CHAPTER 4: Partial-equilibrium trade-policy simulation

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A. Overview and learning objectives

Chapters 4, 5 and 6 introduce you to *ex-ante* analysis of trade policy changes. Analyzing a policy or policy reform using statistical methods such as those discussed in Chapter 3 requires the policy or reform to have been in place for a sufficient period of time for its effects to be observable in the data. However, if policymakers are interested in an *ex-ante* assessment of its likely effects, a different approach is needed. Another possible scenario is that the reform has been in place for a while, but that no appropriate counterfactual is available to benchmark its effect. In this case, a simulation approach is suitable even if data are available.

In the absence of data, the logic of *ex-ante* policy evaluation has to be different from the empirical logic of statistical assessments. There are two important differences. First, although proper econometric estimations must in general be backed by theory, this is even truer of simulations because the diagnostic tests available in statistics have no equivalent here. All you can do is to replicate the simulation over a range of parameter values in order to check the results' sensitivity; but beyond this relatively crude type of robustness check there is no alternative to simply trusting the model. Second, in a statistical assessment we want to control for as many outside influences as possible, which means estimating many parameters. In a simulation, by contrast, we want as few parameters as possible because parameter values often have to be guessed or borrowed from previous studies and because the more there are, the harder it will be to understand what drives the results. Often, this means imposing constant-elasticity forms for demand and supply functions.

The typical trade policy simulation procedure consists of four steps:

1. Choose a theoretical model that is appropriate to predict the effects of the policy under consideration.
2. Collect the corresponding trade (including import and export flows as well as tariffs) and production data for the specific sector(s) before the policy change.
3. Select values for the model's key parameters (elasticities).
4. Change the value of the policy variables of interest and recalculate the prices and trade volume for comparison with the baseline one.

One of the key choices facing the analyst is whether to use a partial-equilibrium (PE) or general-equilibrium (GE) model. The choice involves a trade-off: on the one hand, a GE approach takes into account inter-market linkages which a PE approach cannot; on the other hand, a GE model will typically be set up at an aggregate level, whereas a PE model can be as disaggregated as you wish. What is best — disaggregation or a proper treatment of inter-market linkages — depends on the nature of the policy experiment conducted and on the specific concerns of the policymaker.

There are other considerations to take into account when deciding whether to choose PE or GE analysis. PE analysis offers several advantages compared to GE models. First, a number of simple, ready-made models are available online that are relatively easy to use. The working of those models and their results are relatively straightforward to interpret, since only a relatively limited number of equations are used to calculate changes in demand and supply. Second, the data requirements are typically smaller, as only data from the sector in question is needed: mainly trade flows, trade policy data and elasticities. At the same time, these advantages may be seen as weaknesses in the PE models. First, PE models do not include constraints on production factors. Second, the results of PE

Table 4.1 Partial vs. general equilibrium models

	PE	GE
Capturing economy wide linkages		X
Consistency with budget constraints		X
Capturing disaggregated effects	X	
Capturing complicated policy mechanisms	X	
Use of timely data	X	
Capturing short and med. term effects	X	
Capturing long term effects		X

Source: WITS Advanced Course Presentation (World Bank, 2008)

models can be very sensitive to the values used for the elasticities, for which the empirical literature is still limited. Table 4.1 provides an overview of the main characteristics of PE and GE models.

This chapter provides an introduction to PE analysis. The first part describes the key theoretical concepts behind PE while the second part gives an overview of four ready-made PE models, namely:

- SMART
- Global Simulation Analysis of Industry-Level Trade Policy (GSIM)
- Tariff Reform Impact Simulation Tool (TRIST)
- Agricultural Trade Policy Simulation Model (ATPSM).

The chapter first explains the theoretical assumptions behind the models (Part B) and then shows how the models can be implemented in practice (Part C). It provides a comparison of the main features of the four models and highlights the context in which each model applies best. Several *ex ante* PE simulation case studies that explore the implications and feasibility of trade reforms are presented. The first case study uses SMART to analyse the example of Albania liberalizing the tariff on buses from the EU. The second case study applies GSIM to the hypothetical example of China and the EU mutually opening their markets for socks. Finally, TRIST is used to assess how modifying the common external tariff of the Common Market for Eastern and Southern Africa (COMESA) would affect the revenues of Malawi, Zambia and Kenya.

In this chapter, you will learn:

1. the basic idea behind partial equilibrium models
2. the logic of several ready-made PE simulation models and the situations in which these models are best applied
3. what are the key elasticities and how to exploit simulation analysis to explore the sensitivity of results to assumptions about elasticity values
4. how to use the basic features of these PE simulation models, including generating simulation results.

After reading this chapter, you will have understood the choices facing a modeller: (i) the advantages and disadvantages of a disaggregated analysis and when it is useful; (ii) the choice of a functional form; (iii) an introduction to the different simulation models; (iv) the choice between these different simulation models.

B. Analytical tools
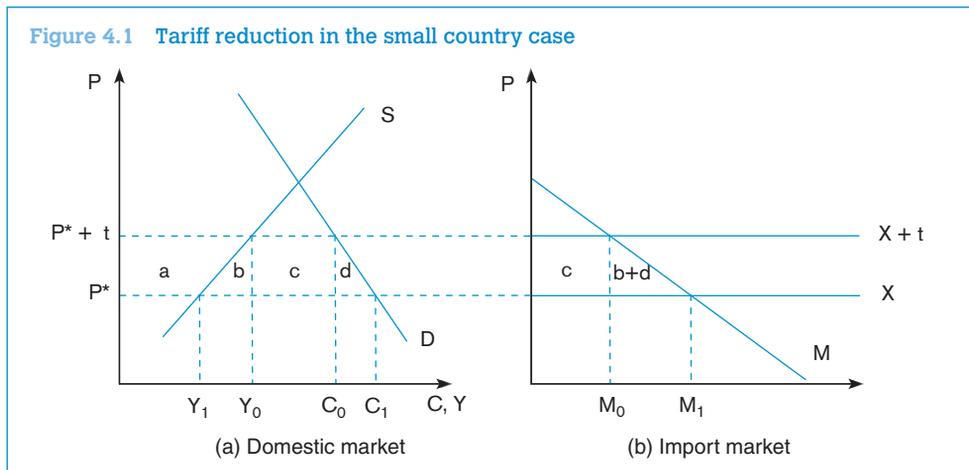
1. Preliminary discussion

a. The basic set-up

Assume that we would like to gauge *ex-ante* the impact of a change in trade policy on prices, trade flows, tariff revenues and welfare. We start with a graphical illustration of the simplest case, namely the effect of the elimination of a tariff t by a small country that faces fixed world prices, P^* (see Figure 4.1).

At world price $P^* + t$, domestic demand is given by C_0, domestic supply is Y_0 and imports are M_0. The elimination of the tariff t decreases the domestic price by the full amount t and as a consequence increases demand to C_1 and increases domestic supply to Y_1. Imports increase from M_0 to M_1.

The change in domestic price leads to a consumer surplus gain ($a+b+c+d$), as she/he is now able to purchase a larger amount of goods (i.e. $C_1 - C_0$). The tariff elimination leads to a producer surplus loss (a) and a loss in tariff revenue for the taxpayers (c). The total gain of the tariff elimination is thus the area ($b + d$) or the triangle under the import demand curve. As the height and base of the triangle depend on the tariff, the deadweight loss depends on the square of the tariff.

Overall, we observe that in the case of a small country an import tariff elimination lowers the domestic price by the full amount of the tariff t. It also increases imports and removes the tariff revenue, c. However, the elimination of a tariff always results in a net gain that depends on the square of the tariff.

In the case of a large country, we assume that the foreign supply curve X is upward sloping as depicted in panel (d) of Figure 4.2. With the tariff, the price equilibrium is at $P_0 + t$. Eliminating the tariff shifts the export supply to X, which results in a new domestic price P_0. As the supply curve is upward sloping, the decrease in the domestic price is less than the full amount of the tariff t. This also means that the foreign price in the presence of the tariff (P) is lower than the free trade

Figure 4.1   Tariff reduction in the small country case

(a) Domestic market

(b) Import market

Figure 4.2   Tariff reduction in the large country case

(a) Domestic market   (b) Import market
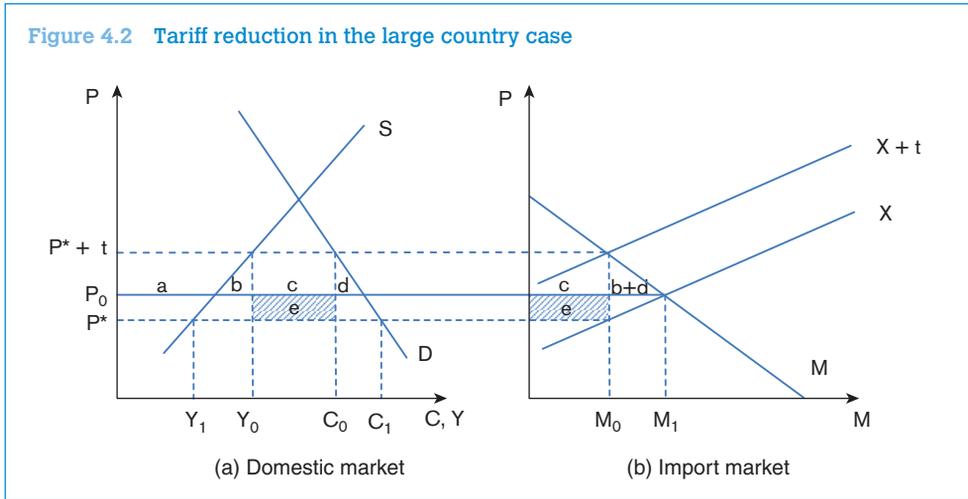
price P_0, which translates into a terms of trade gain (e) for the importing country. We recall that the terms of trade are usually defined by the price of a country's exports divided by price of its imports.

As in the case of a small country, eliminating a tariff leads to lower domestic prices, more imports and less domestic supply. However, all three effects are attenuated by the fact that the foreign supply curve is assumed to be upward sloping. The change in welfare looks now also slightly different, since there exist terms of trade gains. The area e measures these terms of trade losses by multiplying the drop in prices by the new import demand, M_1. The net gain triangle still corresponds to $(b + d)$ and depends on the square of the tariff, t^2. The net welfare effect $e − (b + d)$ is thus positive for sufficiently small tariffs and negative for large tariffs.

b.   Measuring net welfare gains (the Harberger triangle)

Let us now turn to a theoretical analysis of the effect of an elimination of a tariff on trade flows, tariff revenue and welfare. Consider an economy whose representative individual has quasi-linear (QL) preferences over two goods: good zero, the numéraire, and good one (without subscript), the import-competing one. That is, the consumer's utility is:

$$U = C_0 + u(C) \tag{4.1}$$

where C_0 and C are the quantities of numéraire and good one consumed, respectively, and $u(.)$ is an increasing, concave sub-utility function. Two useful properties of QL preferences are that:

- The indirect utility function is the sum of income I and consumer surplus $u(C) − PC$, where $P = P^*. (1+t)$ is the domestic price with t being the tariff rate (it can be shown that the consumer derives no consumer surplus from good zero).
- The marginal utility of income is always one, so at the consumer's optimum $u' = P$.

