The present invention comprises a methodology for forecasting the effects of domestic and international trade policies on future trends in world dairy trade on an annualized as well as longer-term basis. The spatial hedonic equilibrium model employed in the present invention is used to analyze world dairy sector data and to forecast future trends by simulating the regional market equilibrium impacts of trade policies in the world dairy sector. The model reflects both vertical (e.g., the processing of farm milk into many different dairy products processing that reflects the allocation of milk components (e.g., milkfats, caseins, whey proteins and lactose) to various dairy commodities including primary, intermediate and processed commodities) and spatial characteristics (e.g., the distribution of milk production, demand and trade for dairy products in different regions of the world). Both domestic and trade policies, and their variations among countries, are incorporated in the model. The analysis forecasts the effects of trade liberalization on attributes of the world dairy sector (including prices, production, consumption, trade flows and the welfare of producers, consumers and taxpayers in various countries).
STEP I: CREATING DATABASE OF WORLD DAIRY SECTOR DATA. 100

- Compile and update data 110
- Manipulate and transform data 120
- Updated base data (aggregated) 130
- Updated supply/demand trend and exchange rate forecasts 125

STEP II: REFINING THE MODEL. 200

- Run base model with transformed data to generate preliminary world dairy sector base model 210
- Calibrate prices 220
- Re-solve model 230
- Solution valid? 240
- Yes: updated world dairy sector base model 310
- No: refine parameters 250

STEP III: FORECASTING. 300

- Run model forecast and/or policy scenarios 320
- Scenario 1 forecast
- Scenario 2 forecast
- Scenario 3 forecast
- Determine effects of scenarios by comparing scenario forecast with base model 340
\[ w_{in} \] 
production of primary commodity n in region i 

\[ x_{in} \] 
utilization of primary commodity n in region i 

\[ y_{ik} \] 
production of processed commodity k in region i 

\[ z_{ik} \] 
consumption of processed commodity k in region i 

\[ T_{ijn}, T_{ijn} \] 
trade of primary commodity n between regions i and j 

\[ x_{in'} \] 
utilization of primary commodity \( n' \) in region i 

\[ y_{jk'} \] 
production of processed commodity \( k' \) in region i 

\[ t_{jk'}, t_{ijk} \] 
trade of processed commodity k between regions i and j
FIG. 2b

- \( w_i \) production of primary commodities in region i

- \( x_i \) utilization of primary commodities in region i

Stage I: \( x_i \) is processed into \( u_i \)

- \( u_i \) production of intermediate commodities in region i

- \( v_i \) utilization of intermediate commodities in region i

Stage II: \( vv_i \) is processed into \( y_i \) through reconstitution, and \( v_i - vv_i \) stays the same.

- \( v_i - vv_i + y_i \) production of final commodities in region i

- \( z_i \) consumption of final commodities in region i

- \( T_{ii}, T_{jj} \) trade of primary commodities between regions i and j

- \( T_{ij}, T_{ji} \) trade of intermediate commodities between regions i and j

- \( T_{ij}, T_{ji} \) trade of final commodities between regions i and j
### FIG. 3

<table>
<thead>
<tr>
<th>WHOLE MILK POWDER PRICE PROJECTION (US$/MT)</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
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<tbody>
<tr>
<td>OECD/FAO</td>
<td>1852</td>
<td>2.890</td>
<td>2.897</td>
<td>2.790</td>
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<td>2.897</td>
<td>2.790</td>
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<td>2.426</td>
<td>2.369</td>
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<tr>
<td>S. Asia</td>
<td>2.426</td>
<td>2.429</td>
<td>2.426</td>
<td>2.365</td>
</tr>
<tr>
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<td>1.672</td>
<td>1.679</td>
</tr>
<tr>
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<td>1.679</td>
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<tr>
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<td>3.202</td>
<td>3.290</td>
<td>3.410</td>
</tr>
<tr>
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<td>3.434</td>
<td>3.506</td>
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<td>2.610</td>
</tr>
<tr>
<td>C. &amp; S. America</td>
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<td>2.835</td>
<td>2.835</td>
</tr>
<tr>
<td>Mexico</td>
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<td>3.212</td>
<td>3.212</td>
<td>3.212</td>
</tr>
<tr>
<td>SAM. N.</td>
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<td>2.267</td>
<td>2.267</td>
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</tr>
<tr>
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<td>2.267</td>
<td>2.267</td>
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</tr>
<tr>
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<tr>
<td>World Average</td>
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### FIG. 4

