# Appendix B
# The GTAP and USAGE Models

## Simulating Global Growth Effects Using the GTAP Model

The standard GTAP model is a static model used commonly for policy analysis. However, the model can be used for specialized purposes as is done in this report. Trade policies remain constant, and the effects of growth alone and its implications for trade are assessed. In the model, economic growth has both a supply-side and a demand-side component. In order for the growth to take place, factors of production must increase. In the standard model for trade policy analysis, factors of production are fixed. In the growth scenarios conducted in this report, these become exogenous shocks (determined outside the model) and are targeted to specific points in time both in the past and in the future (app. fig. 2). To maintain equilibrium conditions for supply and demand, income accrues to households as payments to the primary factors, labor and capital. The model determines economic income generated from growth in factors of production. Income is spent by the household on goods and services and taxes, and used for savings. To assess how global economic growth affects U.S. trade, we adopt an approach similar to that employed by Coyle et al. (1998) and Gehlhar and Coyle (2001) using the GTAP framework. For simulating historical growth effects, we use a general approach, termed "backcasting" (or back-ward forecasting), which takes as exogenous the population, labor force, capital stock, and GDP variables. We use the model to determine how U.S. agricultural trade was influenced by growth with all trading partners in the past and the implications of economic growth on changes in the directions of trade in the future. To make global projections, we use projected growth in real GDP, capital, labor (skilled and unskilled), and population. Capital stock projections are estimated consistently from projections of gross domestic investment. Capital stock and labor estimates for individual countries are based on estimates prepared by the Center for Global Trade Analysis as a baseline prepared for a dynamic version of the GTAP model (Ianchovichina and McDougall, 2002). Total factor productivity is endogenized while targeting prespecified GDP levels. This is done at the economy-wide level. Ideally, we would prefer to adopt sector-specific rates of productivity. This is particularly critical for agricultural productivity growth.[31]

The standard model has undergone a number of improvements since the earliest version of standard GTAP modeling. These improvements all have some bearing on the ability of the model to reproduce historical trade patterns. Some of the most critical features with implications for agricultural trade are demand-side specification and trade elasticities in the model.[32] Modifications of the demand side include calibrating to own price and income elasticity targets of nine consumption goods that are derived from estimated parameters. In doing so, expenditure and price responsiveness can vary considerably from high-income countries to low-income countries for different goods.

[31]A methodology developed recently by Ludena et al. (2006) provides better treatment of commodity-specific productivity rates within primary agriculture and processed food. This method could be used to generate productivity projections for specific agricultural sectors. Ideally, projections for agriculture should include productivity using this methodology.

[32]See Reimer and Hertel (2003) for elaboration for cross-section estimates of demand for use in the GTAP model.

Trade pattern shifts are simulated from global trade models often governed heavily by trade elasticities known as Armington elasticities. Previous parameters in the standard GTAP model were based on outdated and highly aggregated estimates that restricted the ability to reproduce historical trade shifts. As a result, price changes for home and foreign goods could change by unrealistic magnitudes. Better methodologies for generating estimates based on Hummels (1999) have become available for more appropriate estimates of the elasticity of substitution among imports from competing sources. Other estimates, including those by Harrigan (1995) and Trefler and Lai (1999), also support higher elasticities of substitution parameters than the original estimates used in the GTAP model.
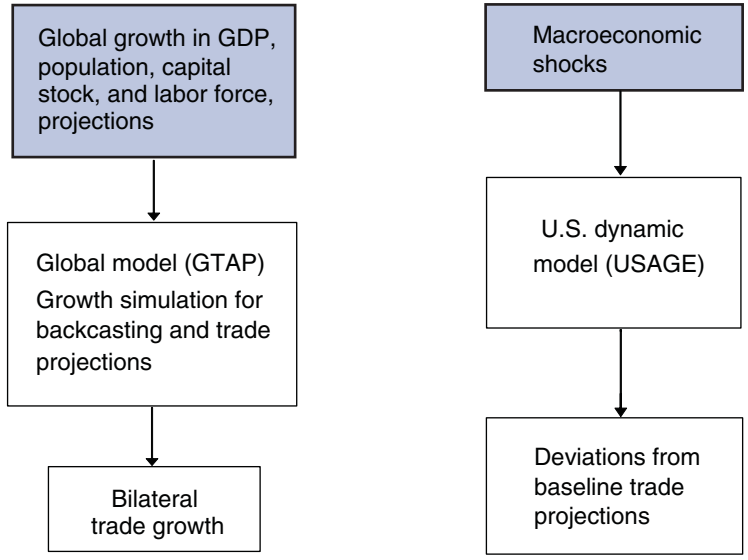
## Measuring Macroeconomic Influences With the USAGE Model