Income is the sum of profits π and tariff revenue tM. Thus, once the representative individual's optimal choices are taken into account, welfare as a function of the tariff is

$$W(t) = I + u(C) - PC \tag{4.2}$$
$$= \pi + tM + u(C) - PC$$

and the derivative of this expression with respect to the tariff is

$$W' = u'C' - (C + PC') + \pi' + M + tM'$$
$$= (u' - P)C' - C + Y + M + tM'$$
$$= Y + M - C + tM'$$
$$= tM' \tag{4.3}$$

In going from the first to the second line of (4.3) we used Hotelling's lemma, according to which the price derivative of the profit function is output (that is, $\pi' = Y$); in going from the second to the third line we used the second property of QL preferences (namely that the marginal utility of income is one). Finally, in going from the third to the last line note that by definition, for the import-competing good, consumption C is the sum of domestic output Y and imports M.

Now let us take a second-order Taylor approximation of (4.3) around $t = 0$:

$$W(t) \cong W(0) + tW'(t) + \frac{1}{2}t^2 W''(t) \tag{4.4}$$

so, noting that at $t = 0$ $W''(t) = 0$ and that $W''(t) = M'$ (this can be directly derived from simply noting that $W'' = M' + tM'' = M'$ if $t = 0$),

$$\Delta W \equiv W(t) - W(0) \cong \frac{1}{2}t^2 M' \tag{4.5}$$

As $tM' = dM$ (that is, the change in imports from a position of zero tariff is the tariff times the price derivative of import demand) the welfare change is $t\Delta M/2$, i.e. the area of a right-angle triangle whose height and base are respectively the tariff and import changes — the familiar "Harberger triangle".

Because functional forms in simulation models are often of the constant-elasticity type, it is useful to cast expression (4.5) in terms of the elasticity of import demand. To do this, write M' as dM/dP, where as before $P = P^*(1+t)$ is the domestic price (p^* being the world price) and write

$$M' = \frac{M}{P}\left(\frac{P}{M}\frac{dM}{dP}\right) = \frac{M}{P}\varepsilon \tag{4.6}$$

where the price elasticity of import demand ε is in algebraic form (i.e. negative); so, finally,

$$\Delta W = \frac{1}{2}\frac{M}{P}\varepsilon t^2 \leq 0 \tag{4.7}$$

In this formula, the net welfare gain ΔW generated by elimination of a tariff t depends only on the own-price elasticity of demand and the tariff itself. Where did we slip in the assumption needed to get rid of cross-price elasticities? Looking back at the utility function, obviously with only two goods we could have only one cross-price elasticity. However, even that one has been eliminated, because the utility function is strongly (i.e. additively) separable. We could easily generalize it to

Figure 4.3 How tariff elimination increases welfare
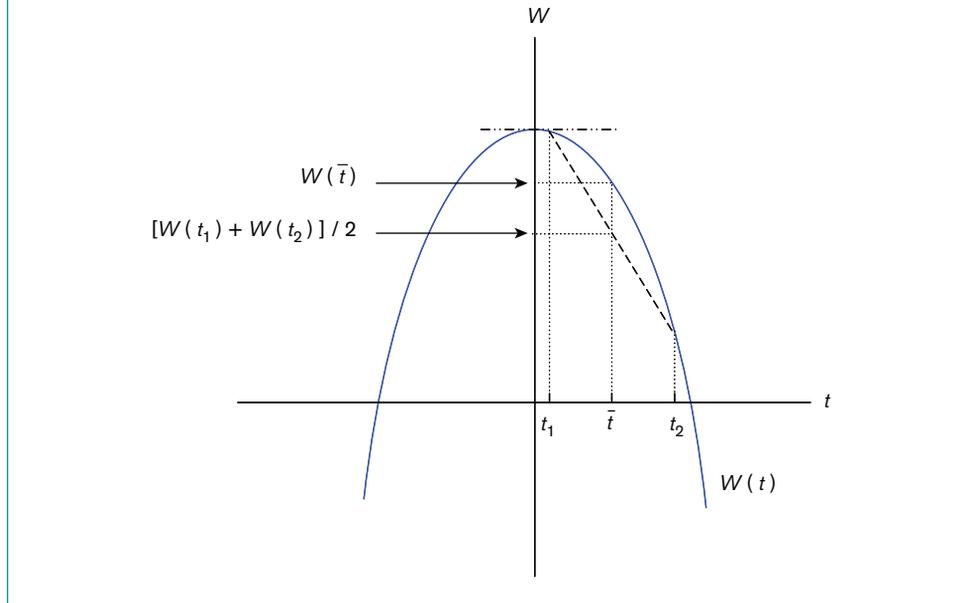
$= X_0 + u(X_1) + \ldots + u(X_n)$; as long as it remains additive, no cross-price elasticity will appear in (4.7). But we need to remember that this is only an assumption on preferences and not a feature of the data.

Because welfare shrinks with the *square* of the tariff in (4.7), with several goods, tariff variance in itself reduces welfare. To see why, consider a two-good economy with the following policy options:

- a low tariff t_1 on good one and a high tariff t_2 on good two
- a uniform tariff $\bar{t} = (t_1 + t_2)/2$ on both.

Average welfare generated in the two markets is shown in Figure 4.3 as a parabolic function of tariffs, with a maximum at $t_1 = t_2 = 0$.

Under a uniform tariff, welfare is $W(\bar{t})$; under a pair of differentiated tariffs, it is the average of $W(t_1)$ and $W(t_2)$. It is obvious that the former is higher than the latter because the arc is above the chord; this is a straightforward application of a mathematical principle known as Jensen's inequality. We will discuss its practical implications later on in this chapter.

C. Product differentiation

As we will see in the next section, most simulation models use the "Armington assumption" whereby varieties of goods are differentiated by country of origin (Armington, 1969). Why this assumption? Schott (2004) reports evidence that at a highly disaggregated level the price of goods imported

into the US is correlated with the exporting country's level of income. This suggests that rich countries export higher-quality or higher-technology varieties than poor ones do. However, the rationale for the Armington assumption is less clear-cut when varieties are imported from countries at similar income levels. There is in fact a more technical reason for avoiding the assumption of homogeneity across national varieties.

The first problem relates to prices and specialization. In a Heckscher–Ohlin model with just as many goods as factors, all countries are fully diversified, the outputs of all goods are jointly determined by full-employment conditions (one per factor of production) and factor prices are determined by zero-profit conditions (one per good). In this setting, a tariff change will trigger factor-price adjustments as predicted by the Stolper-Samuelson theorem.

With more goods than factors — the typical case in simulation exercises — things are less smooth and two situations can arise:

1. If the vector of good prices happens to be such that our country of interest is fully diversified, its sectoral output levels are, in general, indeterminate because there are not enough full-employment conditions to determine all output levels.
2. If the vector of prices is different from the particular value that ensures diversification, then each country produces just as many goods as it has factors; countries are then in different "diversification cones".

Thus, instead of merely pinning down factor *prices*, good prices now determine the *number* of goods produced. This complicates the analysis. To see why, consider an initial situation where *n* goods are produced. Under the assumption of perfect competition and constant unit costs, all industries make zero profits. Suppose now that tariffs are reduced on some of those goods. Their domestic prices then drop below the break-even point and because of constant unit costs reducing output does not help (as it would with an upward-sloping supply curve). Domestic industries will therefore disappear altogether. This is both unrealistic and awkward to deal with mathematically.

Several fixes are possible. For one, in a fully specified model such as in the GE models examined in the next chapter, where supply curves are derived from underlying technologies, we can impose upward-sloping supply curves so that price changes induce smooth quantity adjustments. The alternative and standard fix for our problem is to assume that domestic varieties are not perfect substitutes for each other; this is what we called earlier the Armington assumption. We now have a two-dimensional definition of products: "goods", say bananas, and "varieties", say bananas from St Lucia, from Costa Rica or from Cameroon. This has several advantages. First, it solves our problem with the number of goods; a tariff change will now induce smooth substitution between domestic varieties with the number of goods remaining constant. Second, it makes it possible to accommodate two-way trade: Japan exports the Japanese variety of steel and imports the US variety because they are not perfect substitutes in the eyes of buyers.

However, the Armington assumption creates a new difficulty. Suppose that, as discussed in the overview of this chapter, we impose constant-elasticity forms to all our demand functions so we have only elasticities to worry about. However, we have to recall that the advantage of PE is to "go disaggregate", so let us have 5,000 goods (at the HS-6 level) and, say, 50 countries from which we

import. With one differentiated variety per country, we have potentially 250,000 own- and cross-price elasticities to guess! This is, of course, way too many. Own-price elasticity estimates are available at the HS-6 level from Kee et al. (2006), but cross-price estimates are yet to be found, and even if they existed, you would not want to interpret a model with 250,000 elasticities.

So an additional simplifying ingredient must be thrown in, namely what is called "two-stage budgeting". Simulation exercises typically assume a form for individual utility functions that ensures strong separability between goods, so cross-price elasticities between goods (not national varieties) are all zero, along with CES (constant elasticity of substitution) for national varieties.

All these assumptions can be relaxed as per the modeller's needs at the cost of added complication. It is common to assume a similar framework on the supply side, where export markets are imperfect substitutes for each other. The equivalent of the CES function is a CET (constant elasticity of transformation), and changes in producer prices induce smooth substitution across export markets rather than complete withdrawal.

2. Empirical tools

a. SMART

This section describes the analytical set-up of the SMART model, following Jammes and Olarreaga (2005). The core assumption of this PE model is the Armington assumption, i.e. the imports from different countries are imperfect substitutes. When it comes to export supply elasticities, SMART can either be solved with perfectly elastic export supplies, i.e. world prices of each variety are given, or by assuming upward-sloping export supply curves.

Case 1: Perfectly elastic export supply

Let us start by assuming that agents in a representative country (whose index we omit) have a quasi-linear utility function of the form

$$U(c_0, c_1, \ldots, c_n) = c_0 + \sum_{i=1}^{n} u(c_k^i) \qquad (4.8)$$

where c_0 stands for consumption of a composite good used as numéraire and c_k^i for consumption of good k imported from country i. The function $u(.)$ is increasing, concave and identical in all countries. The fact that the utility function is additive ensures that we do not have substitution effects between goods k, as explained above.

Consider a representative good, an importer and two exporters. Let us use subscript k for the good and superscript i and l for the exporters, whereas importer indices are omitted (all indices are dispensed of when not needed). Let P be the good's domestic price in the importing country, P^* its world price and M the quantity imported. All variables should carry three indices (for the importer and exporter and for the good).

Let $\tilde{M}_k^{il} = M_k^i / M_k^l$ be the ratio of a representative country's imports of good k from exporters i and l respectively, and $\tilde{P}_k^{il} = P_k^i / P_k^l$ the ratio of their landed (duty-paid) prices. The elasticity of

substitution σ between the two origins for good k, assumed to be the same across all origins, for all countries and for all goods, is

$$\sigma = \frac{\tilde{P}^{il}_k}{\tilde{M}^{il}_k} \frac{d\tilde{M}^{il}_k}{d\tilde{P}^{il}_k} \tag{4.9}$$

Without indices, the elasticity of import demand (in algebraic value, i.e. negative) is

$$\varepsilon = \frac{P}{M} \frac{dM}{dP} \tag{4.10}$$

where p is the landed price of a representative good in a representative importer country, equal to

$$P = P^*(1+t) \tag{4.11}$$

and t is the applied tariff, i.e. the MFN tariff reduced by the preference margin:

$$t = t^{MFN}(1-\delta) \tag{4.12}$$

SMART assumes that all countries face fixed world prices (also labelled as small country case). As a consequence, in all the derivations of this section P^* is fixed and the change in the domestic price is simply the direct effect of tariff changes (as seen in the graphical analysis above).

