

## AGRICULTURAL TRADE POLICY SIMULATION MODEL

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### **1. Brief overview**

ATPSM is a multi-country, multi-commodity partial equilibrium framework which analyzes particularly the domestic and world market effects of trade policies in a comparative static fashion. The working principle of the ATPSM is such that trade policy and non-policy induced price shocks in the domestic market alters the domestic supply, demand, export and import amounts which results in excess demand and supply in the world market. ATPSM derives a world market clearing price which equals global sum of net import changes to zero and this price feeds back into the commodity markets in each country to recalculate the impacts on domestic supply, demand, exports and imports.

The framework covers 153 countries and includes all larger economies in agricultural markets. Except the 25 members of the EU, all countries are covered explicitly and the EU is included as a group. There are 36 commodities considered in the model and the framework allows for creating particular country and commodity groups.

The commodities included in the model are allowed to be heterogenous with respect to the country of origin and destination. Therefore imported, exported and domestically consumed goods can be differentiated via the use of different price formation for these goods. The model was built as non-spatial but exports and imports of each country are emphasized and endogenized separately. The supply and demand shares of countries in trade can be traced down. The economic welfare implications of policy changes are also calculated in the ATPSM by using the producer and consumer surplus measures.

The interdependencies between primary and processed products and/or between substitutes are reflected by cross-price elasticity measures. In general there are four behavioural equations and one economic identity for each commodity under each country in the ATPSM framework. Basically, the model works by simulating the commodity based world market clearing price on the domestic quantities and prices, which may or may not be under the effect of policy changes, in each country. Exports and imports in each country spills over onto the world market to determine world prices. The world market-clearing price is determined at the level that equilibrates the total excess demand and supply of each commodity in the world market.

The dairy sector is modeled as three commodities; fresh and concentrate milk and butter. Meat is separated into bovine, sheep meat, pig meat and poultry. There are six crop groups. Cereals include wheat, barley, maize, sorghum and rice while sugar is included as refined. Fruits and vegetables include four and three products respectively, whereas oils are grouped under two. Finally, tobacco is modelled in four product markets. In the ATPSM, beverage markets are

covered as well in eight different product markets. Lastly fibers as a group are also modeled explicitly.

## 2. General characteristics

*Table 1: General characteristics*

| <i>Model</i>  | <i>ATPSM</i>  |
|---|---|
| <i>Modeling Approach</i>                              | Partial equilibrium, price equilibrium                                    |
| <i>Temporal Properties</i>                            | Comparative static, medium term   |
| <i>Solution Type</i>                                  | Non-spatial, separate exports and imports, Armington solution is possible |
| <i>Solution Algorithm</i>                             |   |
| <i>Base Year</i>                                      | 2002-2004 average   |
| <i>Parameters</i>                                     | Synthetic   |
| <i>Commodity Coverage</i>                             | 36  |
| <i>Country Coverage</i>                               | 153   |
| <i>Behavioural Equations (per commodity, country)</i> | Domestic supply<br>Domestic demand<br>Exports<br>Imports<br>Price         |
| <i>Economic Identity</i>                              | One of the trade functions  |

### 3. Country and commodity coverage

*Table 2: Country coverage*

| <i>Developed*</i> | <i>Developing</i> | <i>Developing<br/>(cont.)</i> | <i>Least developed<br/>(LDC)</i> |
|-------------------|-------------------|-------------------------------|----------------------------------|
| Australia         | Albania           | Latvia                        | Afghanistan                      |
| Brunei            | Algeria           | Lebanon                       | Angola                           |
| Canada            | Argentina         | Libya                         | Bangladesh                       |
| China Hong Kong   | Armenia           | Lithuania                     | Benin                            |
| China Taiwan      | Azerbaijan        | Macedonia                     | Burkina Faso                     |
| Cyprus            | Bahamas           | Madagascar                    | Burundi                          |
| European Union    | Barbados          | Malawi                        | Central African Rep.             |
| French Polynesia  | Belarus           | Malaysia                      | Cambodia                         |
| Iceland           | Belize            | Malta                         | Cape Verde                       |
| Israel            | Bolivia           | Mauritius                     | Comoros                          |
| Japan             | Bosnia Herzegov.  | Mexico                        | Congo                            |
| Kuwait            | Botswana          | Moldova                       | Congo Dem. Rep.                  |
| Macao             | Brazil            | Mongolia                      | Djibouti                         |
| Neth. Antilles    | Bulgaria          | Morocco                       | Eritrea                          |
| New Zealand       | Cameroon          | Namibia                       | Ethiopia                         |
| Norway            | Chad              | Nicaragua                     | Gambia                           |
| Slovenia          | Chile             | Nigeria                       | Guinea                           |
| Switzerland       | China             | Pakistan                      | Guinea Bissau                    |
| U. A. Emirates    | Colombia          | Panama                        | Haiti                            |
| United States     | Costa Rica        | Papua New Guinea              | Lao PDR                          |
|                   | Croatia           | Paraguay                      | Lesotho                          |
|                   | Cuba              | Peru                          | Liberia                          |
|                   | Czech Rep.        | Philippines                   | Maldives                         |
|                   | Dominica          | Poland                        | Mali                             |
|                   | Dominican R.      | Romania                       | Mauritania                       |
|                   | Ecuador           | Russia                        | Mozambique                       |
|                   | Egypt             | Saudi Arabia                  | Myanmar                          |
|                   | El Salvador       | Seychelles                    | Nepal                            |
|                   | Estonia           | Slovakia                      | Niger                            |
|                   | Fiji              | South Africa                  | Rwanda                           |
|                   | Gabon             | Sri Lanka                     | Sao Tome                         |
|                   | Georgia           | St. Lucia                     | Senegal                          |
|                   | Ghana             | St. Vincent                   | Sierra Leone                     |
|                   | Grenada           | Suriname                      | Solomon Islands                  |
|                   | Guatemala         | Swaziland                     | Somalia                          |
|                   | Guyana            | Syria                         | Sudan                            |
|                   | Honduras          | Tajikistan                    | Tanzania                         |
|                   | Hungary           | Thailand                      | Togo                             |
|                   | India             | Trinidad Tobago               | Uganda                           |
|                   | Indonesia         | Tunisia                       | Vanuatu                          |
|                   | Iran              | Turkey                        | Yemen                            |
|                   | Iraq              | Turkmenistan                  | Zambia                           |
|                   | Ivory Coast       | Ukraine                       |                                  |
|                   | Jamaica           | Uruguay                       |                                  |
|                   | Jordan            | Uzbekistan                    |                                  |
|                   | Kazakhstan        | Venezuela                     |                                  |