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<tr>
<th>Region</th>
<th>GATT 2000</th>
<th>GATT 2005/Quota</th>
<th>GATT 2005/Both</th>
<th>GATT 2005/Subsidy</th>
<th>GATT 2005/All</th>
<th>&quot;FREE TRADE&quot;</th>
</tr>
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<tbody>
<tr>
<td>W. Europe</td>
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<td>-8.4</td>
<td>-12.2</td>
<td>-25.8</td>
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<tr>
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<td>4.3</td>
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<tr>
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<td>-0.3</td>
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<td>-26.4</td>
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<td>0.2</td>
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<td>5.8</td>
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<td>2.7</td>
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</tr>
<tr>
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<td>-1.2</td>
<td>-3.5</td>
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<td>-30.0</td>
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</tr>
<tr>
<td>Canada</td>
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<td>-2.0</td>
<td>-2.0</td>
<td>-2.0</td>
<td>-2.0</td>
<td>-2.0</td>
</tr>
<tr>
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<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
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<td>SAM, N</td>
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<td>1.3</td>
</tr>
<tr>
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<td>14.4</td>
<td>16.1</td>
<td>16.1</td>
<td>16.1</td>
<td>16.1</td>
</tr>
<tr>
<td>Rest of World</td>
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<td>-0.1</td>
<td>-0.1</td>
<td>-2.5</td>
<td>-3.5</td>
<td>-3.5</td>
</tr>
<tr>
<td>World Average</td>
<td>-1.6</td>
<td>-2.4</td>
<td>-1.7</td>
<td>-2.5</td>
<td>-3.5</td>
<td>-3.5</td>
</tr>
</tbody>
</table>
**FIG. 5**

Maximum Allowable Subsidized Exports for Selected Regions Under Alternative Scenarios (1000 MT).

<table>
<thead>
<tr>
<th></th>
<th>Cheese</th>
<th></th>
<th></th>
<th>Butter/Butteroil</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>West Europe</td>
<td>563</td>
<td>431</td>
<td>320</td>
<td>513</td>
<td>407</td>
<td>319</td>
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<tr>
<td>E. Europe/FSU</td>
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<td>13</td>
<td>12</td>
<td>17</td>
<td>15</td>
<td>13</td>
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<tr>
<td>Australia</td>
<td>72</td>
<td>50</td>
<td>31</td>
<td>64</td>
<td>39</td>
<td>18</td>
</tr>
<tr>
<td>S. Africa</td>
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<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Canada</td>
<td>12</td>
<td>9</td>
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<td>9</td>
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<td>3</td>
<td>2</td>
<td>47</td>
<td>21</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Skim Milk Powder</th>
<th></th>
<th></th>
<th>Whole Milk Powder</th>
<th></th>
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<tbody>
<tr>
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<td>298</td>
<td>234</td>
<td>594</td>
<td>480</td>
<td>385</td>
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<tr>
<td>E. Europe/FSU</td>
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<tr>
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<td>68</td>
<td>35</td>
<td>102</td>
<td>65</td>
<td>34</td>
</tr>
<tr>
<td>S. Africa</td>
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<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Canada</td>
<td>55</td>
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<td>37</td>
<td>6</td>
<td>5</td>
<td>4</td>
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<tr>
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<td>68</td>
<td>28</td>
<td>15</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S. America, South</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
METHOD FOR FORECASTING THE EFFECTS OF TRADE POLICIES AND SUPPLY AND DEMAND CONDITIONS ON THE WORLD DAIRY SECTOR

BACKGROUND

[0001] The present invention relates generally to economic models to forecast the effects of trade policies and supply and demand trends on market sector pricing and shares, and, in particular, to an hedonic spatial equilibrium trade model that accommodates interregional variations, multiple products, and implicit markets for milk components (e.g., milkfat, casein, whey protein and lactose as allocated to various dairy commodities including primary, intermediate and processed commodities) to generate annualized and longer-term forecasts of the effects of trade policies and supply and demand conditions on attributes of the world dairy sector (including prices, production, consumption, trade flows and the welfare of producers, consumers and taxpayers in various countries).

[0002] Historically, the U.S. dairy sector has been a minor player in world dairy markets. Over the 1989-94 period, for example, the U.S. exported the equivalent of only 2.5% of total domestic milk production while accounting for 6% of the total world dairy exports (excluding intra-European Community trade). Evolving world trade liberalization, especially the completion of the General Agreement on Tariffs and Trade (GATT) Uruguay Round Agreement (URA), is changing this situation. The U.S. dairy sector is increasingly integrated into a global dairy economy characterized by increased private exports of U.S. dairy products, increased dairy imports, less government intervention, and additional foreign investment in the U.S. dairy industry.

[0003] This changing dairy trade environment offers the U.S. opportunities to expand dairy exports, as well as further opening domestic markets to imports from the rest of the world. To better understand the impacts of global trade liberalization on the competitiveness of the U.S. dairy sector in these markets, additional knowledge of international dairy markets and improved policy modeling capabilities are needed to help the U.S. dairy sector adjust effectively to the new environment.

[0004] With this motivation, the original goal of the present inventors was to improve world dairy sector policy modeling capabilities and to provide a detailed, quantitative assessment of the impacts of trade liberalization, especially the Uruguay Round of the GATT, on world dairy markets and the U.S. dairy sector. While the literature on trade liberalization is vast, comprehensive and systematic studies on world dairy markets, both in regional and in commodity detail, have been quite limited.

