

Linking GTAP to national country models: A tale of two approaches

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1. Introduction

Understanding the national and distributional impacts of multi-lateral trade agreements often requires the combined use of global and national models. For example, the collection of country case studies in Hertel and Winters (2006) and Anderson, Cockburn and Martin (2010) have underscored the importance of following the effects of global shocks down to the household level.

Two methodologies have so far been used to link global and national country models. The first approach, applied in the collection of studies referred above, implements a top-down link in which simulation results from the global model—i.e., vectors of changes in exports prices, exports volume and import volumes—are used as shocks to a national model following the method of Horridge and Zhai (2006). On the other hand, Horridge and Filho (2003) provide an alternative but more complicated approach in which a national model of Brazil is fully integrated into the global GTAP model. In their application, the Brazilian part of the GTAP model is turned off and replaced by the Brazilian national model.

This paper contributes by first providing a technical overview of both approaches. To provide for a better comparison, we use the Philippines as a case study to analyse the potential effects of the ASEAN Free Trade Agreement (AFTA) on the Philippines. In each application, we shock the global GTAP model to simulate a complete tariff elimination scenario in the ASEAN region.

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2. Analytical Framework

Two methodologies have so far been used to link global and national country models. The first approach, applied in Hertel and Winters (2006) and Anderson, Cockburn and Martin (2010), implements a top-down link in which simulation results from the global model—i.e., vectors of changes in exports prices, exports volume and import volumes—are used as shocks to a national model following the method of Horridge and Zhai (2006). On the other hand, Horridge and Filho (2003) provide an alternative but more complicated approach in which a national model of Brazil is fully integrated into the global GTAP model. In their application, the Brazilian part of the GTAP model is turned off and replaced by the Brazilian national model.

2.1 Top-down Link between GTAP and Philippine model

Hertel and Ivanic [2006] identify two issues that arise when linking global and national CGE models. The first issue is double counting because global policy reforms should not be implemented twice, i.e., once in the global model (GTAP hereafter) and another in the national model (say of the Philippines, referred to as PHILGEM hereafter). To prevent double-counting, we first use the standard GTAP model to simulate a tariff elimination policy by the rest of the world—i.e., excluding our focus country: the Philippines. The resulting changes in export demand and foreign currency import (c.i.f.) prices for the region “Philippines” in GTAP are then transmitted as shocks to PHILGEM. The Philippines’ participation in the global tariff reform is also implemented in this second step, via unilateral tariff elimination shocks imposed on the PHILGEM model.

The second issue relates to properly communicating results, in a top-down manner, from GTAP to PHILGEM via the trade channel. For imports, Horridge and Zhai [2006] suggest passing as exogenous shocks the import price results for each commodity in GTAP to the same commodity² in PHILGEM. This is possible because the PHILGEM model takes foreign import prices as given (small country assumption) and because the regional import supply curves (including the “Philippines”) in GTAP are very elastic.

In contrast, Horridge and Zhai [2006] point out that transmitting export-side results is more complicated. The GTAP model treats products as differentiated by origin (the Armington assumption), hence export prices for each region are not exogenous even for commodities for which that region’s market share is small. In addition, individual commodity export supply

² Mapping between commodities in GTAP and PHILGEM is necessary.

schedules of the region “Philippines” in GTAP and PHILGEM may be different. Often, national models of developing countries incorporate domestic constraints on export expansion, leading to export supply schedules which are less elastic than those in GTAP. On the other hand, export supply schedules in national models are also influenced by the imposed factor market closure, hence may end up being more elastic than in GTAP.³

Figures 1 and Figure 2 illustrate transmission of export-side results from GTAP to PHILGEM, for a tradeable commodity, say clothing. By construction, the export demand schedule of the region “Philippines” in GTAP and PHILGEM have the same slope; PHILGEM adopts for its individual commodity export demand function, the values of elasticity parameter $ESUBM$ from GTAP. In both figures, point A is the initial equilibrium for clothing exports in both GTAP and PHILGEM. We first impose a global tariff elimination policy on clothing imports in the GTAP. This policy increases demand for clothing exports, so shifting the demand curve from $D0_{GTAP,PHILGEM}$ to $D1_{GTAP,PHILGEM}$ in both GTAP and PHILGEM models.

