAP projections of the long-run impacts of APEC trade liberalisation.

The stylised model assists in identifying the principal theoretical mechanisms that underlie the projections from the full model. It also aids in highlighting the important elements of the database (see Table 7). In the context of the long-run APEC liberalisation simulation, insights gained from the stylised model include the following.

1. Changes in relative factor prices play an important role in determining the GDP response in a fixed-factor simulation.

2. Tariff cuts that are oriented towards investment goods have a larger positive impact on real GDP in a long-run simulation, all else unchanged, than tariff cuts oriented towards labour-intensive goods.[16]

3. Adjustment of land rentals is an important consideration in understanding the macro response to a tariff cut of agricultural-dependent countries.

4. The size of the GDP response is positively related to the size of the tariff cut as a share of GDP.

5. Changes in the real exchange rate reflect changes in real GDP relative to changes in real domestic absorption.

6. Changes in the terms of trade play an important role in determining the size of the GDP response and in determining the composition of that response across the large expenditure-side aggregates.

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[16] The reverse is true in a short-run simulation, with labour variable and capital fixed.

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Levels equations

$$Y^{MP}(r) = C(r) + I(r) + G(r) + (X(r) - M(r)) \qquad (1)$$

$$Y^{FC}(r) \times A(r) = F_Y(L(r), K(r)) \qquad (2)$$

$$Y^{MP}(r) = Y^{FC}(r) + Y^{TAX}(r) \qquad (3)$$

$$P^C(r) \times C(r) = \Omega(r) \times P_{GDP}^{MP}(r) \times Y^{MP}(r) \qquad (4)$$

$$P^G(r) \times G(r) = \Gamma(r) \times P_{GDP}^{MP}(r) \times Y^{MP}(r) \qquad (5)$$

$$M(r) = F_M(Y^{MP}(r), RER(r), 1/(1 + T(r))) \qquad (6)$$

$$X(r) = F_X(-RER(r)) \times Y_W(r) \qquad (7)$$

$$I(r)/K(r) = \Phi(r) \qquad (8)$$

$$RER(r) = P_{GDP}^{MP}(r)/(\Theta(r) \times P_W(r)) \qquad (9)$$

$$P_{GDP}^{MP}(r) = P_{GDP}^{FC}(r) \times (1 + T(r)) \qquad (10)$$

$$TOT(r) = 1/\{F_{TOT}(X(r)) \times P_W(r)\} \qquad (11)$$

$$P^C(r)/P_{GDP}^{MP}(r) = 1/F_{P_C}(TOT(r)) \qquad (12)$$

$$P^G(r)/P_{GDP}^{MP}(r) = 1/F_{P_G}(TOT(r)) \qquad (13)$$

$$K(r)/L(r) = F_{KL}(RP_L(r)/RP_K(r)) \qquad (14)$$

$$RP_L(r)^{S_L(r)} = RP_K(r)^{-S_K(r)} \times A(r) \qquad (15)$$

$$RP_L(r) = F_{RP_L}(RW(r), (1/TOT(r)), (1 + T(r))) \qquad (16)$$

$$RP_K(r) = F_{RP_K}(ROR(r), (1/TOT(r)), (1 + T(r))) \qquad (17)$$

Linearised equations in the percentage changes of variables

$$y^{mp}(r) = S_C(r) \times c(r) + S_I \times i(r) + S_G(r) \times g(r) + \\ (S_X(r) \times x(r) - S_M(r) \times m(r)) \tag{1'}$$