[0005] The present inventors accomplished their initial general goal by (a) conducting a comprehensive survey of the world dairy situation at a twenty-one country level; (b) assessing and summarizing the then current trade liberalization agreements, especially the URA of the GATT, for their potential impacts on world dairy markets; (c) assessing the literature to obtain insights on supply/demand trends and agricultural trade policy for the U.S. and major dairy producing/consuming and exporting/importing regions; (d) using the insights and parameters from (a)-(c), designing, building and calibrating a world dairy trade model including twenty-one regions and nine dairy product markets; and, (e) summarizing and evaluating the farm/wholesale impacts of alternative trade liberalization scenarios and demand/supply growth conditions on the U.S. dairy sector.

[0006] These initial objectives were met and resulted in a world dairy trade model capable of forecasting the effects of various domestic and international trade policies and supply and demand trends on world dairy trade in three to five year trends (Cox, et al., An Economic Analysis of the Effects on the World Dairy Sector of Extending Uruguay Round Agreement to 2005, Can. J. of Agr. Econ. 47 (1999)169-183; and, Zhu, et al., An Economic Analysis of the Effects of the Uruguay Round Agreement and Full Trade Liberalization on the World Dairy Sector, Can. J. of Agr. Econ. 47 (1999)187-200). However, further refinement of the data and model was required to improve the accuracy of those predictions and to allow more detailed annualized trend reporting.

[0007] The present invention addresses these problems by providing a refined methodology for creating a database of world dairy sector information sufficient to the task and for modeling the effects of domestic and international trade policies and supply and demand trends on future trends in world dairy trade on an annualized as well as longer-term basis. The spatial equilibrium model employed in the present invention is used to analyze the data and to forecast future trends by simulating the regional market equilibrium impacts of trade policies in the world dairy sector. The model reflects both vertical (e.g. the processing of farm milk into many different dairy products, processing that reflects the allocation of milk components to various dairy commodities, including primary, intermediate and processed commodities) and spatial (e.g. the distribution of milk production, demand and trade for dairy products in different regions of the world) characteristics. Both domestic and trade policies (and their variations among countries), as well as supply/demand trends and exchange rate changes, are incorporated in the model. The analysis forecasts the effects of trade liberalization on attributes of the world dairy sector (dairy prices, production, consumption, trade flows and the welfare of producers, consumers and taxpayers in various countries). The forecasts are generated on an annual, as well as longer-term basis, providing information regarding various attributes of the world dairy sector valuable to businesses involved in the U.S. and other regional dairy sectors. The world dairy price and trade flow data forecasts provide valuable information that can be used by businesses to compete in the world dairy market, and by governments in policy negotiations.

[0008] In the accompanying drawings:

[0009] FIG. 1 is a flow diagram depicting the general steps in the method of the present invention;

[0010] FIG. 2a is a flow diagram of the allocation process of primary and processed commodities;

[0011] FIG. 2b is a flow diagram of the allocation process of primary, intermediate and processed commodities;

[0012] FIG. 3 is a sample of an annualized forecast over a period of 5 years, including validations;

[0013] FIG. 4 is a sample comparison of the regional forecasted milk price impacts under various alternative policy scenarios; and,
FIG. 5 is a sample comparison of the regional forecasted maximum allowable subsidized exports under various alternative policy scenarios.

DESCRIPTION

Referring now to the figures, in which identical or similar steps are designated by the same reference numerals throughout, a detailed description of various alternative embodiments of the present invention is given. However, the present invention can assume additional embodiments, as will become apparent to those skilled in the art, without departing from the appended claims.

Referring to FIG. 1, the steps in the method of the present invention generally comprise (1) creating a database of world dairy sector data 100, (2) refining the model 200, and (3) running the refined and updated model under various policy scenarios to forecast the effects of each of the scenarios on the world dairy sector attributes 300 (see FIG. 1). The descriptions of these basic steps are preceded by a description of the spatial equilibrium model and policy scenarios of the present invention, since it will be referred to throughout the remainder of this section.

Multiple modes of implementation of the method of this invention are possible. For example, the method may be implemented in a variety of programming languages on a variety of computer systems. It may be implemented using pre-packaged software or customized programming.

Portions of the database compilation step may involve the downloading of data over the Internet, retrieval from a form of electronic storage media and/or input by hand.

The Model and Policy Scenarios.

The hedonic spatial equilibrium model employed in the present invention is a model of the world dairy markets. The model is a static, spatial, multi-product, multi-component (hedonic) framework of the world dairy sector with vertical linkages among production stages. It is used to analyze the data and to forecast future trends by simulating the regional market equilibrium impacts of trade policies in the world dairy sector. The analysis considers many separate regions of the world, including the U.S., Canada, Mexico, China, India, Japan, Australia, New Zealand, western Europe, eastern Europe and the former Soviet Union (FSU). The model considers five types of farm milk (cow, buffalo, camel, sheep and goat) embodying several milk hedonic characteristics (fats, casein proteins, whey proteins, other nonfat solids (lactose, salts, other minerals and ash) and further frictions thereof) that can be processed into eight types of dairy products (cheeses, butters, whole milk powders, skim milk powders, dry wheys, caseins, evaporated/condensed milks, and other dairy products). The crucial linkages between primary and processed products are the milk components (milk fats, caseins, whey proteins, other non-fat solids and further frictions thereof) that are “rearranged” by dairy processing plants. In each region, the total amount of components found in processed products must come from the primary products. To the extent that each product has fixed composition, this means that the processing technology can be represented by a Leontief technology with respect to milk components. Let $A(x_1x_2)$ denote the matrix of quantities of the $k$-th component per unit of the primary (processed) commodities in the $i$-th region. And let matrix $A_i$ denote $[x_1, \ldots, x_k]$ and $B_i$ denote $[y_1, \ldots, y_k]$, where $S$ is the number of components. Then the transformation relationship between primary and processed goods in region $i$ must satisfy