Trade creation is calculated in SMART as the direct increase in imports attributable to a tariff reduction. That is, using (4.10),

$$\begin{aligned} TC &\equiv PdM = \varepsilon MdP \\ &= \varepsilon MP^* dt \tag{4.13} \\ &= \varepsilon MP^* \frac{dt}{(1+t)} \end{aligned}$$

Total trade creation from a set of tariff reductions $\Delta t^1_k, \ldots, \Delta t^n_k$ applied on good k to partners $i = 1, \ldots, n$ is then

$$TC_k = \sum_{i=1}^{n} TC^i_k = \sum_{i=1}^{n} \varepsilon_k M^i_k P^{*i}_k \frac{\Delta t^i_k}{1+t^i_k} \tag{4.14}$$

where the elasticity of import demand for good k is assumed to be the same for all source countries $i = 1, \ldots, n$.

A preferential tariff reduction granted by j to partner country i will induce substitution of imports away from other countries. This trade diversion is calculated in SMART using the elasticity of substitution. With a little bit of algebra, it can be checked that

$$\frac{d\tilde{P}^{il}_k}{\tilde{P}^{il}_k} = \frac{dt^i_k}{1+t^i_k} \tag{4.15}$$

Moreover, by the definition of $\tilde{m}^{il}_k$,

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$$d\tilde{M}''_k = \frac{M'_k\, dM^i_k - M^i_k\, dM'_k}{(M'_k)^2} = \frac{1}{M'_k}(dM^i_k - \tilde{M}''_k\, dM'_k) \tag{4.16}$$

The "diversion" component of the change in trade flows is the increase in imports from the preferred sources (i) that displace imports from MFN sources (l). That is, set

$$dM'_k = -dM^i_k \tag{4.17}$$

where l is an aggregate of all MFN partners. Then it can be rewritten as

$$d\tilde{M}''_k = \frac{1+\tilde{M}''_k}{M'_k}\, dM^i_k \tag{4.18}$$

Substituting for $d\tilde{M}''_k$ using (4.19) gives (after several simple transformations):

$$dM^i_k = \left(\frac{M^i_k M'_k}{M^i_k + M'_k}\right)\sigma \frac{dt^i_k}{t^i_k} \tag{4.19}$$

This is the basic expression for measuring trade diversion in SMART. Observe that it is increasing in σ (the elasticity of substitution), which is itself unbounded. As the amount of trade diverted cannot be larger than the initial value of imports from l, we need to introduce a constraint to that effect. We write trade diversion TD as

$$TD = \begin{cases} \left(\dfrac{M^i_k M'_k}{M^i_k + M'_k}\right)\sigma \dfrac{dt^i_k}{t^i_k} & \text{if } -dM'_k \le M'_k \\ M'_k & \text{otherwise} \end{cases} \tag{4.20}$$

where M'_k is the initial level of MFN imports.[1]

SMART is typically used to analyse the effect of a tariff change that provides a more favourable treatment for one trading partner. For example, granting country A a lower tariff compared to country B changes relative prices of the two goods. Consumption of the good from country A will increase (from A_0 to A_1), whereas imports from B will decrease from B_0 to B_1. This effect is called trade diversion (as calculated in SMART; see Figure 4.4(a)).

Trade creation happens when the lower price of the variety coming from A enables consumers to reach a higher composite quantity curve q_1. Keeping the expenditures constant, consumers are now able to import more of the variety coming from A (A_1 to A_2). (See Figure 4.4(b).)

In SMART, exporter A will enjoy both a positive diversion effect (from A_0 to A_1) and a positive creation effect (from A_1 to A_2), whereas exporter B will suffer from a negative diversion effect (from B_0 to B_1), and yet no trade creation effect.

SMART also calculates the effect of trade policy changes on tariff revenue, consumer surplus and welfare. The change in tariff revenue is simply calculated by the difference between the old tariff revenue (initial *ad valorem* tariff multiplied by initial import value) and the new tariff revenue (new *ad valorem* tariff multiplied by new import value).

Figure 4.4   Trade creation and trade diversion in SMART

(a) Trade diversion   (b) Trade creation
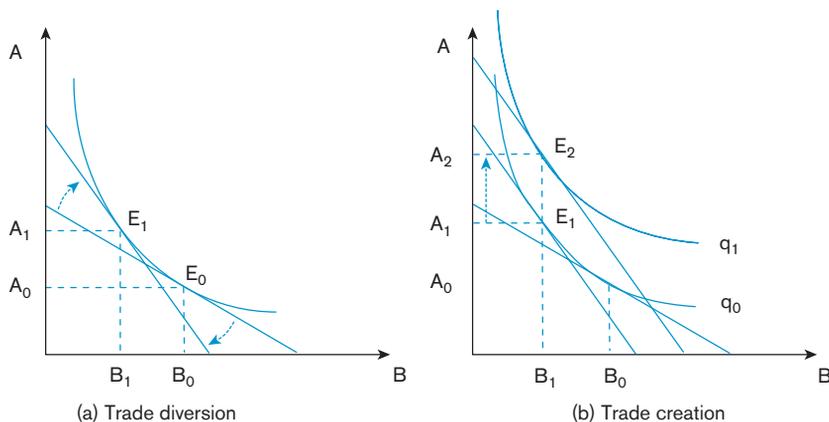
Source: WITS Online Help on SMART

Box 4.1   Example of Albania's unilateral tariff liberalization with the European Union

Let us now turn to a small example in order to illustrate the functioning of SMART in the case of a small country. In the year 2007, Albania sourced buses (HS 870210) from 19 trading partners, of which 11 were European Union countries. The total imports under HS 870210 amounted to US$ 8.6 million. Albania levied tariffs from all sources, including the EU. Using SMART, the user can simulate the effect of a full trade liberalization towards the EU but not the rest of the world. SMART yields the results that all 11 EU countries would be able to increase their exports to Albania. Germany, for example, the biggest exporter, would see its exports increase by almost US$ 1 million. Non-EU countries, by contrast, would see their shares shrink. The United States, in particular, would see their exports decrease by about US$ 0.3 million.

When it comes to changes in revenues, SMART generates a so-called "Revenue Impact Report". In the case of our example, the tariff liberalization would obviously increase imports but at the same time lower tariff revenue (see Table 4.2). SMART calculates the new tariff revenue, the change in tariff revenue and the consumer surplus. As we have seen above graphically and analytically, the trade opening would result in lower tariff revenues but at the same time a higher consumer surplus.

Table 4.2   SMART output "Revenue Impact Report" for the case of Albania, liberalization of HS 870210

Imports Before in US$ 1,000	Import Change	Tariff Revenue in US$ 1,000	Tariff New Revenue in US$ 1,000	Tariff Change in Revenue in US$ 1,000	Consumer Surplus in US$ 1,000
8599.096	1714.038	1289.86	346.363	−943.502	157.335

Case 2: Upward-sloping demand curves

Until now, we have discussed the case where export supplies are elastic. This is a reasonable assumption for cases such as Albania, a small country with little influence on world market prices. We will now turn to the case of upward-sloping demand curves, i.e. the case where world prices are endogenous.

Few countries can claim to be large enough to affect world price. However, the "large country" assumption can be useful in other contexts as well. Consider the effect of Brazil's elimination of intra-MERCOSUR tariffs on its imports of, say, milk from Uruguay. The small-country assumption means that Uruguay is assumed in practice to be able to supply the entire Brazilian market at unchanged prices. This is unlikely to be true. So in many preferential-liberalization contexts, assuming a finite elasticity of supply — and hence a variable "world", or more exactly foreign, price — is more realistic.

However, this raises an additional issue. Take the Uruguay–Brazil example again. If Brazil's preferential liberalization *vis à vis* Uruguay makes it possible for Uruguayan producers to obtain a higher price on the Brazilian than on other markets, then all of Uruguay's production should now be diverted to Brazil, which means that Uruguay's export supply to Brazil should *jump* to the total value of Uruguay's production, a big-bang outcome that is not amenable to calculus. There is no obvious fix to this problem; you are to assume symmetric structures on the import and export side, with a finite elasticity of transformation between geographical markets playing the same role on the export side as Armington's elasticity of substitution on the import side. On this, see Francois and Hall (1993), Hoekman et al. (2004) or Jammes and Olarreaga (2005).

We can again derive the term that measures the extent of trade creation. For each good, we now have three unknowns to determine instead of two: dX, dP and dP^*, all in terms of the tariff change dt. In order to have a solution we need three equations: the definition of the elasticity of supply,

$$\mu = \frac{P^*}{xX}\frac{dX}{dP^*},$$

(4.21)

the equation linking the world price, the tariff, and the domestic price, given by (4.11), and the definition of the elasticity of demand, given by (4.10). We will close this simple system of equations by noting that home imports equal foreign exports.

Differentiating again (4.11), but now without holding p^* constant and substituting from (4.19), gives

$$dX = \frac{\varepsilon X}{P}dP$$

$$dP = P^* dt + (1+t)dP^*$$

(4.22)

$$dP^* = \frac{P^*}{\mu x}dx$$

or, after substitution and replacing X by M,

$$TC \equiv \Delta X = \left(\frac{\mu \varepsilon}{\mu - \varepsilon}\right)M\frac{\Delta t}{1+t}$$

(4.23)

Recall that ε is in algebraic value and is thus normally negative, so trade creation is *positive* when the tariff goes *down*. (The large-country formula for trade diversion is more tedious to derive but follows the same logic. Please refer to Jammes and Olarreaga, 2005 for details.)

The easiest way to use SMART is to access it through the World Integrated Trade Solution (WITS) Portal (see Chapter 1). In the main menu under "Tariff and Trade Simulations" you are able to access SMART and to estimate the effect of tariff changes on trade flows, tariff revenues and consumer welfare.

b. Global Simulation Analysis of Industry-Level Trade Policy (GSIM)

GSIM was developed as an extension and improvement of SMART by Francois and Hall (2003). It shares the same insight that a relatively simple yet flexible PE framework for detailed analysis of trade policy was needed. One simplifying assumption of SMART was that everything is treated in terms of bilateral relationships and world markets are ignored. The key difference between the two tools is therefore that in SMART the market clearing conditions only apply to the import markets, whereas in GSIM the global market is cleared. In the simplest case, we look at a trade policy change between two countries, e.g. a tariff cut, and also include in the analysis of the outcome the impact on the rest of the world. Taking into account global markets enhances the complexity of the model and requires greater computational power, which is, however, easily available today.

Let us illustrate the notion of market clearing using a concrete example. Let us assume a tariff reduction in a particular sector between two countries, assumed to be the EU and the United States, with no changes with respect to the rest of the world. GSIM enables us to calculate the changes in world prices and the welfare impact of the three parties involved (EU, the United States and the rest of the world). The tariff reduction would lead to a new market clearing price. In our example, the bilateral tariff cut would lead to an increase in prices for exporters in the EU and the United States and thus gains in producer surplus for the latter. For producers outside the two, the preferential liberalization would bring down demand for third-country exports and their prices would fall. The result is a loss in producer surplus. The net effects, including the combination of producer surplus, consumer surplus and tariff revenue changes, involve gains for the EU and the United States and losses for the rest of the world.