$$y^{fc}(r) = S_L(r) \times l(r) + S_K(r) \times k(r) - a(r) \tag{2'}$$

$$y^{mp}(r) = S_{FC}(r) \times y^{fc}(r) + S_T(r) \times y^{tax}(r) \tag{3'}$$

$$c(r) = \omega(r) + (p_{gdp}^{mp}(r) + y^{mp}(r)) - p^c(r) \tag{4'}$$

$$g(r) = \gamma(r) + (p_{gdp}^{mp}(r) + y^{mp}(r)) - p^g(r) \tag{5'}$$

$$m(r) = y^{mp}(r) + \sigma_M \times (rer(r) - S_T(r) \times t(r)) \tag{6'}$$

$$x(r) = \sigma_X(r) \times rer(r) + y_W(r) \tag{7'}$$

$$i(r) - k(r) = \phi(r) \tag{8'}$$

$$rer(r) = p_{gdp}^{mp}(r) - (\theta(r) + p_W(r)) \tag{9'}$$

$$p_{gdp}^{mp}(r) = p_{gdp}^{fc}(r) + S_T(r) \times t(r) \tag{10'}$$

$$tot(r) = (1/\sigma_X(r)) \times x(r) + f_X(r) - p_W(r) \tag{11'}$$

$$p^c(r) = p_{gdp}^{mp}(r) - S_X(r) \times tot(r) \tag{12'}$$

$$p^g(r) = p^c(r) + \eta(r) \tag{13'}$$

$$k(r) - l(r) = \sigma_{KL}(r) \times (rp_L(r) - rp_K(r)) \tag{14'}$$

$$rp_L(r) = (-S_K(r)/S_L(r)) \times rp_K(r) + a(r) \tag{15'}$$

$$rp_L(r) = rw(r) - S_X(r) \times tot(r) + S_T(r) \times t(r) \tag{16'}$$

$$rp_K(r) = ror(r) - S_X(r) \times tot(r) + S_T(r) \times t(r) \tag{17'}$$

Table 2: Coefficients and Parameters in the Percentage-change form of the Stylised Model

Symbol	Description
$S_C(r)$	Share of private consumption in GDP at market prices
$S_I(r)$	Share of investment in GDP at market prices
$S_G(r)$	Share of public consumption in GDP at market prices
$S_X(r)$	Share of exports in GDP at market prices
$S_M(r)$	Share of imports in GDP at market prices
$S_L(r)$	Share of the cost of labour in GDP at factor cost
$S_K(r)$	Share of the cost of capital in GDP at factor cost
$S_{FC}(r)$	Share of the cost of factors (labour and capital) in market-price GDP
$S_T(r)$	Share of indirect taxes less subsidies in market-price GDP
$\sigma_M(r)$	Average domestic/imported substitution elasticity.
$\sigma_X(r)$	Price elasticity of world demand for region r's exports (negative parameter)
$\sigma_{KL}(r)$	Capital/labour substitution elasticity

Symbol	Description	Naturally exogenous(X)/ endogenous (N)	Short-run	Long-run
$y^{mp}(r)$	Real GDP at market prices	N		
$c(r)$	Real private consumption	N		
$i(r)$	Real investment	N		
$g(r)$	Real public consumption	N		
$x(r)$	Real exports	N		
$m(r)$	Real imports	N		
$y^{fc}(r)$	Real GDP at factor cost	N		
$l(r)$	Employment		N	X
$k(r)$	Capital stock		X	N
$a(r)$	All factor technical efficiency	X		
$y^{tax}(r)$	Quantity to which indirect taxes are attached.	X		
$\omega(r)$	Ratio of private consumption to GDP	X		
$\gamma(r)$	Ratio of public consumption to GDP	X		
$p_{gdp}^{mp}(r)$	GDP price (market prices)	N		
$\theta(r)$	Nominal exchange rate (domestic per foreign)	X (numeraire)		
$tot(r)$	Terms of trade	N		
$p_w(r)$	Average foreign-currency price of imports	X		
$f_X(r)$	Shift in foreign-currency price of exports	X		
$p^c(r)$	Price of private consumption	N		
$p^g(r)$	Price of government consumption	N		
$\eta(r)$	Ratio government to private consumption prices	X		
$rer(r)$	Real exchange rate	N		
$y_W(r)$	Average GDP change - region r's trading partners.	X		
$ror(r)$	Rate of return on capital		N	X
$\phi(r)$	Ratio of investment to capital in solution year	X		
$t(r)$	*Ad valorem* rate of indirect taxes	X		
$p_{gdp}^{fc}(r)$	GDP price (factor cost)	N		
$rp_l(r)$	Real price of labour	N		
$rp_k(r)$	Real price of capital	N		
$rw(r)$	Real wage rate		X	N

Table 4: Regional aggregation of GTAP used for this paper

	Identifier	Countries in region
1.	NAM	*North America* (United States, Canada and Mexico)
2.	JPN	Japan
3.	AUS	Australia
4.	NZL	New Zealand
5.	CHINA	China (includes Hong Kong)
6.	SKOR	South Korea
7.	TWN	Taiwan
8.	MYS_SGP	Malaysia and Singapore
9.	THA_PHL	Thailand and the Philippines
10.	IDN	Indonesia
11.	ROW	Rest of the World