\begin{equation}
B_i = A_i X_i, \quad i=1, \ldots, L
\end{equation}

This is a Lancasterian specification establishing fixed proportion relationships between products and their components, where the components are perfect substitutes across commodities. Under the Leontief specification, $G(x_i, y_i)$ can be written as $g(y_i)$ plus component balance restrictions (equation (2)).

Market Equilibrium:

In certain settings, market equilibrium is obtained through the maximization of a net social payoff function given by the sum of producer and consumer surplus across commodities as well as regions, net of transportation and processing costs. In a vertical sector involving more than one stage of production, the cost of transformation in each stage also needs to be subtracted. This gives the following quasi-welfare function

\begin{equation}
V(w, x, l, T) = \sum_i S_i(x_i) + \sum_i P_i(w_i) - \sum_i g(y_i) - \sum_i T_i C_i,
\end{equation}

where $C_i(x_i)$ is consumer surplus in region $i$, $P_i(w_i)$ is producer surplus for the primary commodity $w_i$ in region $i$, and let $T_i(x_i)$ be the vector of transportation and marketing cost per unit of primary (processed) commodities traded from region $i$ to region $j$.
Assume that the quasi-welfare function \( V(w, x, y, z, T, i) \) is concave and satisfies \( \partial C_S(x_i)/\partial z_2 = p_i^* \) and \( \partial C_P(w_i)/\partial w = p_i^* \), where \( p_i^* \) is the vector of market prices for the processed (primary) commodities. This assumes that, under competition, market prices reflect marginal benefits for consumers and marginal costs for producers. In the presence of trade, the maximization of aggregate net social payoff is subject to two sets of constraints: the trade flow constraints and non-negativity constraints. For the \( i \)-th region, the trade flow constraints are

\[
\begin{align*}
  w_i^* &\geq \Sigma_j f_{ij}^* \\
  y_i^* &\geq \Sigma_j \delta_j \\
  z_i^* &\geq \Sigma_j \nu_j \\
  \Sigma_j C_i &\geq C_i
\end{align*}
\]

These restrictions state that exports plus domestic uses cannot exceed domestic production, and that domestic consumption cannot exceed domestic production plus imports. This is true for primary commodities (equations (4a) and (4b)) as well as processed commodities (equations (4c) and (4d)).

The optimization problem representing spatial competitive equilibrium then is

\[
\max_{w, x, y, z, T} \left[ \Sigma_i C_i(x_i) + \Sigma_i P_S(w_i) + \Sigma_i \nu_j \right] \\
\text{s.t.} \quad \Sigma_i C_i = C_i \\
\text{subject to equations (2) and (4); } \left( w, x, y, z, T \right)
\]

The restrictions on export subsidies are dealt with in a similar way. For each country, subsidized exports of a particular commodity are subject to a quantitative restriction, i.e., the maximum allowable volume subject to subsidies under the GATT. A country’s subsidized exports may also be subject to another constraint: the maximum allowable budgetary outlays that the country can spend on export subsidies for a commodity or a group of commodities. A country will always use up its export subsidy “quota” before exporting with no subsidy.

Domestic government programs include price support programs, production quotas and classified pricing. Price supports can be modeled by introducing a government sector (funded by tax-payers) with a perfectly elastic demand at the price support level. Milk production quotas are handily modeled by adding appropriate constraints to farm milk production and adjusting farm level milk prices (the marginal cost of production) as market milk prices minus milk quota rents. If over-quota taxes are not too prohibitive, then a two-tier pricing scheme is needed for modeling domestic production (i.e., using a within- and over-quota pricing scheme in a way similar to the two-tier pricing discussed above). Classified pricing is modeled by introducing appropriate price wedges for the relevant products (e.g., fluid milk).

The following notation is used to incorporate these government policies into (5). Let \( \Pi_i \left( \pi_i \right) \) be the vector of unit-tariffs imposed on imports of primary (processed) commodities from region \( i \) to region \( j \), and \( \Delta_i = \left( \delta_j \right) \) be the vector of unit-subsidy towards exports of primary (processed) commodities from region \( i \) to region \( j \). The vector of import quotas for the primary (processed) commodities in region \( i \), \( i = 1, \ldots, I \), is denoted by \( Q_i \left( q_i \right) \). Finally, let \( S_i \left( s_i \right) \) be the vector of maximum allowable volume of subsidized exports for the primary (processed) commodities in region \( i \), \( i = 1, \ldots, I \).