Approaches to examining the influence of macroeconomic variables on agricultural trade often focus on exchange rate movements and their long- and short-term effects (see Carter and Pick, 1989; Mattson and Koo, 2005). Macroeconomic influences, however, can involve a multitude of factors beyond exchange rate price effects. Our analysis examines a broader question of how U.S. agricultural trade might be affected by macroeconomic factors as a result of shifting foreign demand for U.S. assets, which, in turn, can affect domestic consumption of goods in the United States and the rest of the world. The framework we employ is a dynamic computable general equilibrium model of the United States known as MONASH-USA, developed by Dixon and Rimmer (2002). This type of model has been widely applied in forecasting, policy analysis, estimation of technology trends, and analysis of historical events for the Australian economy. The USAGE model has many distinguishing features, including the explicit treatment of international financial flows. Although the model can be run with 500 industries, the dynamic version of the model used here is aggregated to 40 sectors. We use the aggregated version of the USAGE model. Our primary interest is obtaining estimates of the impact of macroeconomic influences on U.S. trade, which does not require full industry detail. The aggregated version retains the main theoretical features of full-scale Monash-style models. The dynamic aspects of the USAGE model described in Dixon and Rimmer (2002) include physical capital accumulation and rate-of-return-sensitive investment; foreign debt accumulation and the balance of payments; public debt accumulation and the public sector deficit; and dynamic adjustment of wage rates in response to gaps between the demand for and supply of labor. The model has explicit treatment of net foreign liabilities, where the current account deficit includes payments for servicing foreign-owned assets, and payments on foreign debt, where all foreign liabilities are assumed to be debt repayable in U.S. currency.

As described by Dixon and Rimmer (2002), the model can be run with four basic closures: historical closure, decomposition closure, forecast closure, and policy closures.[33] The model is capable of producing estimates of changes in technological change and consumer preferences, explanations of historical developments, forecasts for industries, and deviations from forecast paths that would be caused by proposed policies and by other shocks, such as macroeconomic shocks.

[33]A closure is a specified set of variables that become endogenous or exogenous for a given simulation. Closure depends on the objective of the model simulation.

Appendix figure 2
**Schematic of modeling approaches**

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┌─────────────────────┐              ┌─────────────────────┐
│ Global growth in GDP,│              │  Macroeconomic       │
│ population, capital  │              │  shocks              │
│ stock, and labor     │              │                      │
│ force, projections   │              └─────────────────────┘
└─────────────────────┘                        │
          │                                     ▼
          ▼                           ┌─────────────────────┐
┌─────────────────────┐              │  U.S. dynamic        │
│ Global model (GTAP)  │              │  model (USAGE)       │
│                      │              │                      │
│ Growth simulation for│              └─────────────────────┘
│ backcasting and trade│                        │
│ projections          │                        ▼
└─────────────────────┘              ┌─────────────────────┐
          │                           │  Deviations from     │
          ▼                           │  baseline trade      │
┌─────────────────────┐              │  projections         │
│  Bilateral           │              └─────────────────────┘
│  trade growth        │
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Source: Prepared by USDA, ERS.