Table 5: Sectoral aggregation of GTAP used for this paper

1.PDR	Paddy Rice	20.LEA	Leather, etc.
2.WHT	Wheat	21.LUM	Lumber
3.GRO	Grains	22.PPP	Pulp, Paper, etc.
4.NGC	Non-Grains Crops	23.P_C	Petroleum and Coal
5.WOL	Wool	24.CRP	Chemicals, Rubbers, Plastics
6.OLP	Other Livestock	25.NMM	Non-Metallic Minerals
7.FOR	Forestry	26.I_S	Primary Ferrous Metals
8.FSH	Fisheries	27.NFM	Non-Ferrous Metals
9.COL	Coal	28.FMP	Fabricated Metal Products
10.OIL	Oil	29.TRN	Transport Industries
11.GAS	Gas	30.OME	Machinery and Equipment
12.OMN	Other Minerals	31.OMF	Other Manufacturing
13.PCR	Processed Rice	32.EGW	Electricity, Water and Gas
14.MET	Meat Products	33.CNS	Construction
15.MIL	Milk Products	34.T_T	Trade and Transport
16.OFP	Other Food Products	35.OSP	Other Services (Private)
17.B_T	Beverages and Tobacco	36.OSG	Other Services (Govt)
18,TEX	Textiles	37.DWE	Ownership of Dwellings
19.WAP	Wearing Apparels		

Table 6: Percentage deviations in the average ad valorem tariff on import by region

	NAM	JPN	AUS	NZL	CHINA	SKOR	TWN	MYS/ SGP	THA/ PHL	IDN	ROW
$t(r)$	-2.9	-12.4	-19.8	-8.7	-33.0	-26.2	-40.4	-29.4	-63.0	-176.5	0
$S_T(r)t(r)$	-0.2	-1.0	-1.4	-1.1	-6.6	-3.4	-3.6	-5.9	-7.6	-1.8	0

Table 7: Values for coefficients and parameters from the GTAP database in the percentage-change form of the stylised model*

	NAM	JPN	AUS	NZL	CHINA	SKOR	TWN	MYS/ SGP	THA/ PHL	IDN	ROW
$S_C(r)$	0.68	0.60	0.63	0.63	0.51	0.54	0.56	0.47	0.61	0.60	0.63
$S_I(r)$	0.17	0.29	0.22	0.20	0.35	0.37	0.22	0.38	0.37	0.29	0.19
$S_G(r)$	0.16	0.10	0.18	0.14	0.12	0.10	0.14	0.11	0.10	0.08	0.18
$S_X(r)$	0.12	0.10	0.19	0.31	0.36	0.32	0.48	1.33	0.42	0.27	0.26
$S_M(r)$	0.14	0.09	0.21	0.28	0.34	0.34	0.39	1.28	0.51	0.25	0.26
$S_L(r)$ [a]	0.64	0.58	0.60	0.54	0.44	0.49	0.63	0.40	0.31	0.41	0.60
$S_K(r)$ [b]	0.36	0.42	0.40	0.46	0.56	0.51	0.37	0.60	0.70	0.59	0.40
$S_{FC}(r)$	0.92	0.92	0.93	0.87	0.80	0.87	0.91	0.80	0.88	0.99	0.92
$S_T(r)$	0.08	0.08	0.07	0.13	0.20	0.13	0.09	0.20	0.12	0.01	0.08
$\sigma_M(r)$ [c]	2.98	2.60	2.80	2.77	2.69	2.60	2.68	2.71	2.74	2.64	2.73
$\sigma_X(r)$ [d]	-5.48	-6.09	-4.95	-4.68	-5.82	-5.68	-5.42	-5.22	-5.33	-5.49	-5.44
$\sigma_{KL}(r)$ [e]	1.32	1.32	1.28	1.27	1.10	1.21	1.31	1.23	1.17	1.04	1.25

* Source: GTAP database, version 5.

(a) Ratio of the economy-wide cost of skilled and unskilled labour to the total cost of endowed commodities.

(b) Ratio of the economy-wide cost of capital, land and natural resources to the total cost of endowed commodities.

(c) Computed as a weighted average of the import substitution elasticities across commodity in the home region. The weights were calculated from the cif-paid values of imports.

(d) Computed as a weighted average of the import substitution elasticities by commodity across regions of destination. The weights were calculated from the fob values of exports.

(e) Computed as a weighted average of the factor substitution elasticities across industries. There weights were based on total factor payments.