In the context of a two-tiered pricing scheme, let the superscript IQ denote in-quota, OQ denote over-quota import restrictions, and superscript s denote subsidized exports. Assuming that import quotas for each region are pooling quotas (i.e., not bilateral quotas), the distorted market equilibrium can be expressed as

\[
\max_{w, x, y, z, T} \left[ \Sigma_i C_i(x_i) + \Sigma_i P_S(w_i) + \Sigma_i \nu_j \right] \\
\text{s.t.} \quad \Sigma_i C_i = C_i \\
\text{subject to equations (2) and (4); } \left( w, x, y, z, T \right)
\]
in (6) is similar to (5), but expanded to include classical trade distortions (within and over quota tariffs, export subsidies, and production and import quotas). The following lines in (6) reflect the price distortions and quantity restrictions generated by government policies. Model (6) can be used to investigate empirically the effects of trade liberalization or other trade policies on the dairy sector.

[0042] Incorporate Intermediate Products:

[0043] Milk reconstitution technology is reflected in the model with the inclusion of intermediate commodities (see FIG. 2b). Several categories of products can be used as intermediate dairy processing commodities (e.g., butters, skim milk powders, whole milk powders, condensed and evaporated milks, caseins, dry wheys, milk protein concentrates and other products embodying fractionated milk components) that may be used in the production of other dairy products. For example, cream may be considered an intermediate commodity as it can be further processed into butter, butter oil, ice cream, buttermilk and many other dairy products. In the dairy processing practice of milk reconstitution, milk powders, milk fat products, and other dairy products are converted back into fluid milk for consumption or are used for making other dairy products.

[0044] To incorporate the reconstitution technology in the model, we assume there are two stages in the processing sector. First, the primary products are converted into intermediate products. At the second stage, some of the intermediate products are further processed into final reprocessed products. The other intermediate products and the reprocessed products compose the final consumption goods. Trade is possible following the first stage of processing.

[0045] Suppose a technology allows L types of intermediate commodities to be reprocessed into M types of final products, which is a subset of final products. Let \( u_i \) be the vector of intermediate commodities produced in the \( i^{th} \) region and \( v_i \) be the vector of intermediate goods available in the \( i^{th} \) region following the trade. A portion of \( v_i \) is the vector of intermediate goods reprocessed into final commodities in the \( i^{th} \) region, and vector \( y_i \) is the output of the reprocessing procedure. Let \( G_i(x_u, u_i) \) be the cost (i.e., costs of other inputs except for dairy material inputs) of transforming the \( x \) of primary goods into \( u_i \) of intermediate goods. Under the Leontief specification, \( G_i(x_u, u_i) \) can be written as \( g_i(u_i) \) plus component balance restrictions. In a similar fashion, let \( H_i(v_i, y_i) \) be the transformation costs converting \( v_i \) of intermediate goods into \( y_i \) of final commodities, which can be written as \( h_i(y_i) \) plus component balance restrictions. Let \( \tau_i \) be the shipment of intermediate goods from the \( i^{th} \) to the \( j^{th} \) region. Furthermore, let \( E_i \) be the matrix representing the nutrient composition of reconstituted goods and \( F_i \) be the matrix representing the nutrient composition of intermediate goods.

[0046] The optimization problem (6) with an intermediate product reprocessing stage is characterized in equation (7) assuming that reprocessed products share the same trade policies as other products:

\[
\min_{x_{u},v_{i},y_{i},\tau_{i}} \left\{ \sum \left( x_{u} f_{i}(x_{u}) + \sum P_{S} (w_{i}) - \sum g_{i}(u_{i}) \right) \right\}
\]

Equation 7 extends the optimization problem (6) by incorporating: 1) the cost of processing intermediate commodities (\( h_{i}(y_{i}) \)); 2) the shipments of intermediate commodities (\( \tau_{i} \)) under within (\( \tau_{i}^{SS} \)) and over quota (\( \tau_{i}^{OS} \)) tariffs and export subsidies (\( \delta_{i} \)); 3) an expanded component balance incorporating the conversion of intermediate products into final products (\( E_{v_{i},y_{i}} \); 4) expanding the trade balance (\( v_{i},v_{j} \); 5) reconstituted products share the same trade policies as other products. This gives a BASE Scenario that reflects recent world economic conditions. Conditions for a BASE Scenario are summarized below. It should be noted that several scenarios describing specific year forecasts are described in the following by way of example only. The actual years forecasted will change with each set of model simulations.

[0049] BASE Scenario:

[0050] The model equation (6) is solved using the General Algebraic Modeling System (GAMS) optimization package (though as noted previously, alternative computer programs may be used). First, a model is specified to provide an accurate representation of the world dairy markets. This gives a BASE scenario that reflects recent world economic conditions.
conditions 310. This BASE scenario is then modified to simulate the effects of various alternative policy scenarios regarding, for example, GATT commitments and demand/supply shifts. A series of sensitivity analyses are then conducted on the BASE model with respect to the magnitude and the functional form of transportation costs, demand and supply elasticity parameters, and manufacturing cost specifications. In order to understand the relative importance of natural trade barriers (transportation costs) versus man-made trade barriers (trade distortions) in world dairy trade, several scenarios are generated with each of the major policy instruments (tariffs, import quotas, and export subsidies) eliminated and the results compared with the role of transportation costs.

