Appendix A
Further Details of the Simulation Procedure

The main objective of computable general equilibrium models is to operationalize the abstract models of general equilibrium theory and thereby create a practical tool for policy analysis. This is accomplished by melding real world data on production, trade, and protection with an appropriate theoretical structure representing the behavior of economic agents within the system and the constraints they face. Models built along these lines have similar advantages to general equilibrium theory, notably the ability to account comprehensively for economywide constraints and subsequent market interrelationships, and the ability to deal adequately with the second-best implications of policy changes.

Model solutions, being expressed numerically, help us to understand orders of magnitude, and provide results that are more easily interpreted than algebraic comparative statics. The model that we have used in this book is a modified version of Rutherford (1998), with several changes in the underlying functional forms and data. It is similar in many respects to the widely adopted GTAP model (Hertel 1997). In this appendix, we provide a brief overview of the model and its assumptions, and of our simulation procedure.

Production

Each sector is represented by a neoclassical production function of the nested constant elasticity of substitution (CES) form. Intermediate goods enter each function in fixed proportions to a CES composite of primary productive factors (value added). Letting $i(j)$ index industries, f index factors, and r index regions, we have:

$$Q_{ir} = \{\alpha_{ir}/(1 - \Sigma_j \alpha_{ji})\}(\Sigma_f \theta_{fir} FD_{fir}^{-\rho_i})^{-1/\rho_i} \quad (1)$$

where Q_i is total output of i, α_i is a scale term, the α_{ji} are intermediate input-output coefficients (unit demands), the θ_{fi} are the factor input shares, the FD_{fi} are factor demands, and ρ_i is the elasticity parameter (which is assumed to be constant across all regions). Constant returns to scale are assumed, and each industry takes both input and output prices as given, making zero economic profit. The model identifies five primary factors (land, natural resources, skilled labor, unskilled labor, and capital), all of which are assumed to be fully employed. Factor demand functions and constraints can be derived in the usual manner.

Final Demand

Final demand in each region is divided into three components: household consumption, government expenditure, and investment. The quantity of government and investment demand is treated as exogenous. The single representative household maximizes a Stone-Geary (LES) utility function:

$$U_r = \alpha_r \Pi_i (C_{ir} - \lambda_{ir})_{ir}^{\theta} \quad (2)$$

where U is the level of household utility in each region, α is a scale term, C_i is consumer demand for each product, the θ_i are the factor consumption shares, and the λ_i are the "subsistence" levels of consumption of each good. The λ_i levels are chosen to replicate target income elasticities of demand in the calibration procedure. Demand functions follow as usual, and are not discussed here.

Once total demand is determined for each agent, the optimal combination of domestic and importable goods is selected, subject to prevailing domestic and world prices. Once this bundle is determined, the optimal bundle of imports is selected from the alternative sources (i.e., all other regions in the model). The multistage optimization procedure is known as the Armington (1969) specification. It serves the purpose of allowing two-way trade, tracking bilateral trade flows, and avoiding unreasonably large swings in trade and production. In both cases, these choices are represented by single-level CES functions of a similar form to the value-added component of equation (1).

Note that, unlike in some other models such as GTAP, we do not allow Armington aggregates to differ by agent. Each agent is assumed to consume the same aggregate bundle (in other words, Armington aggregation takes place at the national level, once total demands have been determined). We also do not incorporate a constant elasticity of transformation (CET) specification on the export side; that is, exports and domestic production are treated as perfect substitutes.

Closure

In terms of microeconomics, as indicated above, we have taken a neoclassical approach. Factor prices are endogenous, and factors are mobile within economies, but not across national borders. On the macroeconomic side, we close the model by fixing the current account balance. Because the quantity of investment demand is exogenous, and the balances identity $S - I = CA$ must hold (where I represents the value of investment expenditures), changes in household savings are the primary macroeconomic adjustment mechanism. In addition, because government demands are also exogenous and are not linked to tax revenue, we also have a situation of government deficit financing through (implicit) transfers from the domestic household. Clearly, other closure assumptions are possible.

Data and Simulation

We have used the input-output, trade, and protection data in the GTAP4 database (McDougall, Elbehri, and Truong 1998). The free parameters are also drawn from the GTAP4 database. Substitution elasticities are as in the database; the Armington elasticities at both levels have been doubled. The income elasticities of demand are also drawn from the GTAP4 database, with the price elasticities of demand scaled by minus the reciprocal of the marginal utility of income (Frisch parameter) to match those in the GTAP4 database in the initial equilibrium.

We update the protection data in GTAP4 to reflect the completion of the Uruguay Round. We use the tariff database developed for GTAP4 by François and Strutt (1999), and assume uniform reductions of 36 and 20 percent in agricultural export subsidies and output subsidies, respectively (24 and 13 percent for developing economies), as per the Uruguay Round Agreement on Agriculture. Appropriate adjustments are made for reductions that should have occurred before 1995, and are thus accounted for in the GTAP4 dataset. We also eliminate the tariff equivalents of textile export quotas. We do not assume accession to the WTO by China or Taiwan, but do assume that reductions in protection by other economies are made available to these two economies on an MFN basis. We also make adjustments to the tariffs of ASEAN economies to reflect the implementation of AFTA.

The model is implemented and solved as a nonlinear program (levels form) in the General Algebraic Modeling System (GAMS), with the results presented as comparative statics from the same base (i.e., 1995, with adjustments in protection levels, as noted above). There is no explicit time dimension. The time frame implied in the results is represented only through microeconomic elements of closure, as discussed above. Because we have assumed that capital is mobile and factor returns endogenous, our simulations are implicitly medium to long run in nature.

Except where otherwise noted, for each RTA we impose shocks that remove all import tariffs between the subset of economies under consideration (on a preferential basis). It is important to note that each RTA is simulated independently of the others. This means that the results should be interpreted as representing the effect of the RTA or RTAs in question, assuming no simultaneous developments in the rest of the world (of course, this feature of the analysis is fundamental to comparative statics, and is essential to isolate the effect of each agreement). However, because a comparative static model has no explicit time dimension, it is possible to consider the effect of multiple agreements by summation of the results from the individual agreement (provided that the units are appropriate).