Figure 1: Export-side link between GTAP and PHILGEM (steep supply curve)

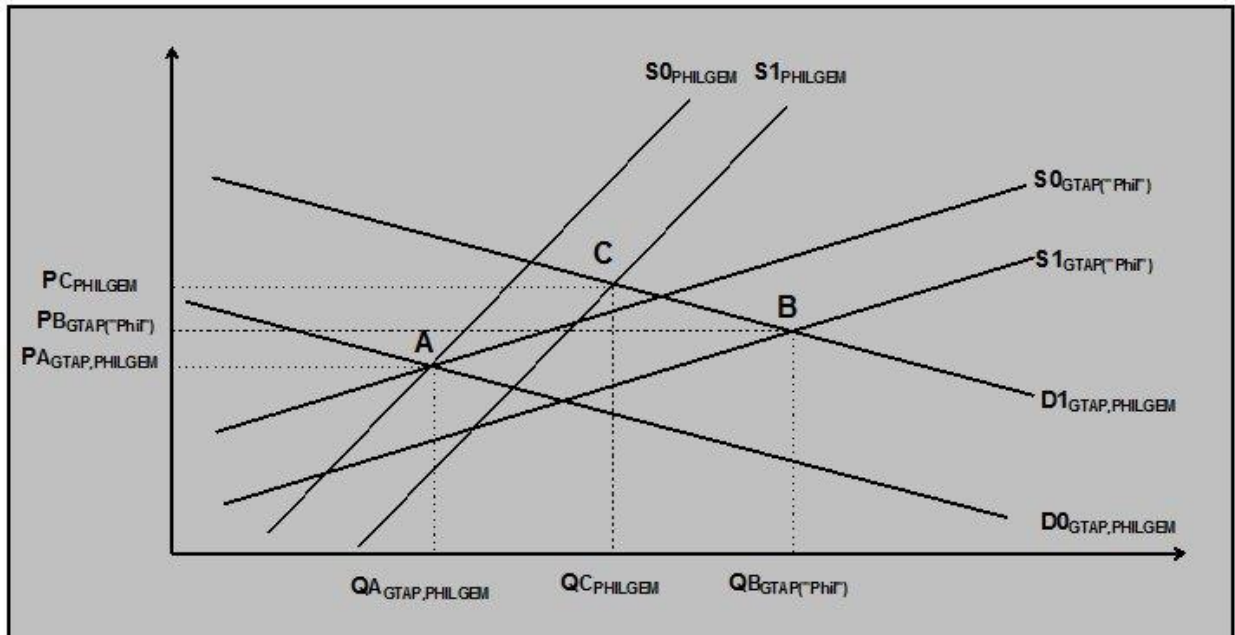


Figure 1 shows that in PHILGEM, assuming limited production of resources, higher demand for clothing will lead to resource reallocation effects that will release factors used in the production