[0051] After the model is judged to reasonably replicate the data inputs in the BASE scenario, it is used to simulate the world dairy situation in several alternative policy scenarios 320. Combining policy changes with predicted demand/supply changes, a number of scenarios are then generated to forecast the annualized changes in the world dairy situation, as well as longer term changes.

[0052] Policy Scenario Simulations:

[0053] When the calibrated BASE model generates solutions that are reasonably close to data inputs, it is used as the benchmark against which the results from other simulation scenarios are compared 340. These simulation scenarios are divided in two major groups: ceteris paribus policy analyses, and forecasting scenarios. The first group includes a free market scenario (FM, total elimination of trade and trade related domestic policies), a scenario with the trade policies of a certain year under the GATT (e.g., for the year 2000 under the GATT (GATT 2000), and one with both trade and domestic policy changes from the BASE period to the year selected (e.g. the year 2000 (Policy 2000)). The forecasting scenarios consist of various combinations of policy changes and projected exogenous demand/supply changes.

[0054] Ceteris paribus is used to mean comparative static analysis of policy changes only, given that regional demand/supply curves are fixed. Three policy scenarios are considered. The first policy scenario assumes that each GATT member country fulfills its minimum trade liberalization obligations in the year 2000, for example, under the URA (i.e., maximum tariff rates, minimum market accesses, and maximum allowable export subsidies). This scenario reflects, in some sense, the pure effects of the URA. The second scenario analyzed in this section involves GATT trade policy changes as well as projected domestic dairy policy reforms. These are considered simultaneously because some domestic policies have to be adjusted accordingly to meet GATT commitments during the implementation period of the URA. The third scenario in this section is the Free Market situation. This scenario is identical to a scenario in the previous section (i.e., one with full elimination of the status quo tariffs, import quotas, export subsidies, and related domestic policies). Unlike tariffs, export subsidy restrictions are specified in terms of maximum allowable subsidized quantity and budgetary outlays under the URA. Member countries are free to choose their subsidy rates as long as they do not violate the volume and budgetary outlay restrictions. The model assumes that the countries having export subsidy policies will try to maximize their export volume during the implementation period of the URA.

[0055] GATT 2000:

[0056] GATT 2000 refers to the scenario where each GATT member country fulfills marginally its URA commitments for trade liberalization by the year 2000 (or other year as appropriate). Hence, the model assumes that maximum allowable tariff rates and minimum import quotas under the URA will be the applied trade policies. Non-WTO members are assumed to keep their current (or the BASE period) trade policies. Domestic policies remain at the BASE level, as do the demand and supply schedules. Thus, this scenario is used to assess the ceteris paribus effects of the URA of the GATT on the world dairy sector.

[0057] Policy 2000—Adding Domestic Policy Reforms:

[0058] The pressures for liberalization in world dairy trade come not only from the multilateral agreement, i.e., GATT, but also from internal sources in many developed countries. The large budget burdens of commodity programs in heavily protected dairy sectors increasingly conflict with the domestic considerations that led to their extensive adoption.

[0059] In Policy 2000, trade policy changes under the URA and projected domestic policy changes (for the year 2000, or other year as desired) are combined. Three types of domestic policies are assumed to change in this scenario: price supports, production quotas, and direct dairy subsidies for manufacturing milk utilization.

[0060] Free Market (FM):

[0061] In the Free Market scenario, the model assumes all tariffs, import quotas, and export subsidies are eliminated from the BASE. Domestic farm policies that are closely related to trade, such as price supports and production quotas, are also eliminated. The only type of farm policies kept is classified pricing policies in the U.S., Canada, and Australia. This is an analysis to explore the foremost potential of trade liberalization in world dairy markets. It provides important information about the competitiveness of each region in world dairy markets, and about the potential ultimate results of the trade liberalization efforts of the GATT (WTO). This assessment can also serve as a supporting analysis for the future WTO negotiations.

[0062] Adjustment for Demand/Supply Shifts and Forecasts:

[0063] Income and population are generally considered the most important determinants for aggregate demand. The linkage between income/population changes and demand shifts is the income elasticity (using per capita income) and population elasticity. The model assumes the population elasticity for all dairy productions is one, i.e., 1% population growth leads to a 1% increase in total demand. In a partial equilibrium analysis, income and population changes are treated as exogenous demand shifts. In this study, the model assumes parallel demand curves shifts, which means slopes of demand curves are fixed during the shifts. Generally, the income elasticity of food products tends to be lower the higher the income level and the higher the per capita consumption.

[0064] The other set of demand shifter estimates is based on projected regional gross domestic product (GDP) growth rates (e.g., 1994-2000, or other ranges as data are available). The World Bank has already published the GDP growth rates
for the first three years of this period. For the second three years, the forecast data from other sources is used, especially investment companies, which publish a variety of GDP growth rate forecasts with consideration of important macroeconomic factors, such as reform processes and economic crises.