As in SMART, one of the key assumptions of GSIM is that imports are imperfect substitutes for each other. The elasticity of substitution is assumed to be equal and constant across products from different sources.

Following the formulation of Jammes and Olarreaga (2005), the theoretical model on which GSIM is built up can be summarized as follows.

Within each importing country m, imports (M_{mki}) of the product category k from country i are a function of their prices and the total expenditure on the category:

$$M_{m,k,i} = f(P_{m,k,i}; P_{m,k,\neq i}; Y_{m,k}) \tag{4.24}$$

where $Y_{m,k}$ is the total import expenditure of country m on product k and $P_{m,k,i}$ is the domestic price in country m of product k exported by i. $P_{m,k,i}$ includes the tariff, therefore

$$P_{m,k,i} \equiv (1 + t_{m,k,i})\dot{P}_{k,i} \equiv T_{m,k,i}\dot{P}_{k,i} \tag{4.25}$$

where $t_{m,k,i}$ is the respective tariff imposed by country m on its imports of good k from i. $\dot{P}_{k,i}$ stands for the world price of product k exported by i.

In order to obtain the own price demand elasticity and the cross-price elasticity, we differentiate (4.24) applying the Slutsky decomposition of partial demand and taking advantage of the zero homogeneity property of Hicksian demand:

$$\varepsilon_{m,k,i} = \theta_{m,k,i}(\varepsilon_{m,k} + \sigma_k)$$
$$\varepsilon_{m,k,\neq i} = \theta_{m,k,\neq i}\varepsilon_{m,k} - (1 - \theta_{m,k,\neq i})\sigma_{m,k} \tag{4.26}$$

$\varepsilon_{m,k,i}$ is the own price demand elasticity in country m for product k exported from different countries. The import demand function is the product of $\theta_{m,k,i}$, which is the expenditure share of product k exported by country i in total imports of product k by country m and the sum of $\varepsilon_{m,k} < 0$ (the composite import demand function for product k in country m) and $\sigma_{m,k} > 0$ (the elasticity of substitution in country m for product k exported from different countries). $\varepsilon_{m,k,\neq i}$ is the cross-price elasticity of the import demand function in country m for product k exported from i when the price of product k exported from other countries $\neq i$ changes.

Before establishing the market equilibrium, we need to define the export supply function as a function of world prices:

$$X_{k,i} = g(\dot{P}_{k,i}) \tag{4.27}$$

Differentiating the export supply function and rearranging in percentage terms gives us the export supply elasticity:

$$e_{k,i} = \frac{\hat{X}_{k,i}}{\hat{P}_{k,i}} > 0 \tag{4.28}$$

As we have now defined demand and supply, we are able to estimate the impact of a trade reform on world prices. We use matrix notation in order to obtain a quick analytical solution. First, denote $\mathbf{E_{m,k}}$ as a diagonal x by x matrix of elasticities in country m for product k. The elements in the diagonal are equal to $\varepsilon_{m,k,i}/e_{k,i}$ and the elements off the diagonal are given by $\varepsilon_{m,k,\neq i}/e_{k,i}$.

We note $\mathbf{\dot{P}_k}$ as a vector of percentage changes in world prices of product k. $\mathbf{T_{m,k}}$ is a vector recording the tariff changes imposed by country m on import of k from different countries. We further denote $\mathbf{E_k} = \sum_m \mathbf{E_{m,k}}$ and $\mathbf{B_k} = \sum_m \mathbf{E_{m,k}T_{m,k}}$. Assuming market clearing conditions and solving for the changes in the world prices yields:

$$\mathbf{\dot{P}_k} = (\mathbf{I} - \mathbf{E_k})^{-1}\mathbf{B_k} \tag{4.29}$$

Equation (4.29) allows us to calculate the percentage change in world prices. Once we obtain this information, it is relatively simple to calculate the changes in import and export flows, tariff revenue and welfare (consumer and producer surplus).

The percentage change in imports is obtained by using (4.26) and the definition of import demand elasticity (i.e. the ratio of percentage quantity changes over percentage price changes).

The linear approximation of the changes in tariff revenue is given by:

$$TR_{m,k,i} = t_{m,k,i} \, M_{m,k,i} \, P^{*}_{m,k,i} \left(\hat{t}_{m,k,i} + \hat{P}^{*}_{m,k,i} \left(1 + \varepsilon_{m,k,i}\right) \right) \tag{4.30}$$

where $\hat{t}_{m,k,i}$ is the percentage change in the tariff levied by m on good k exported from i and $\hat{P}^{*}_{m,k,i}$

is the percentage change in the world price of good k exported from i.

The price and quantity effects can also be used to estimate the producer and consumer surplus. A linear approximation of the exporter producer surplus is given by:

$$\Delta PS_{k,i} = P^{*}_{k,i} \, X_{k,i} \, \hat{P}^{*}_{k,i} \left(1 + \frac{e_{k,i} \, \hat{P}^{*}_{k,i}}{2} \right) \tag{4.31}$$

For the consumer surplus the linear approximation can be estimated as:

$$\Delta CS_{m,k} = \sum_{i} M_{m,k,i} \, P^{*}_{m,k,i} \, T_{m,k,i} \left(\frac{1}{2} \varepsilon_{m,k} \left[\hat{P}_{m,k} \right]^{2} \text{sign} \left(\hat{P}_{m,k} \right) - \hat{P}_{m,k} \right) \tag{4.32}$$

where $P_{m,k} = \sum_{i} \theta_{m,k,i} \, \hat{P}^{*}_{k,i} + \hat{T}_{k,i}$.

The consumer surplus is measured with respect to the composite import demand curve, with $P_{m,k}$ representing the price for composite imports and $M_{m,k,i} P^{*}_{m,k,i} T_{m,k,i}$ representing initial expenditure at internal prices. Finally, the welfare changes can be calculated as the sum of producer surplus, consumer surplus and import tariff revenues.

In summary, GSIM is an analytical tool for global simulations, i.e. tariff reforms by one or more countries at a time. As in SMART, it assumes imperfect substitution among imported sources. GSIM solves by clearing world markets for the price of each source taking into account substitution across all sources. GSIM can hence be considered as an extension of SMART by adding a multiple market simulation and a solution for world prices.

The developers of GSIM, Francois and Hall, have made available two simple Excel spread sheets to estimate the model.[2] The simplest version is the 4x4 case, meaning three importing and exporting countries as well as all other countries lumped together as the rest of the world. The more complex version is a 25x25 case. The data requirements in the 4x4 case are the trade flows between the four entities, the tariffs before and after a trade policy change as well as the relevant demand, supply and substitution elasticities. In contrast, in SMART you only need information on the trade flows and tariffs of one particular country (for the elasticities default values are set).

Box 4.2   Example of a trade liberalization in HS 6115 between China and the European Union

We would like to take a concrete example to show how the 4x4 Excel sheet implements the model. Let us take the global market for the product group HS (2002) 6115: Panty hose, tights, stockings, socks and other hosiery, knitted or crocheted. In this product group the three biggest exporters are, in the following order, China, Turkey and the European Union (considering only extra-EU trade and not intra-EU trade).

Taking the year 2009 as the baseline for trade flows and tariffs, let us assume a bilateral trade liberalization for this product group between the EU and China. Hence the tariffs between the two fall from around 15 per cent and 9 per cent to zero on both sides, whereas the tariffs towards Turkey and the ROW are maintained.

Using the Excel solver we obtain the new prices that clear all markets. These new prices then yield the new changes in trade values and quantities and finally the welfare effects (see Table 4.3). In our case we observe that European consumers and Chinese producers would be the big winners of a mutual trade opening. The total welfare effect would be strongly positive for both economies. The gains would come at the cost of Turkey and the rest of the world. Suffering from a terms-of-trade deterioration, their producers as well as consumers would lose out.

Table 4.3   Total welfare effects (changes) in case of a trade liberalization in HS 6115 between China and the European Union

		A	B	C	D = A + B
		Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect
Country	EU	6.9	98.8	−79.7	26.0
	CHINA	65.4	0.7	−0.5	65.5
	TURKEY	−8.8	−0.1	0.0	−8.9
	ROW	−32.1	−58.6	−3.3	−93.9

c.   Tariff Reform Impact Simulation Tool (TRIST)

The Tariff Reform Impact Simulation Tool (TRIST) was developed by experts at the World Bank (Brenton et al., 2009). The development of TRIST was motivated by the observation that more and more countries ask for World Bank support to estimate the adjustment costs of trade policy reforms such as free trade agreements, customs unions or unilateral tariff cuts. The most immediate concern, especially for low-income countries, is typically the impact on tariff revenue, as the latter often represents an important source of government revenue. Compared to other PE tools, TRIST therefore takes a more careful look at actual revenues collected from trade, including all taxes levied on trade and not just tariffs. In case suitable data are available, TRIST also allows estimating the impact of changes in trade policy on output, employment and possibly household income. The latter information also proved to be key for policy makers when trying to garner support for trade

reforms. Since TRIST is a PE model, it can obviously not be used to project the aggregate impact of trade reforms on domestic production and employment but rather to identify sectors that are likely to be hardest hit.

TRIST has the stated objective to overcome two limitations of existing PE models. First, the models presented above assume that the statutory tariffs are indeed being levied on all recorded trade flows. However, it is common for import regimes to grant tariff exemptions for various reasons, such as for consumption by government agencies or on intermediated products to provide incentives for domestic and foreign investment. Brenton et al. (2009) estimate that low-income countries would be able to substantially increase their tariff revenue if they removed all tariff exemptions. Ignoring the tariff exemptions therefore leads to a substantial overestimation of the impact of tariff reform on trade flows and revenues.

The second objective of TRIST is to incorporate the interplay between tariffs and other forms of taxes collected at the border. Many countries levy excise taxes, VAT or sales tax that often generate more revenue than customs duties. In principle, these taxes are applied to both domestic and foreign goods; however, in practice the domestic tax base is usually very small in developing countries. It is unclear *ex ante* whether lowering tariffs will lead to lower or higher VAT and excise tax revenues. Increasing imports could provide more tax revenues. Conversely, as these taxes are usually levied on the value of imports including the tariff, it could also result in a fall of revenues.

Again, TRIST is based on the assumption of imperfect substitution between imports from different sources (Armington, 1969). As in the simplest version of SMART, TRIST assumes that export supplies are perfectly elastic, i.e. changes in tariffs leave world prices unaffected. The model presumes that tariffs are collected as a percentage of the CIF import value, the excise tax as a percentage of CIF import value plus the tariff, and finally the VAT as a percentage of CIF import value plus the tariff plus the excise tax.

In order to calculate the percentage change in the price of good *k* from exporter *i* due to a change in tariff (and leaving the VAT and excise rate unchanged), TRIST uses the following formula:

$$\frac{\Delta P_i}{P_i^{old}} = \frac{\left[\frac{P_i^{new}}{P_{wld}}\right] - \left[\frac{P_i^{old}}{P_{wld}}\right]}{\left[\frac{P_i^{old}}{P_{wld}}\right]} = \frac{\left(1 + t_i^{new}\right)\left(1 + ext_i\right)\left(1 + vat_i\right) - \left(1 + t_i^{old}\right)\left(1 + ext_i\right)\left(1 + vat_i\right)}{\left(1 + t_i^{old}\right)\left(1 + ext_i\right)\left(1 + vat_i\right)} = \frac{t_i^{new} - t_i^{old}}{\left(1 + t_i^{old}\right)}$$

(4.33)

The superscripts "new" and "old" denote the prices and tariffs before and after the policy reform.