|  |            |            |  |
|--|------------|------------|--|
|  | Kenya      | Viet Nam   |  |
|  | Korea DPR  | Yugoslavia |  |
|  | Korea Rep. | Zimbabwe   |  |
|  | Kyrgyzstan |            |  |

\*Other than the LDCs, country classification is based on per capita income using World Bank data.

**Table 3: Commodity coverage**

| <i>SITC</i> | <i>Product</i>        | <i>SITC</i> | <i>Product</i>        |
|-------------|-----------------------|-------------|-----------------------|
|             | <i>Meat</i>           |             | <i>Vegetables</i>     |
| 01100       | Bovine meat           | 05420       | Pulses                |
| 01210       | Sheepmeat             | 05480       | Roots, tubers         |
| 01220       | Pigmeat               | 05440       | Tomatoes              |
| 01230       | Poultry               |             | <i>Fruit</i>          |
|             | <i>Dairy products</i> | 05700       | Apples & pears        |
| 02212       | Milk, fresh           | 05710       | Citrus fruits         |
| 02222       | Milk, conc.           | 05730       | Bananas               |
| 02300       | Butter                | 05790       | Other tropical fruits |
|             | <i>Cereals</i>        |             | <i>Beverages</i>      |
| 04100       | Wheat                 | 07110       | Coffee green bags     |
| 04400       | Maize                 | 07120       | Coffee roasted        |
| 04530       | Sorghum               | 07131       | Coffee extracts       |
| 04300       | Barley                | 07210       | Cocoa beans           |
| 04200       | Rice                  | 07240       | Cocoa butter          |
|             | <i>Sugar</i>          | 07220       | Cocoa powder          |
| 06100       | Sugar                 | 07300       | Chocolate             |
|             | <i>Oils</i>           | 07410       | Tea                   |
| 22100       | Oil seeds             |             | <i>Tobacco</i>        |
| 42000       | Vegetable oils        | 12100       | Tobacco leaves        |
|             |                       | 12210       | Cigars                |
|             |                       | 12220       | Cigarettes            |
|             |                       | 12230       | Other tobacco - mfr.  |
|             |                       |             | <i>Fibers</i>         |
|             |                       | 26300       | Cotton linters        |

#### 4. Behavioral equations

The standard equation system for all countries for each commodity is presented through equations 1 to 14.

$$\hat{D}_{i,r} = \eta_{i,i,r} [\hat{P}_{w_i} + (1 + \hat{t}_{c_{i,r}})] + \sum_{\substack{j=1 \\ j \neq i}}^J \eta_{i,j,r} [\hat{P}_{w_j} + (1 + \hat{t}_{c_{j,r}})] \quad 1$$

$$\hat{S}_{i,r} = \varepsilon_{i,i,r} [\hat{P}_{w_i} + (1 + \hat{t}_{p_{i,r}})] + \sum_{\substack{j=1 \\ j \neq i}}^J \eta_{i,j,r} [\hat{P}_{w_j} + (1 + \hat{t}_{p_{j,r}})] \quad 2$$

$$\Delta X = \gamma_{i,r} \Delta S_{i,r} \quad 3$$

$$\Delta M_{i,r} = D_{i,r} \hat{D}_{i,r} - S_{i,r} \hat{S}_{i,r} + \Delta X_{i,r} \quad 4$$