[0065] Supply shifters are more difficult to identify in sectoral models. The major determinant, technological change, is hard to measure directly. An indirect approach may sometimes be used in which the changes in other production factors are subtracted from the total production change and a residual computed that is interpreted as a measure of technological change. This idea also applies to the estimation of supply shifters in sectoral models. A change in production can be explained by price changes (movement along a supply curve) and other changes (supply shifters). Assuming the production growth rate and price change rate are known, the supply shifter can be measured as

\[ \Delta \eta_A = Q - \eta_A \]  

(8)

where \( \eta_A \) is the price elasticity of the supply.

[0066] This supply shifter embodies not only the technological change, but also possible changes in government subsidy, tax policies and other farm policies. Other factors, such as weather and input prices, are also likely included in this shifter. Because several policy changes are explicitly integrated in the model, using the shifter estimated by equation (8) to forecast the future world dairy situation might be inappropriate in certain situations.


[0069] The first scenario analyzed in this section assumes no policy changes over the BASE Scenario and shifts demand/supply following the historical trends observed during 1980-95 (or other period as appropriate). This scenario can be considered a new BASE (referred to as 2000GR, where “GR” stands for “Growth”) on which the assessment of impacts of policy changes is made. Moreover, comparing the impacts of demand/supply change with the ceteris paribus policy analyses in the previous section will provide information about the relative magnitude of policy impacts with respect to other factors, such as income, population growth and technological changes.

[0070] Forecasting Year 2000 (2000GRG and 2000GRP; or Other Year as Appropriate):

[0071] The scenarios combining projected demand/supply changes and policy changes reflect the model forecasts of the year 2000 world dairy situation (or other year as appropriate). Two scenarios (2000GRP and 2000GRG) are implemented for the forecasting purpose in this study. In both scenarios, GAAT member countries use their marginal policies under their URA commitments (i.e., maximum tariffs, minimum import quotas, and maximum allowable export subsidies) for the year 2000. The difference between these two scenarios is that, in 2000GRG, several domestic dairy policies change in selected countries (the same as in the Policy 2000 Scenario), while in 2000GRP, domestic farm policies are the same as in the BASE. In short, 2000GRP is the combination of 2000GR and Policy 2000, while 2000GRG combines 2000GR and GAAT 2000.


[0073] The 2000GRFM scenario reflects the full trade liberalization situation in the year 2000 given that the demand/supply shifts follow historical trends (1989-1995; years may vary with the particular analysis). Trade related domestic policies (price supports, production quotas and direct subsidies) are eliminated as well in this scenario.

[0074] Adjustments to Demand and Supply Shifters:

[0075] In the previous forecast scenarios, the demand and supply shifters are projected from the trends in historical data (i.e., 1989 to 1996, or other period of time as appropriate). This type of simple projection approach can be useful in general, but it is quite naive. Forecasts based on adaptive expectations do not consider what has happened recently and what will happen in the future, and consequently, should be treated cautiously. For example, in Eastern Europe and FSU, the GDP growth rate was about −5% a year during the BASE period, when the countries in these regions started economic reforms. These economies have become more stable and positive GDP growth rates have been observed recently in many of these countries. As a result, a minus five percent growth rate is definitely not a good projection of growth rate for the period of 1994-2000. The current financial and economic crisis in East Asian countries will reduce the GDP growth rates in affected countries significantly, due to the contagion effects on the rest of the world. A similar situation exists in the forecasts for regional milk supply shifters in the regions with sharp declines in milk production in the BASE period due to various macroeconomic factors that are expected to disappear in the future.

[0076] Under these considerations, a rational expectation approach where new information being used could be more appropriate than the adaptive expectation (where only historical trends are used) to predict demand/supply changes. A set of modified projections based on real GDP growth is constructed. For countries without forecasting information, the historical data is still used. Changes are made mostly on Organization for Economic Cooperation and Development (OECD) countries and important emerging markets, such as East Asia and Europe, the former Soviet Union. For example, due to the currency, financial and economic crises in most East Asian countries, their economies are expected to have lower GDP growth rates than before.

[0077] Simulating Low Demand Growth (2000LGR):

[0078] The 2000LGR scenario (LGR stands for “Low-Growth”) is the counterpart of 2000GR with new projections on demand and supply shifts (again, the year may vary with the particular analysis conducted). The scenarios with the adjusted demand/supply shifts are referred to as the Low-Growth because the major differences between 2000LGR and 2000GR result from the lower GDP growth (thus the demand growth) in East Asia. It should be emphasized that the “Low-Growth” scenarios are not sensitivity analyses, but rather as more realistic projections of the year 2000 situation.