The import response to this price change is modelled in three consecutive steps. The substitution effect between different exporters due to changes in tariffs *vis à vis* different exporters is modelled first. Next comes the substitution effect between imports and domestic goods as the relative price between the two changes. Finally, the demand effect as a response to the overall change in the price of a product is modelled last.

In the first stage, TRIST calculates how a given expenditure for imports of a certain good is reallocated across different exporters following a trade policy change. The extent to which a given change in relative prices translates into a change in relative imports hinges on the exporter substitution elasticity (user-defined).

$$M_i^{ES} = \left[\frac{\Delta P_i}{P_i^{old}} \gamma_i^{ES} + 1 \right] M_i^{old} \frac{\sum_{i=1,\dots,n} M_i^{old}}{\sum_{i=1,\dots,n} \left(\left[\frac{\Delta P_i}{P_i^{old}} \gamma_i^{ES} + 1 \right] M_i^{old} \right)}$$

(4.34)

where M_i^{ES} stands for the imported quantity from i after exporter substitution, M_i^{old} is the imported quantity from i before reform and γ_i^{ES} is the exporter substitution elasticity for imports from country i.

In the second step, TRIST estimates how the total expenditure on the good is reallocated between domestic and imported products due to the change in relative prices. The change in allocation is defined by the elasticity of substitution between domestic and foreign goods, λ^{DS}. The change in imports is then distributed across individual suppliers according to their share of overall imports. The total domestic consumption remains constant at this stage, since any change in imports is offset by an opposite change in domestic output.

$$M_i^{DS} = \left[\frac{\Delta \bar{P}_{imp}}{\bar{P}_{imp}^{old}} \lambda^{DS} + 1 \right] M^{old}$$

(4.35)

$$M_i^{DS} = M_i^{ES} + [M^{DS} - M^{ES}] \left[\frac{M_i^{old}}{\sum_{i=1,\dots,n} M_i^{old}} \right]$$

(4.36)

where M^{old} is the total imported quantity before the tariff reform, M^{DS} is the total imported quantity after substitution with domestic input and M_i^{DS} is the imported quantity from country i after substitution between imports and domestic output. The price change of total imports is given by:

$$\frac{\Delta \bar{P}}{\bar{P}^{old}} = \sum_{i=1,\dots,n} \left[\frac{M_i^{old}}{\sum_{i=1,\dots,n} M_i^{old}} \frac{\Delta P_i}{P_i^{old}} \right]$$

(4.37)

In the third and final step, TRIST simulates how the demand effect leads to a change in domestic consumption, i.e. the change of the relative price of the good to which the trade reform applies results in a change in domestic consumption of the good.

$$Q_{TD}^{new} = \left[\frac{\Delta \tilde{P}}{\tilde{P}^{old}} \mu^D + 1 \right] Q_{TD}^{old}$$

(4.38)

$$M^{new} = M^{DS} + \left[Q_{TD}^{new} - Q_{TD}^{old} \right] \left[\frac{M^{old}}{M^{old} + D^{old}} \right].$$

(4.39)

$$m_i^{new} = m_i^{DS} + \left[M^{new} - M^{old} \right] \left[\frac{m_i^{old}}{\sum_{i=1,\dots,n} m_i^{old}} \right]$$

(4.40)

Table 4.4   Breakdown of effects if tariffs are reduced with country A but not with country B

	Imports from A	Imports from B	Domestic Prod.
Exporter substitution effect	↑	↓	—
Domestic substitution effect	↑	↑	↓
Demand effect	↑	↑	↑
Total effect	↑	In theory ambiguous, depends on elasticities	In theory ambiguous, depends on elasticities

where Q_{TD}^{old} is the initial total demand for product k, Q_{TD}^{new} is the total demand after the change in the overall price of product k, D^{old} is the initial quantity of demand for domestic output, M^{new} is the final demand for import of product k, M_i^{new} stands for the quantity imported from supplier i after all three effects and μ^D is the demand elasticity for product k.

The change in price of total domestic consumption is defined as:

$$\frac{\Delta P}{\bar{P}^{old}} = \left[\frac{M^{old}}{M^{old} + D^{old}} \frac{\Delta \bar{P}}{\bar{P}^{old}} \right] \tag{4.41}$$

TRIST is again set up in Excel and is free to use.[3] It is based on two spread sheets that can be downloaded from the internet. The first one is the Data Aggregation Tool which organizes and formats the data to be imported into the second, the Simulation Tool. The Data Aggregation Tool allows users to create all necessary country and product groups in order to simulate various trade policy scenarios. In the Simulation Tool the user is able actually to define the various policy scenarios and can modify the parameters underlying the calculations.

As TRIST is built upon the idea of carefully examining trade transactions, the model requires detailed and complete data on import flows. For each import transaction the data should include the type of product (typically at the HS eight-digit level), the country of origin, the customs procedure code (CPC) that defines the customs regime under which the good enters, the actual import value, the statutory tariff and the applied tariff along with the value of VAT, excise and other taxes. This data is typically available from customs authorities that have implemented computerized customs systems, such as Asycuda and TradeNet.

The description of the three calculation steps above showed that elasticities played a key role in the model. Detailed estimates of elasticities are not readily available and therefore TRIST includes sensible default values for all three elasticities. The sensitivity of the results can be easily assessed by using different values for the elasticities. The users can also use import demand elasticities estimated by Kee et al. (2004), which are however not available for all product groups at the HS six-digit level.

Before entering the data, TRIST recommends preparing the data appropriately in three steps. First, clean the data by deleting trade flows that do not enter the home market in free circulation. Second, check for possible data entry errors and consistency in the raw data. Finally, manipulate the data into the format required for TRIST, basically with one row for each product imported (identified by the HS code) and one column for each trading partner. The exact procedure for entering the data is described in more detail in section D and also in a manual that can be downloaded for free.[4]

Box 4.3   Example of COMESA customs union

Let us now turn to a concrete example, the COMESA customs union (Brenton et al., 2009).[5] TRIST has been used in a considerable number of cases, including in Africa, to analyse the impact of regional trade initiatives. COMESA members were eager to know the possible impact, especially on revenues, of joining the customs union. This policy scenario assumes that all remaining non-zero intra-COMESA tariffs would be set at zero and that a common external tariff is applied to all other trading partners.

Table 4.5 shows the anticipated effects of the implementation of a customs union on three countries, namely Malawi, Zambia and Kenya. As expected, imports in all three countries would increase and tariff revenues would fall. Higher imports would also drive up the revenue by excise tax and VAT, but at the same time lower tariffs would lower the tax base for excise taxes and VAT. In total, all three countries would experience a small trade revenue loss, which is highest in the case of Kenya at 6.3 per cent.

Table 4.5   Revenue implications of a COMESA common external tariff (in US$ million)

Country	Malawi	Zambia	Kenya
Old imports	1416.0	3930.9	9909.1
New imports	1416.6	3949.5	9947.9
% change	0.0	0.5	0.4
Old tariff revenue	75.9	245.8	436.4
New tariff revenue	72.2	203.0	330.3
% change	−4.8	−17.4	−24.3
Old excise revenue	78.8	98.5	517.6
New excise revenue	78.4	98.0	517.6
% change	−0.4	−0.5	0.0
Old VAT revenue	117.0	684.7	798.4
New VAT revenue	115.9	680.1	794.2
% change	−1.0	−0.7	−0.5
Old total revenue	271.8	1029.0	1752.4
New total revenue	266.5	981.2	1642.1
% change	−1.9	−4.6	−6.3
Old collected tariff rate	5.4	6.3	4.4
New collected tariff rate	5.1	5.1	3.3

Source: Brenton et al. (2009) with author modifications

d.   Agricultural Trade Policy Simulation Model (ATPSM)

As the name indicates, the Agricultural Trade Policy Simulation Model (ATPSM) has been developed to analyse specifically agricultural trade policy issues. The model was mainly developed by UNCTAD in the 1990s in order to estimate the implications for developing countries of agricultural trade liberalization in the Uruguay Round. Compared with the PE models described above, ATPSM

focuses more on standard agricultural policies such as quotas or subsidies as long as the latter are quantifiable.

In the model, domestic prices are assumed to be a function of world market prices and national tariffs, subsidies, quotas and other support measures. For aggregate commodity groups such as beverages or cereals, countries are typically importers and exporters at the same time. To take into account this feature, ATPSM calculates composite tariffs that then determines the domestic consumption and production price.

A domestic market tariff (t_d) is calculated as the weighted average of export tariffs (t_x) and import tariffs (t_m) using the imports (M) and exports (X) as weights:

$$t_d = \frac{Xt_x + Mt_m}{M + X} \tag{4.42}$$

ATPSM then computes a consumption (domestic market) tariff as the weighted average of the import tariff (t_m) and the domestic market tariff (t_d), with weights for imports and domestic supply, S_d, divided by total demand, D:

$$t_c = \frac{Mt_m + S_d t_d}{D} \tag{4.43}$$

In a similar way, a supply (domestic market) tariff is calculated as the weighted average of the export tariff (t_x) and the domestic market tariff (t_d), with weights for exports, domestic supply plus the domestic support tariff (t_p).

$$t_s = \frac{Xt_x + S_d t_d}{S + t_p} \tag{4.44}$$

These calculations are done for the baseline scenario and the scenario for a trade policy change.

Four equations define the standard equation system for all countries:

$$\hat{D}_{j,i} = \mu_{j,j,i} \left[\hat{P}_{w_j} + (1 + \hat{t}_{c_{j,i}}) \right] + \sum_{\substack{k=1 \\ j \neq k}}^{K} \mu_{j,k,i} \left[\hat{P}_{w_k} + (1 + \hat{t}_{c_{k,i}}) \right] \tag{4.45}$$

$$\hat{S}_{j,i} = \varepsilon_{j,j,i} \left[\hat{P}_{w_j} + (1 + \hat{t}_{p_{j,i}}) \right] + \sum_{\substack{k=1 \\ j \neq k}}^{K} \varepsilon_{j,k,i} \left[\hat{P}_{w_k} + (1 + \hat{t}_{p_{k,i}}) \right] \tag{4.46}$$

$$\Delta X_{j,i} = \gamma_{j,i} \Delta S_{j,i} \tag{4.47}$$

$$\Delta M_{j,i} = D_{j,i} \hat{D}_{j,i} - S_{j,i} \hat{S}_{j,i} + \Delta X_{j,i} \tag{4.48}$$

where ^ denotes a relative change and Δ an absolute change. The demand elasticity is denoted μ and the supply elasticity ε. P_w stands for the world prices. Furthermore, γ is the ratio of exports to production, i is the country index and j and k are the commodities indices.

Equation (4.47) implies that the change in exports goes hand in hand with a change in production. In other words, the proportion of exports to production is always maintained. Equation (4.48) clears the market so that imports plus production equals domestic consumption and exports. This market clearing solution differs from the models above, as we no longer assume Armington elasticities.

Using several mathematical manipulations, one is able to derive the change in world prices that can then be inserted into (4.45–4.48) in order to obtain the volume response, ΔX, ΔM, ΔS and ΔD. Using the volume response, the trade revenue and welfare effect (sum of changes in producer surplus, consumer surplus and net government revenue) can be estimated (for details please refer to the ATPSM Manual, pp. 17–22).