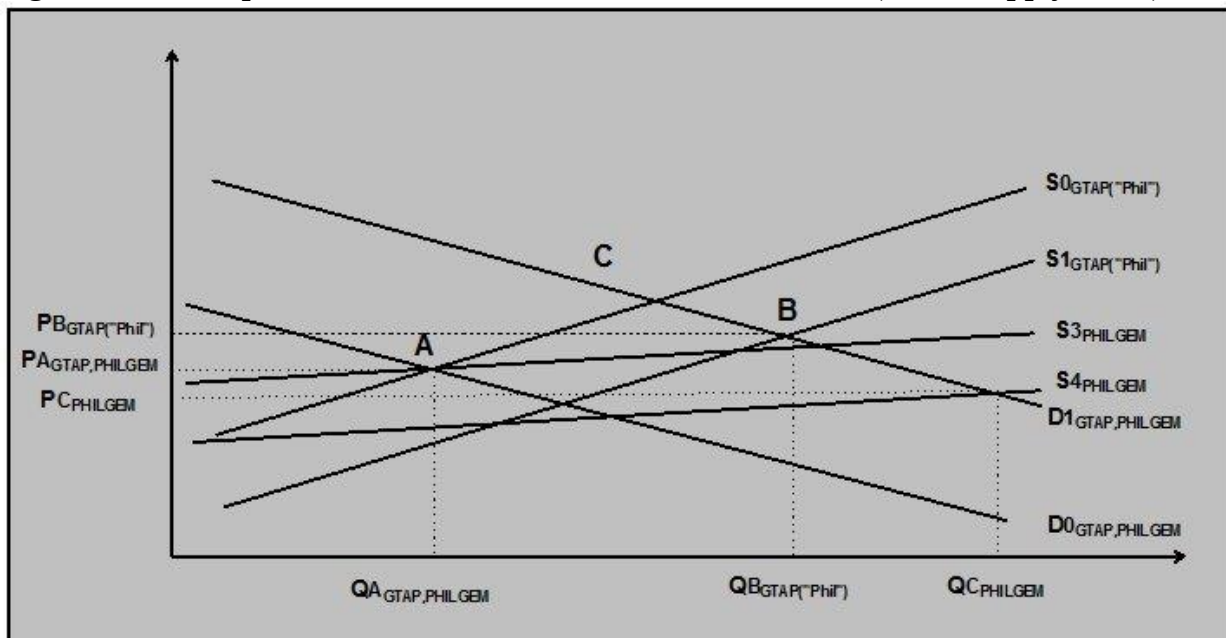
³ Both PHILGEM and GTAP fix aggregate labour which is mobile between sectors. In GTAP, aggregate capital is fixed and moves between sectors. In long-run PHILGEM, capital is available in elastic supply.

of other goods for clothing production. This shifts the steeper supply curve of clothing in PHILGEM from $S_{0\text{PHILGEM}}$ to $S_{1\text{PHILGEM}}$, while in GTAP, the flatter supply curve of clothing for the region “Philippines” will shift from $S_{0\text{GTAP(“Phil”)}}$ to $S_{1\text{GTAP(“Phil”)}}$.

Figure 2 shows the opposite case, where PHILGEM has more elastic supply than GTAP. The factor market closure in PHILGEM allows for slack capital market and labour mobility, a global tariff elimination policy on clothing imports shifts the more elastic supply curve of clothing in PHILGEM from $S_{3\text{PHILGEM}}$ to $S_{4\text{PHILGEM}}$, while in GTAP, the steeper supply curve of clothing for the region “Philippines” will still shift from $S_{0\text{GTAP(“Phil”)}}$ to $S_{1\text{GTAP(“Phil”)}}$.

We see in both Figures 1 and 2 that the equilibrium points for both models are different: point **C** in PHILGEM (Q_{CPHILGEM} , P_{CPHILGEM}) and point **B** in GTAP ($Q_{\text{BGTAP(“Phil”)}}$, $P_{\text{BGTAP(“Phil”)}}$). Horridge and Zhai [2006] suggest that point **C** is preferred because PHILGEM contains country-specific details that reflect supply shifts associated with domestic constraints that are not captured by GTAP.

Figure 4.3.2A: Export-side link between GTAP and PHILGEM (elastic supply curve)



Given that both GTAP and PHILGEM have the same export demand slope, GTAP must then transmit to PHILGEM, the extent of the export demand shift (i.e., from point **D0** to **D1**) for each commodity; PHILGEM then solves for the necessary shift in export supply to hit equilibrium point **C**.

Horridge and Zhai [2006] explain how to deduce, from GTAP results, the size of the export demand shift. In GTAP, the export demand function is:

$$Q = \left(\frac{FP}{P} \right)^{ESUBM} \quad (1)$$

where FP is the export demand shifter, P is the price of exportable commodity, and $ESUBM$ is the slope of the export demand curve or the elasticity of substitution among imports.

In per cent change form, Equation 1 becomes:

$$q = -ESUBM (p - fp) = p - fp - \frac{q}{ESUBM} \quad (2)$$

where the lower case variables represent the percentage changes of the upper case variables shown in Equation 1.