$$\sum_{n=1}^N (\Delta X_n - \Delta M_n) = 0 \quad 5$$

$$t_d = (Xt_x + Mt_m) / (M + X) \quad 6$$

$$t_c = (Mt_m + S_d t_d) / D \quad 7$$

$$t_s = (Xt_x + S_d t_d) / (S + t_p) \quad 8$$

$$\Delta R = (P_w + \Delta P_w) [(X + \Delta X) - (M + \Delta M)] - P_w (X - M) \quad 9$$

$$U = QP_w (t_{m2} - t_{m1}) \quad 10$$

$$\Delta PS = \Delta P_s [S + 0,5(\Delta S)] + c\Delta U \quad 11$$

$$\Delta CS = -\Delta P_c [D + 0,5(\Delta D)] \quad 12$$

$$\Delta NGR = \Delta TR - \Delta ES - \Delta DS + (1 - c)\Delta U^i \quad 13$$

$$\Delta W = \Delta PS + \Delta CS + \Delta NGR \quad 14$$

*Variable and parameter definitions:*

$\hat{\phantom{x}}$ : relative change

$\Delta$ : absolute change

$i, j$ : commodities indices

$r$ : country index

$\varepsilon$ : supply elasticity

$\eta$ : demand elasticity

$\gamma$ : ratio of exports to production

$D$ : demand

$M$ : imports

$NGR$ : net government revenue

$P_w$ : world price

$Q$ : import quota

$R$ : trade revenue

$S$ : supply

$S_d$ : quantity supplied to the domestic market

$U$ : quota rent

$X$ : exports

$t_c$ : domestic consumption tariff

$t_d$ : domestic market tariff

$t_m$ : import tariff

$t_{m1}$ : in-quota applied tariff

$t_{m2}$ : out-quota applied tariff

$t_p$ : domestic production tariff

$t_x$ : export tariff

Domestic supply and demand are determined as a function of various prices and related elasticity measures, equations 1 and 2. Exports in the ATPSM are maintained as a proportion of the supply, equation 3. Market clearance is shown in equation 4 which equalizes sum of domestic production and imports to domestic consumption and exports. This equilibrium requires that in the world market the change in world excess supply is zero, equation 5.

Domestic prices are function of world market prices, border protection and/or domestic support measures and transaction costs (such as wholesale and retail margins) are taken into account. All protection measures are expressed in tariff rate equivalents.

The countries in the ATPSM are often both importer and exporter of the same good. To accommodate this feature, composite tariffs for determining the domestic consumption and production price are estimated. At the first step, the volumes are grouped under imports, exports and production supplied to the domestic market. A domestic market tariff is computed as the weighted average of export and import tariff and export and import amounts are used as weights, equation 6. Then, a consumption (domestic market) tariff is computed as the weighted average of the import tariff and the domestic market tariff, where the weights are imports and domestic supply, equation 7. Similarly, a supply (domestic market) tariff is computed as well, as the weighted average of the export tariff and the domestic market tariff, where the weights are exports and domestic supply plus the domestic support tariff, equation 8.

Given the volume responses in the ATPSM the trade revenue and welfare effects can be computed. The trade revenue effect of the policy changes is computed for each country and each commodity by employing equation 9. The welfare change has three components. The first two are the changes in producer surplus, equation 11, and consumer surplus, equation 12. These changes depend on the domestic market price changes and the own price response of domestic demand and supply. The change in producer surplus is also dependent on the change in quota rent received, equation 10. Rent accrues only if the importing country is applying the out-quota tariff rate. The capture rate,  $c$ , is the proportion of the rent captured by exporting producers as opposed to the proportion,  $1-c$ , captured by the importing government. The change in quota rent received is added to producer surplus. The third part is the change in net government revenue, consisting of change in tariff revenue, change in export subsidy expenditure, change in domestic support expenditure and change in quota rent not received by exporters, equation 13. Finally, total welfare effect is given in equation 14.

## 5. Policy instruments

**Table 3: Policy variables and parameters**

| <i>Unilateral Policies</i>                          | <i>Bilateral Policies</i> |
|---|---------------------------|
| Land set-aside                                      | Preferential access       |
| Production quota                                    | Quota rents               |
| Domestic producer support policy (price wedge equ.) | Out-quota tariff          |
| Domestic consumer support policy (price wedge equ.) | In-quota tariff           |
| Import tariff                                       |                           |
| Export subsidy                                      |                           |

## 6. Policy incorporation

## 7. Behavioral parameters

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$$\Delta NGR = \underbrace{(t_w + \Delta t_w)(Q + \Delta Q) - t_w Q}_{\text{Change in in-quota revenue}} + \underbrace{(t_o + \Delta t_o)[(M + \Delta M) - (Q + \Delta Q)] - t_o(M - Q)}_{\text{Change in out-of-quota revenue}} - \underbrace{[(t_x + \Delta t_x)(X + \Delta X) - t_x X]}_{\text{Change in export subsidy expenditure}} - \underbrace{[(t_s + \Delta t_s)(S + \Delta S) - t_s S]}_{\text{Change in domestic support expenditure}} + \underbrace{(1-c)\Delta U}_{\text{Change in quota rent forgone}}$$