Quotas

One of the particularities of ATPSM is that it can estimate the economic consequences of import quota changes. The import quotas are assumed to be binding. Changing the import quotas will change the quota rents and tariff revenues but not the level of imports.

The WTO Agreement on Agriculture introduced a new system of tariffication by which low tariffs would be applied within the import quota ("within-quota tariff") and higher tariffs above ("out-of-quota tariff"). This system generates quota rents, which can make an important contribution to welfare and are therefore included in the model.

Quota rents are the import quotas times the difference between the domestic prices and world prices plus the within-quota tariff. Or expressed differently, whenever the quota is filled then imported goods enter the domestic market at two different tariff levels, at the within-quota tariff and the out-of-quota tariff. As the domestic price is identical for all products, it then equals the world price plus the out-of-quota tariff. As a consequence, those foreign producers who only pay within-quota tariffs earn quota rents. This usually only happens in cases where quotas are unfilled. However, the ATPSM assumes that the out-of-quota tariffs always determine the domestic market price, even if the quota is unfilled. Changes in tariff quotas can thus have different consequences. For example, a reduction in within-quota tariffs will increase quota rents and decrease tariff revenue, or a reduction in out-of-quota tariffs will decrease quota rents and out-of-quota revenue.

Each WTO member notifies its global quotas without, however, specifying bilateral quotas. ATPSM therefore uses bilateral trade flows to estimate the bilateral quota distribution. ATPSM gives the user the option to choose whether the rents should be allocated to the supplier or the importing country government. Similar to quotas, ATPSM also offers the option of taking into account export subsidies and export quotas.

Analyzing economic effects of trade policy proposals

The basic idea in estimating the economic effects is that trade policy modifications trigger price changes that will alter supply, demand, exports and imports. ATPSM computes the market clearing world price where the global sum of net import changes is zero. For example, when a country unilaterally cuts a tariff on a certain commodity, the domestic demand will increase and the domestic supply will fall. As a consequence, world prices will increase.

The trade revenue change is calculated as the difference between the change in export and import values. For a country that cuts tariffs unilaterally, the volume, value and price of imports increase, while the export volume decreases. The direction of the change of export price and value is indeterminate.

Welfare in ATPSM is measured as producer surplus, consumer surplus and net government revenue. Producer surplus is calculated as the aggregate difference between price and marginal costs plus any quota rent received on exports. The consumer surplus is computed as the aggregate difference between marginal valuation and price. Finally, government revenue is determined by revenues from import tariffs, including both within-quota and out-of-quota tariffs, and expenditure on export subsidies and domestic support.

In the case of a unilateral tariff cut, the producer surplus shrinks while the consumer surplus increases. The direction of change of the net government revenue is indeterminate for two reasons. First, the tariff cut leads to more imports, which might result in a higher or lower tariff revenue overall. Second, the lowering of the tariff implies a reduction in the quota rents. Overall, the net effect of a unilateral tariff cut on a specific commodity is usually positive, unless the country is large enough to make world prices raise. As we have seen in SMART, in the case of upward-sloping demand curves an optimal tariff level exists.

In the rest of the world, the increased world price results in an increase in producer surplus and a fall in consumer surplus. The change in government revenue is indeterminate and depends on demand elasticity. Those countries that are net exports of the commodity gain in welfare while those that are net importers lose. The net effect is a global increase in welfare.

When a country unilaterally reduces its export subsidies on a commodity, the effects on the domestic economy are similar. Domestic prices fall as producers no longer receive supports for exporting the commodity. The increase in domestic demand (consumer surplus increases) and the reduction of supply (producer surplus shrinks) will lead to an increase in the world price. Now, however, government expenditure will be unambiguously lower. The net effect is an increase in aggregate welfare of the country, unless the country is able to influence world prices.

ATPSM has been translated into a software that can be downloaded for free from the UNCTAD website. Since the focus of ATPSM is on agriculture, the software covers all agricultural commodities. The software holds several predefined aggregated agricultural commodity groups, such as beverages (cocoa, tea, coffee) or cereals (wheat, rice, barley, maize and sorghum). However, the user is also able to change the composition of these groups.

The software is able to analyse various trade policy changes, in particular those particularly prevalent in agricultural trade, such as changes in import quotas or export subsidies. The software produces five economic estimates, namely:

- trade volume changes in production consumption, imports and exports
- trade value changes in production consumption, imports and exports
- welfare changes (producer surplus, consumer surplus and net government revenue)
- price changes (world market, wholesale and farm prices)
- changes in tariff quota rents.

In ATPSM, tariff cuts are expressed as a percentage of the initial tariff. Export subsidies and extra farm support are measured as *ad valorem* tariff equivalents and thus the cuts are also translated into percentage reductions of *ad valorem* equivalents. The model is able to simulate trade policy changes by individual countries, by a group of country or globally.

C. Applications

This section provides a short manual for each of the four PE models. For each PE model, one can download for free very detailed descriptions of how to implement the models. The purpose of this section is therefore to provide a first introduction to potential users in order to enable them to run simple simulations.

Prior to the discussion below, remember that the first question the *ex ante* analyst is faced with is a simple one: what are the options to be compared? Sometimes the "client" — government agency, politician or other — has a clear idea of what the alternatives are but sometimes she/he does not. In that case the analyst must reduce the range of possibilities to a small set of scenarios. There is a trade-off involved in the choice of those scenarios: on the one hand, they should be realistic and thus should not involve extreme values of policy variables; on the other hand, they should be sufficiently differentiated to highlight the consequences of choices. Where the optimum lies is a matter for the analyst's judgment, keeping in mind that as computing is free, the more scenarios that are explored in the early stages of the analysis the better.

1. SMART

SMART is accessible through the World Integrated Trade Solution (WITS) website. Access to this data consultation and extraction software is free and only requires user registration.[6]

a. The start

Once you have logged into WITS, the first page holds an upper bar with the following options: Quick Search, Advanced Query, Tariff and Trade Simulations, Results, Utilities, and Support Materials. Choose "Tariff and Trade Simulations" and then click on "SMART".

A new page will be opened which allows you to give a name to your query or open an existing query. If you are using the program for the first time, enter a name for the new query, e.g. "test", and a description, e.g. "To test SMART". Please note that for the query name, spaces and special characters are not permitted. Once you have defined both the query name and the query description, click on the button "Proceed".

Another new page will open which will allow you to define the year, products, scenario, elasticities and the type of tariff change (applied to applied MFN rate or to bound rate). First, select "Year" and choose the baseline year. The baseline year is the year against which you would like to benchmark a trade policy change.

Next, select the products that you would like to include in your analysis by clicking "Select". This will prompt another window which enables you to make a detailed choice of the product(s) you would

like to include in the analysis. Remember from above that PE models are particularly suitable to estimate trade effects for a specific sector. First, select the nomenclature. You can choose from among 14 different nomenclatures, and depending on the nomenclature specify a product group or a product up to the six-digit level. You can select the product by clicking on the specific product. WITS also offers the possibility of choosing from among product groups predefined by COMESA or by the WTO or to define your own product groups. Once the products have been selected, please click the "Proceed" button which brings you back to the previous page.

b.   Defining a scenario

The next step consists in selecting a scenario. Click on "Modify" on the right of the scenario box which will open a new window. The new window holds two boxes entitled "Available Scenarios" and "Selected Scenarios". As a first step, click on "Add/Modify" at the bottom of the box "Available Scenarios". This will open yet another window called "Modify Scenario".

You will now be asked as a first step to give a name and description of the scenario, for example "Test" as the scenario name and "Zero tariffs for imports from New Zealand". As a second step, you need to identify the partners and the products to which the trade policy change applies. For the partner, click on "Select" and a new window will open. You are now able to select individual countries from a country list or use predefined country groups. A simple click on the country name is enough and the country selected appears in a box on the right side of the screen. Once all countries have been selected, click on the "Proceed" button to return to the previous page.

After selecting the country to which the new trade policy should apply, you have to identify the product that will be covered by the new policy. By clicking "Select", a new window opens that looks almost identical to the window for product selection that came before. Again, select the nomenclature and then the product. You can again choose from among 14 nomenclatures and products up to six digits of detail. Obviously, you need to make sure that those products covered by the new trade policy include those that have been selected previously for the trade policy analysis.

Finally, you will be asked to define the tariff change. You can select either "New Rate", "Maximum Rate", "Linear Cut" or "Swiss Formula". A switch to duty-free market access would, for example, mean that the new rate is zero. A "Maximum Rate" implies that an upper limit for the new tariff level can be chosen. The option "Linear Cut" would imply a linear reduction of all tariffs. Finally, a specific coefficient for the Swiss Formula can be entered. Once the formula has been chosen, please click on the "Proceed" button, which brings you back to the window entitled "Select a Scenario". You can now choose the newly defined scenario, as it will appear under "Selected Scenarios". Again, click the "Proceed" button and the window closes.

c.   The elasticities

You should now be back to the screen where you can choose the year, the products, the scenario and the elasticity. The next step is now to define the substitution and supply elasticity (the import demand elasticity is defined by the system). The default of the substitution elasticity is 1.5 but can be modified. The default of the supply elasticity is 99 in order to simulate a perfectly elastic supply response. As described above, you can also imagine upward-sloping supply curves which would

mean a much lower value for the supply elasticity, e.g. on the order of 2. As the last step, you need to decide whether the tariff changes should be applied to the applied MFN rate or to the bound rate. In order to finish the request, click on the "Save & Submit" button.

d. Download and view results

After the submission of the simulation, a new window pops up. This window has two tabs: one is called "View and Request Download" and the second "Download Data". The first tab holds in one row the following information:

- ID of the request and the query/simulation name
- options to view, download or delete the request
- the log (query definition and execution statistics)
- the status, the source and the date.

Clicking on the view icon opens up a new window that allows you to access the following tables:

- detailed data
- exporter view report
- market view report
- revenue impact report
- trade creation effect report
- trade welfare effect report.

Viewing these tables gives a first impression of the estimation results. The tables can be downloaded by requesting the download (click on the download icon). WITS will then start downloading to your computer.

In order to download the entire estimation results, click on the "Download Data" tab. A very similar table is presented with the following columns:

- ID and query/simulation name
- options to save or delete the request
- information on the status, source, date, file size and the total number of rows.

Clicking on the "save" icon gives you the option to save all the above-mentioned tables as a single zip file. Downloading the zip file is the last step in using WITS for a SMART simulation.

2. GSIM

a. The start

The Excel spread sheets use the Excel solver to find a solution for the new world prices after trade policy changes, assuming market clearing conditions. On the basis of the new equilibrium price values, other changes in the system are calculated subsequently, including the changes in trade quantities and values, in producer and consumer surplus as well as in tariff revenues.

b. The 4×4 case

The simple 4×4 case is constructed to simulate the effect of a trade policy change between three countries as well as the rest of the world. For example, one could imagine a unilateral, bilateral or trilateral trade liberalization. The Excel file provided by Francois and Hall (2003) uses the example of a reciprocal tariff cut between the United States and the European Union to illustrate the functioning of the model.