Table 8: Percentage-changes in key endogenous variables of the stylised model

		NAM		JPN		AUS		NZL		CHINA		SKOR		TWN		MYS/SGP		THA/PHL		IDN		ROW	
		GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised	GTAP	Stylised
1	$y^{mp}(r)$	-0.5	-0.6	0.1	0.7	2.2	1.8	3.2	5.0	5.9	9.8	4.4	4.8	5.6	5.3	8.1	8.4	18.2	13.6	2.8	1.0	-0.8	-1.3
2	$c(r)$	-0.4	-0.6	0.6	0.9	2.7	2.5	5.4	7.3	4.0	8.8	4.6	5.2	6.4	6.8	7.0	7.6	12.0	11.6	2.0	1.1	-0.7	-1.4
3	$i(r)$	-1.6	-2.1	-0.4	-0.2	5.8	1.9	6.7	5.2	9.6	10.6	8.3	6.1	14.5	8.5	13.3	12.4	28.3	16.6	5.1	1.5	-2.0	-2.8
4	$g(r)$	-0.5	-0.6	-0.2	0.9	1.2	2.5	3.0	7.3	2.5	8.8	1.4	5.2	2.3	6.8	3.6	7.6	6.4	11.6	3.0	1.1	-0.5	-1.4
5	$x(r)^{(a)}$	3.0	3.0	9.7	9.7	13.5	13.5	14.5	14.5	25.6	25.6	14.3	14.3	18.2	18.2	10.9	10.9	32.2	32.2	9.3	9.3	-2.3	-2.3
6	$m(r)$	2.8	1.0	11.1	9.9	13.6	15.3	14.7	22.0	29.3	25.2	16.2	16.1	21.7	25.4	13.0	11.9	32.2	28.2	10.3	11.0	-1.4	-3.6
7	$y^{fc}(r)$	-0.6	-0.8	-0.2	-0.1	2.2	0.8	2.9	2.4	4.5	6.0	3.7	3.1	5.1	3.2	7.1	7.5	17.1	11.6	2.4	0.9	-0.7	-1.1
8	$k(r)$	-1.6	-2.1	-0.4	-0.2	5.8	1.9	6.7	5.2	9.6	10.6	8.3	6.1	14.5	8.5	13.3	12.4	28.3	16.6	5.1	1.5	-2.0	-2.8
9	$p^{mp}_{gdp}(r)$	-0.6	0.3	1.1	2.5	2.5	3.4	7.3	5.0	-2.6	-0.8	2.1	1.1	3.3	3.7	-2.8	-4.7	-8.8	-2.3	0.4	2.1	-1.3	-0.8
10	$tot(r)^{(a)}$	0.2	0.2	2.2	2.2	3.8	3.8	7.5	7.5	-2.9	-2.9	1.3	1.3	3.1	3.1	-0.6	-0.6	-4.8	-4.8	0.5	0.5	-0.2	-0.2
11	$p^{c}(r)$	-0.7	0.3	0.4	2.3	1.9	2.7	5.0	2.6	-1.2	0.2	0.9	0.6	1.5	2.2	-3.4	-4.0	-5.0	-0.3	1.1	2.0	-1.2	-0.8
12	$p^{g}(r)$	-0.7	0.3	1.8	2.3	3.4	2.7	7.8	2.6	0.2	0.2	5.6	0.6	7.1	2.2	1.6	-4.0	1.0	-0.3	0.2	2.0	-1.5	-0.8
13	$rer(r)$	0.2	0.3	2.3	2.5	2.8	3.4	7.4	5.0	-2.2	-0.8	2.9	1.1	4.4	3.7	-1.7	-4.7	-8.3	-2.3	0.9	2.1	-0.2	-0.8
14	$p^{fc}_{gdp}(r)$	-0.4	0.5	2.1	3.5	3.9	4.8	8.4	6.1	3.9	5.7	5.4	4.4	7.1	7.5	3.2	1.3	-1.2	5.4	2.1	3.8	-1.3	-0.8
15	$rp_{l}(r)$	-0.6	-0.6	-0.1	-0.1	1.2	0.6	2.2	1.9	3.3	5.5	3.4	2.6	4.1	2.4	5.8	6.1	12.2	9.9	1.7	0.8	-0.7	-0.9
16	$rp_{k}(r)$	0.8	1.0	0.4	0.1	-3.3	-0.9	-4.2	-2.2	-5.3	-4.2	-2.8	-2.5	-6.2	-4.1	-3.7	-4.0	-7.6	-4.3	-2.5	-0.6	1.0	1.3
17	$rw(r)$	-0.3	-0.3	1.6	1.1	3.2	2.7	5.6	5.4	8.4	11.0	7.8	6.3	9.7	7.8	12.5	11.4	16.0	15.5	2.7	2.7	-0.8	-0.9

(a) Exogenously set equal to the GTAP projections for exports via endogenous shifts in equation (7').

(b) Exogenously set equal to the GTAP projections for the terms of trade via endogenous shifts in equation (11').