The per cent change in the export demand shifter fp is:

$$fp = p + \frac{q}{ESUBM} \quad (3)$$

With the value of $ESUBM$ for each commodity the same in GTAP and PHILGEM, we can calculate using Equation 3, the extent of export demand shift (fp) to be transmitted from GTAP to PHILGEM—using percentage changes in exports price (p) and quantity (q) derived from GTAP results. The PHILGEM model first takes these commodity-specific export demand shifts (fp) as shocks, then solves for the necessary export supply response for each commodity.

2.2 Integrated GTAP and Philippine model

Horridge and Filho (2003) provide an alternative but more complicated approach in which a national model of Brazil (ORANIGFR) is fully integrated into the global GTAP model. In their application, the Brazilian part of the GTAP model is turned off and replaced by the Brazilian national model.

We follow Horridge and Filho [2003] by adding four equations that link the GTAP and PHILGEM model (See Horridge and Filho 2003 for details).

3 Macro-economic effects

The macro-economic effects on the Philippines of tariff elimination policies in the ASEAN region are shown in Table 1. We see that the top-down approach brings about greater changes in magnitude relative to the linked global-national modelling approach.

Table 1: Macro-economic effects of ASEAN-FTA on the Philippines (% change from base)

		Change due to:		
		Top-down model (1)	Linked GTAP- PHILGEM (2)	Difference (3)
Prices				
1	CPI: numéraire	-	-	-
2	Investment price index	-2.1	0.1	-2.1
3	Government price index	0.1	0.0	0.1
4	Export price index	0.7	0.2	0.4
5	Imports, c.i.f. (in \$US)	0.3	-0.3	0.6
6	GDP price deflator	-0.3	0.2	-0.5
7	Imports (in local currency)	-3.5	-1.0	-2.4
8	Real exchange rate	0.5	-0.6	1.1
9	Terms of trade	0.4	0.6	-0.2
10	Primary factor costs	1.3	0.5	0.7
11	Nominal wage	0.0	0.0	0.0
12	Nominal return to capital	2.5	1.0	1.5
13	Nominal return to land	4.1	2.2	1.9
Volume				
14	Household demand	1.4	0.4	1.0
15	Investment demand	-	-	-
16	Government demand	-	-	3.9
17	Exports supply	5.9	2.0	4.7
18	Import demand	6.7	2.1	0.4
19	GDP	0.7	0.3	-
20	Aggregate capital	-	-	0.6
21	Aggregate employment	1.0	0.4	-2.1

Source: Simulation results

We first analyse the effects of ASEAN-FTA on the Philippine economy using the top-down modelling approach. The ASEAN- FTA boosts international trade in the Philippines, with total exports and imports rising by 5.9 and 6.7 per cent respectively. Relative to the CPI which is the model's numéraire, the average local currency price of imports falls by 3.5 per cent. The GDP price deflator marginally falls (0.3 per cent) as the reduction in the investment price index (-2.1 per cent) outweighs higher government, exports and imports price indices.

The real exchange rate⁴ slightly depreciates (0.5 per cent) given the decrease in the GDP price deflator (0.3 per cent) and the increase in the nominal exchange rate 0.3 per cent). Our results show that higher exports supply is mainly driven by two factors: the real exchange rate depreciation, so increasing the competitiveness of exports abroad; and higher foreign demand for Philippine exports.

The terms of trade improve due to higher exports price effects. Given downward-sloping foreign exports demand curve, we would expect exports supply to fall as exports prices rise. However, exports supply still increase because of higher foreign demand for exports associated with ASEAN-FTA. Using aggregate household consumption as a simple index of welfare, we can deduce that the Philippine economy benefits from ASEAN-FTA—that is, aggregate household consumption increases by 1.4 per cent. Real GDP expands by 0.7 per cent.

We now look at the results arising from the linked GTAP-PHILGEM approach. We see that although the direction of changes in the linked GTAP-PHILGEM approach is largely similar with the top-down approach, the magnitudes of changes are smaller in the linked GTAP-PHILGEM approach. Moreover, the direction of changes for a number of price variables is different, namely: imports (c.i.f), GDP price deflator, and real exchange rate.

⁴ The real exchange rate is defined as the ratio of world to local prices, i.e., $p0realdev = p0cif_c - p0gdpexp$.