The simplest way to simulate trade policy changes in GSIM is to use one of the two Excel files that can be downloaded from the website.[7] The file GSIM4x4.xls offers the possibility to simulate a trade policy change that affects trade between four countries. The file holds four worksheets that are called "Introduction", "The Model", "Trade Values" and "Welfare". The worksheets "The Model", "Trade Values" and "Welfare" are already filled with data from a hypothetical example of trade between the United States, Japan, the European Union and the Rest of the World (ROW). Users can learn about the functioning of GSIM by going through this example and then replacing the existing numbers with their own numbers.

c. The input

The first worksheet, called "Introduction", only describes GSIM quickly and requests the user to install the Excel solver. The Excel solver is a tool to solve equation systems with constraints. Remember that the condition in GSIM was to have markets cleared. The Excel solver can be easily installed (see Help in Excel) and should be available for free.

The second worksheet, "The Model", is the key worksheet to work with. It holds four input tables that the user is required to fill in. The first input table requires trade data at world prices between the respective four trading partners: the United States, Japan, the European Union and ROW. The user needs to collect these bilateral trade data from sources introduced in the first chapters of this handbook, such as UN COMTRADE or WITS. The data reflects bilateral trade flows for which economists usually prefer to use recorded imports rather than exports.

The next input table in "The Model" worksheet is needed in order to enter the initial import tariffs between the four trading partners. The Excel sheet requires you to enter the tariffs as 1 + per cent of tariff. For example, a 10 per cent tariff should be entered as 1.1. Obviously, you are able to enter the applied or bound tariff rates depending on the purpose of the simulation. Also note that the tariffs are supposed to be bilateral and therefore a preferential rate applies in some cases.

The third input table reflects the trade change scenario and therefore holds all projected tariff rates. Thus in this table you can enter different liberalization scenarios. Again, you will need to decide whether the tariff changes will be implemented on the applied or the bound rates.

The last input table asks for parameters for the three elasticities in the model, namely import demand, export supply and substitution elasticity. The elasticities can obviously be different between countries. As for the import demand elasticity, most models use a value between 1 and 1.5 (Kee et al., 2006). The export supply elasticity depends on whether one country is large enough to influence world prices. In case the country is small, the export supply elasticity can be assumed to go to infinity (a value of 99 can then be entered). Finally, the substitution elasticity is usually assumed to be between 1 and 5.

d. The output

Once the input table is filled, the Excel solver has to be used to solve the excess demand conditions. In the table called "Model Solutions", you will need to highlight all four fields in the column "Excess Demand" with the cursor. Once highlighted, you will need to click on "Solver" (add-in option under the "Data" tab). A small new window opens entitled "Solve Parameters". You simply need to click "Solve" and Excel should be able to find a solution to the optimization problem. A window will then appear called "Solver Results" and ask you whether to keep the solver solution or to restore the original values. Please choose "Keep Solver Solution" and Excel will then adjust the values in the table "Market Clearing Conditions" accordingly. This concludes the entries required of you. Excel automatically generates all other tables using the results produced by the Excel solver.

The results produced by the Excel file consist of several tables and graphs. First, the worksheet "Model Solutions" shows the changes in prices, supply and demand as depicted above. Below these solutions another box called "Other Results" is presented with the following 4x4 tables:

- trade values and quantities as per cent change
- trade at new world prices at new values
- trade at world price as change in values
- proportional change in internal prices.

Finally, the worksheet has a short table on tariff revenue and consumer surplus as well as one on total welfare effect (see below). You can thus identify the changes in producer and consumer surplus as well as the changes in tariff revenue and finally the net welfare effect.

The next worksheet, "Trade Value", duplicates the results from the worksheet "The Model" on trade at world prices as change in values in a table and in a graph. The last worksheet, "Welfare", uses the table on welfare from "The Model" worksheet and also produces a graph by country (see below).

3. TRIST

TRIST is also based on Excel. It is, however, more complex to handle than SMART or GSIM. As explained above, a very detailed description of how to use TRIST can be downloaded from the World Bank's website. Here we would like to give you a general idea of what you will be required to do without going into too much detail.

Table 4.6 GSIM table model solutions

		MARKET CLEARING CONDITIONS				
		Relative price changes				
		Benchmark prices	New prices	Change in supply	Change in demand	Excess demand
Origin	United States	0.0000	0.0792	0.1188	0.1188	0.0000
	Japan	0.0000	−0.0316	−0.0474	−0.0474	0.0000
	EU	0.0000	0.0480	0.0721	0.0721	0.0000
	ROW	0.0000	−0.0184	−0.0276	−0.0276	0.0000

Source: Francois and Hall (2009), GSIM4x4.xls file

Table 4.7   Total welfare effects in GSIM

		Total welfare effects			
		A	B	C	D=A+B
		Producer surplus	Consumer surplus	Tariff revenue	Net welfare effect
Country	United States	46.1	110.6	−138.5	18.2
	Japan	−26.2	−8.9	0.6	−34.5
	EU	39.8	68.6	−93.8	14.5
	ROW	−5.1	−32.9	−2.9	−40.8

Source: Francois and Hall (2009), GSIM4x4.xls file

Figure 4.5   Total welfare effects in GSIM
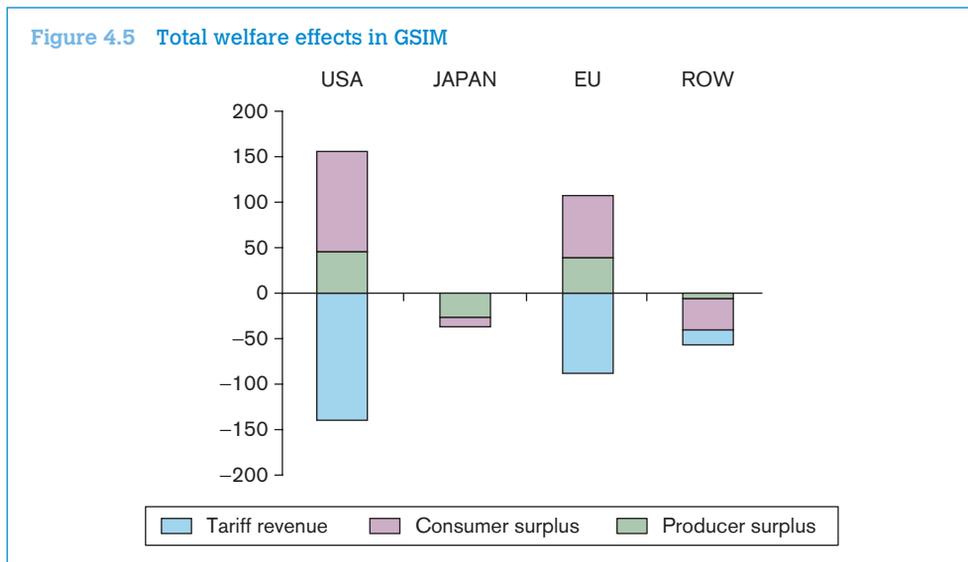
a.   The start

The first step in TRIST is to obtain very detailed trade data (typically at the eight-digit level), which includes the following entries:

- HS code
- country of origin
- Customs Procedure Code (CPC)
- import value
- tariff paid and exempted
- excise tax paid and exempted
- VAT paid and exempted
- other taxes paid and exempted.

In the best case, you might have a table available that looks like the Table 4.8.

Table 4.8   Detailed import data for TRIST

National tariff code	Country of origin	CPC	Import value	Tariff paid	Tariff exempted
01051110	USA	40000	100	10	0
39252000	BRA	400GM	500	100	0
42021210	DEU	40000	1200	0	120
11029000	ZMB	40000	400	40	0
…	…	…	…	…	…

Excise tax paid	Excise tax exempted	VAT paid	VAT exempted	Other taxes paid	Other taxes exempted
0	0	15	0	0	0
0	0	75	0	0	0
0	0	0	180	0	0
80	0	60	0	0	0
…	…	…	…	…	…

Table 4.9   Detailed import data for TRIST

	Albania	American Samoa	Angola	…
01011000	120		320	
01019000		310		
01021000		340		
…				

Obviously, the HS code identifies the type of product. The Customs Procedure Code (CPC) determines the customs regime under which a good enters the country. These codes are necessary in order to know which imports have to be removed from the dataset during the data cleaning procedure (for example, the CPC code 400GM could refer to government imports and could thus be dropped).

It is important to have information on all taxes applied at the border and exemptions granted for these taxes. If information on exemptions is not available, it can be calculated as: Exemptions = [tariff rate] * [import value] − [tariff paid]. For tax, excise and VAT revenue, you can construct:

- applied tariff rate: [tariff revenue] / [imports]
- statutory tariff rate: [tariff revenue + tariff exemptions] / [imports]
- applied excise rate: typically, [excise revenue] / [imports + tariff revenue]
- applied VAT rate: typically, [VAT revenue] / [imports + tariff revenue + excise revenue].

Finally, the data have to be formatted in order to fit into TRIST. TRIST accepts data with the structure as outlined in Table 4.9.

The table should have one row for each product imported, identified by the HS code. If trade has been zero, the cell should stay blank. It is crucial that the codes (and their order) are exactly the same in all five tables. One column is also needed for each trading partner. Again, it is important that trading partners (and their order) are exactly the same in all tables.

You have to generate five separate tables with this structure and cover the following variables:

1. imports
2. statutory revenue (= collected tariff revenue + exemptions)
3. customs revenue
4. excise revenue
5. VAT revenue.

b. Importing data into TRIST

Once the data have been cleaned and brought into the appropriate format, we can import them into TRIST using the TRIST data aggregation tool. First open the file TRIST_Data_Aggregation2RC.xls. It will first ask you to specify the country, currency, year and HS version. Then you are able to open the TRIST-Data Management Menu.

The next window that appears asks you to define the taxes collected at the border. You can choose the name of each tax and the tax base definition from a drop-down menu. Then press "OK". Back in the main menu, click on "Import Data". Next, import the previously cleaned data, i.e. the data sets on imports, statutory tariff revenue, collected tariff revenue, trade tax 1 revenue and trade tax 2 revenue. Once you have finished importing data, press "Close" and in the data import assistant press "Finish". This completes the data import process.

DATASET INFORMATION

Help			
Country:	Burundi		
Currency:	Burundi Franc (F Bu)		
Year:	2007	Open Data Management Menu	
HS Version:	HS 2002 (HS2)		

TAXES: NAMES AND DEFINITIONS

Tax	Name	Definition	Flag Product Group
Tax 1	Excise tax	Imports + Collected Tariff Rev. (CTR)	
Tax 2	VAT	Imports + CTR + Tax1 (T1)	
Other Taxes	No		

TRIST - Status of data imports

Step 3 (Imports data)	Completed
Step 4 (Statutory tariff revenue data)	Completed
Step 5 (Collected tariff revenue data)	Completed
Step 6 (Excise tax)	Completed
Step 7 (VAT)	Completed
Step 8 (Other Taxes)	Optional
Optional Step: EPA Exclusion list	Completed

TRIST - Data Aggregation and Filtering

User Defined Country Groups	6
User Selected Tariff Lines	All

Source: TRIST

c. Using the TRIST simulation tool

Once the data are imported, the user can open the actual simulation tool (TRIST Simulation 3.01. xls). In this tool the so-called "Control Panel" is key. It allows you to upload data from the aggregation tool, to customize TRIST and to define the policy scenarios.

The first step is to upload the data, by choosing "Import Trade and Revenue Data" in the "Control Panel" and by selecting the previously saved data aggregation tool from the respective folder. Closing the control panel brings you back to the worksheet. To the right of the country groups you should see "No tariff change" under the heading "Selected Scenario". This implies that the current scenario is to leave all tariffs as they are.

In order to define tariff reform scenarios go to the "Control Panel" and choose "Manage Tariff Reform Scenarios". There, first choose the product group you would like to apply a separate tariff scenario to by choosing it from the "Affected Products" drop-down menu. Then, choose a type of tariff change to be applied as well as the corresponding parameter, e.g. "Fixed value" with parameter "0" implies that all tariffs are set to zero, or "Linear cut" with parameter "10" implies that all tariffs are cut by 10 per cent. Next, the user has to choose the "Tariff base" to which the change is to be applied. Finally, the user clicks on "Add Definition to the Scenario" and saves the scenario.

Below the reform scenarios, you can see the elasticities for the trade model, which can be customized in the "Control Panel". By clicking again on the "Control Panel" we have now the options to manage the simulation results and to export the post simulation data. This step concludes the simulation exercise with TRIST. The main results are then summarized in the worksheet "Results" and presented in a table as below:

```
RESULTS
Impact on imports:
    Imports pre                                          344,342,907,214
    Imports post                                         344,342,907,214

    Change in imports                                                  0
    % change in imports                                             0.0%

Impact on revenue:
    Tariff revenue pre                                    41,511,784,348
    Tariff revenue post                                   41,511,784,348

    Change in tariff revenue                                           0
    % change in tariff revenue                                      0.0%

Total Tax Revenues on Imports
    Total revenue pre                                    106,463,453,437
    Total revenue post                                   106,463,453,437

    Change in Total revenue                                            0
    % change in Total revenue                                       0.0%

Total Tax Revenues on Imports and Domestic Production
    Total tax revenue pre                                106,463,453,437
    Total tax revenue post                               106,463,453,437

    Change in total tax revenue                                        0
    % change in total tax revenue                                   0.0%

Collected Tariff rate:
    Collected applied tariff rate pre                              12.1%
    Collected applied tariff rate post                            12.1%
    % change in collected applied tariff rate                      0.0%

For more details see worksheet 'Detailed
Results'
```

Source: TRIST

4. ATPSM

ATPSM (version 3.1) can be downloaded for free from the UNCTAD website and installed automatically.[8] Once the program is installed, the user has the choice between six icons at the top of the page, namely "Title", "Scenario", "Country Groups", "Commodity Groups", "Results" and "Help". The software is rather intuitive, combined with the fact that ATPSM is specific to the agricultural sector, so this chapter does not provide a detailed description of how to use it. Instead we would like to sketch out an application of ATPSM.

ATPSM has been used to estimate the gains from a further multilateral liberalization of agricultural trade. One can imagine several scenarios for estimating the potential effects of such reforms on developed and developing countries. ATPSM offers the possibility of calculating the impact so as to include all main agricultural commodities and cover basically all world trade (176 countries including all larger economies). The rate cuts can be undertaken according to three types of measures: out-of-quota tariffs, export subsidies and domestic support. ATPSM contains the default scenarios as set out in Table 4.10.

Table 4.10   Default scenarios for ATPSM

		Parameters			
		Rate cut (%)			
Country code	Commodity code	Out-of-quota tariff	Export subsidy	Domestic support	Applied or bound rate
Developed countries	All commodities	36	21	20	Bound
Developing countries	All commodities	24	14	13	Bound

This implies a 36 per cent reduction in out-of-quota tariff, a 21 per cent reduction in export subsidies and a 20 per cent reduction in domestic support in developed countries. Two-thirds of these cuts apply to developing countries.

ATPSM then estimates the impact on prices and produces five categories of economic estimates for each country:

1.   volume changes in production consumption, imports and exports
2.   trade value changes (changes in export, import and net trade revenue)
3.   welfare changes (changes in producer surplus, consumer surpluses and net government revenue)
4.   price changes (world market, wholesale (consumer) and farm prices)
5.   changes in tariff quota rents (forgone and receivable).

The results of the estimation can be accessed under the icon "Results" and are discussed in detail in the paper by Vanzetti and Graham (2002). From an empirical perspective, the major drawback of the ATPSM is the relatively out-dated price, tariff and trade data. The latest version of ATPSM from 2006 uses volume data based on the average of the years 1999 to 2001, most recent price data from 2001 and applied tariff data from 2000 or 2001. Given the fact that many agricultural commodities have undergone substantial changes in prices, production, trade volume and patterns over recent years, the estimation results would probably look very different when using the most current data as baseline.

D. Exercises

1. Bus market in Albania (SMART)

Albania is a small country in the Balkans with about three million inhabitants and a nominal GDP per capita of around US$ 4,000. Albania is not yet a member of the European Union (EU), but the Albanian government submitted its application for membership in 2009. Albania acceded to the WTO in 2000 and has substantially liberalized its trade since then.

Albania is a net importer of manufactured goods (accounting for almost two-thirds of total merchandise imports) and the main imported goods are machinery and transport equipment, particularly automotive

products and certain non-electrical machinery. In 2009 the average applied MFN tariff for non-agricultural products was 4.2 per cent. The highest applied tariff was 15 per cent.

In 2006 Albania signed the Stabilization and Association Agreement with the EU that included a commitment to liberalize trade further between the EU and Albania. In this exercise, we would like to simulate the effect of such a liberalization towards the EU for one particular product group, namely HS 870210.

Taking the year 2007, we suppose that Albania is considering a full tariff elimination towards the EU for trade of products falling under HS 870210. Using SMART in WITS, you are supposed to generate the following tables:

- exporter view report
- market view report
- revenue impact report
- trade creation effect report
- trade welfare effect report.

2. Japan's meat market (SMART)

Let us assume a scenario in which Japan would fully open up its market of frozen meat from bovine animals (0202: HS 2002) for one particular country, e.g. New Zealand, while maintaining the same tariffs for all other trading partners. In 2009, Japan was the third biggest importer worldwide of frozen meat from bovine animals with imports totalling US$ 840 million. New Zealand, on the other hand, even though it is a relatively small economy, was the third largest exporter worldwide, accounting for around 10 per cent of the world market in 2009 (UN COMTRADE, 2011).

Obviously, one would expect that Japan's decision to lower tariffs to zero on this product group would result in a substantial jump in exports of frozen meat from New Zealand to Japan. Part of this increase would come at the expense of other major meat exporters such as Australia.

In SMART, the export supply elasticity is set at infinite by default (using the value 99) making the country a price-taker. In our example, it would certainly be more realistic to assume that Japan's market opening would affect world prices and thus the export supply elasticity needs to be changed to a finite elasticity. Changing to a finite elasticity will transform part of the trade creation (quantity effect) into price effect.

For this exercise, we would like you to take the imports of Japan in the product group 0202 (HS 2002) for 2009 as the baseline. Now, assume that Japan opens its frozen meat market fully to New Zealand while keeping the same tariff for the other trading partners. Using the values of 99, 10 and 5 for the export supply elasticities, calculate the resulting:

- import shares
- revenue effects
- trade creation effects.

3. Socks trade between the EU and China (GSIM)

The objective of this exercise is to learn how to use the 4x4 Excel sheet of the GSIM model. Take the global market for the product group HS (2002) 6115: Panty hose, tights, stockings, socks and other hosiery, knitted or crocheted. In this product group, the three biggest exporters are, in the following order, China, Turkey and the European Union (considering only extra-EU trade and not intra-EU trade). As a first step, fill in all the trade flows between the three economies as well as between each of them and the rest of the world (ROW) for the year 2009. (The data can be downloaded from the UN COMTRADE website or through the WITS portal. Please measure the trade flows as imports.)

Table 4.11   Trade flows in HS 6115 for the three largest exporters (2009, in US$ million)

| | | Destination | | | | |
		EU	CHINA	TURKEY	ROW	Totals
Origin	EU					
	CHINA					
	TURKEY					
	ROW					
	Totals					

The second data input requirements are the initial import tariffs and the envisaged ones. The model allows using applied or bound tariff rates. In our case, please use the applied tariff rates. Using WITS, download the data for 2009 and fill in the table.

Table 4.12   Applied tariffs in HS 6115 between the three main exporters and ROW (year 2009)

| | | Initial import tariffs | | | |
| | | Destination | | | |
		EU	CHINA	TURKEY	ROW
Origin	EU				
	CHINA				
	TURKEY				
	ROW				

We would like to simulate a scenario of a possible bilateral trade liberalization for this product group between the EU and China. The tariffs between the two would therefore be reduced to zero on both sides.

Table 4.13   Projected tariffs in HS 6115 between the three main exporters and ROW

		Final import tariffs			
		Destination			
		EU	CHINA	TURKEY	ROW
Origin	EU				
	CHINA				
	TURKEY				
	ROW				

The final input requirements are the elasticities, namely for import demand, export supply and substitution. Since it is rather difficult to obtain estimates of these elasticities, we will use the same values provided as default in the 4x4 Excel sheet.

Please now use the function of the Excel solver to obtain the new prices that clear all markets. Look at the changes in trade values and quantities. The table on welfare effects should look similar to the one presented in section B of this chapter.

4. Burundi's trade opening (TRIST)

Burundi is a land-locked least developed country in Central Africa. Burundi's exports are mainly destined for Europe and the United Arab Emirates and are composed of agricultural products. Burundi imports mainly from Europe and other Central African countries. Burundi is a member of various regional trade agreements, namely the Economic Community of Central African States (ECCAS), the Common Market for Eastern and Southern Africa (COMESA), the Economic Community for Great Lakes Countries (CEPGL) and the East African Community (EAC). Recently Burundi initiated an interim Economic Partnership Agreement with the EU, replacing the trade chapter of the expired Cotonou Agreement.

In this exercise, you will be asked to reproduce the simulation results generated by the World Bank for Burundi. The World Bank has made the data on Burundi freely available on their website.[9] We would like you to go through the same steps as described above, importing the data into the TRIST simulation tool. Using the simulation tool, simulate three liberalization scenarios:

- full trade liberalization with COMESA
- full trade liberalization with EAC
- full trade liberalization with the European Union, except for the EPA exclusion list (as defined in the data aggregation file for Burundi).

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Endnotes

1. SMART actually introduces the upper bound in a slightly different way but the spirit is the same.
2. In an earlier version of WITS, GSIM was offered as an option for simulations. In the future, the online-based version of WITS will offer again this functionality.
3. Background material and the two Excel files can be downloaded from the World Bank website: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/TRADE/0,,contentMDK:21537281~pagePK:210058~piPK:210062~theSitePK:239071,00.html. The main file named TRIST_Data_Aggregation2RC.xls is password protected, which means that the content of the cells cannot be altered. To unprotect any worksheet, one needs to click on "tools", "protection", "unprotect sheet" and enter the password "TRIST".
4. The World Bank website offers a manual that shows in great detail how to enter the data. The manual can be downloaded from http://siteresources.worldbank.org/INTRANETTRADE/Resources/239054-1196261607599/4442906-1253911939559/TRIST_Manual.pdf.
5. We basically summarize the results presented in Brenton et al. (2009).
6. Access to some specific databases can be fee-charging or limited depending on the status of the user.
7. http://www.i4ide.org/people/~francois/Models/index.htm
8. http://r0.unctad.org/ditc/tab/atpsm.shtm
9. http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/TRADE/0,,contentMDK:22328199~pagePK:210058~piPK:210062~theSitePK:239071~isCURL:Y,00.html

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CHAPTER 4