[0079] In 2000LGR, trade and domestic policies remain the same as in the original BASE. Using 2000LGR as the new, Low-Growth BASE the impacts of the GATT and domestic policy changes on world and regional dairy markets are reassessed, and compared to the results with those from the previous ceteris paribus analyses.
[0080] Forecasting 2000 with Adjusted Demand/Supply Shifters:

[0081] With the above adjustments to the demand/supply shifters, two scenarios (2000LGRG and 2000LGRP) are simulated to forecast the global dairy situation in the year 2000. Only trade policy changes have been taken into account in the 2000LGRG simulation. Both trade policy and domestic policy changes are considered in the 2000LGRP simulation. 2000LGRG parallels the 2000LGRP scenario but with adjusted demand/supply shifts and 2000LGRP parallels 2000GRP in the same fashion. Free Market at 2000 Revised (2000LGRFM): The 2000LGRFM Scenario reflects the full trade liberalization situation in the year 2000 with the adjusted projections for demand/supply changes.

[0082] Welfare Measures and General Results:

[0083] In addition to the traditional partial equilibrium welfare measures, producer and consumer surplus, government revenues from or expenditures on trade policies (tariff revenue minus export subsidy spending, which can be considered as the net benefit to taxpayers) as a part of total welfare are also considered.

[0084] In the GATT 2000/Domestic Policy Changes simulation the focus is on the regional welfare implications of the changes in trade/domestic policies in the scenarios relative to the “Low-Growth” BASE (2000LGR). In the Free Market scenario the welfare changes under full trade liberalization (versus the “Low-Growth” BASE) are analyzed. In this Free Market scenario (2000LGRFM), all tariffs and export subsidies are eliminated. Thus, government revenues from and expenditures on trade policies are zero.

[0085] Step I: Creating a Database of World Dairy Sector Data 100

[0086] A tremendous amount of data is required to operationalize the world dairy hedonic spatial equilibrium model of the present invention. As a result, the first step in the process of forecasting the effects of trade policies on world dairy sector attributes is to condition a preliminary set of data (for a number of years) for use as the input to the BASE scenario model. This is done by (a) compiling and updating a database of world dairy sector data from various sources 110, (b) manipulating and transforming the data to produce a database of the data in a format usable by the spatial equilibrium model on the present invention 120, and (c) updating the BASE model files of aggregated data 130. It should be noted, that it may be possible to acquire a preexisting database to use as input to the model of the present invention, in which case, this first step of creation of a database may be skipped.

[0087] Some of the main data inputs used to operate the BASE model include (1) base year farm level prices and production of primary commodities, wholesale level prices, production, and consumption of secondary dairy products; (2) a regional wholesale sector value-added matrix (farm wholesale processing and distribution costs); (3) interregional transportation costs; (4) regional supply and demand elasticities; (5) regional income elasticities; (6) GDP growth rates; and (7) regional trade distortions. These data of inputs are in some cases available as is, and in others must be derived or calculated separately.

[0088] Compiling and Updating a Database of World Dairy Sector Data 110.

[0089] Much of the information on dairy production, consumption and trade that is needed to perform the method of the present invention is available in raw form from public sources. It should be noted, however, that private sources of information may also be used to, in some cases, more accurately simulate the effects of various policy scenarios and supply and demand trends on the world dairy sector.

[0090] Publicly available data used in the spatial equilbrium world dairy model originates generally from three main sources, the Food and Agriculture Organization of the United Nations (FAO), the International Monetary Fund (IMF) and the Organization for Economic Cooperation and Development (OECD).

[0091] In general, production and trade data for various years come from the FAO and OECD (e.g., milk production by country, production data of processed foods, and trade data by country; using OECD data for all OECD countries). The exchange rate and gross domestic product (GDP) growth rate data used in the model come from the IMF. The price data and stock change data for the model is provided by the OECD (OECD data is used for all countries where possible, otherwise FAO data is used for the country). Regional trade distortion data (regional export subsidies, import tariffs and quotas, etc.) are obtained from the URA of the GATT. For certain non-GATT member countries, the U.S. Dairy Export Council provides tariff and import quota information. As well, other commercial sources of actual (de facto versus de jure) implementation of the URA GATT commitments can be utilized (e.g., Tariffic database).

[0092] Once the raw data is downloaded from the various sources, the data must be cleaned (the labels of the data set are changed to conform to the corresponding data labels in the relational database, e.g. MS-Access) and resaved in a form importable into the Access database.

[0093] The data is organized into raw data tables and grouping tables. Raw data tables are tables that include one or more fields that can be mathematically manipulated. Raw data tables are used to store disaggregate raw data, e.g., by country and product. Raw data tables include those for production (milk and commodity), composition (milk and component), import quantity, import value, export quantity, export value, price, stock, exchange rate and GDP growth.

[0094] By contrast, grouping tables store information to define aggregation and sorting criteria for a specific field. Grouping tables include, e.g., region, product category, continent, region order, and category order. By changing the information in these tables, users may easily regroup or sort data in alternative formats, making the data retrieval very flexible.

[0095] Countries are grouped into regions: 220 countries are grouped into 21 regions including, WEU—all countries in Western Europe, including Malta, EEU—all countries in Eastern Europe, FSU—all countries from the former Soviet Union, CHN—China, Hkg—Hong Kong, Taiwan, Macao, and Mongolia, JAP—Japan, KOR—Korea, South and North, SEA—Southeast Asia Countries to the east of Myanmar, IND—India, OSA—other South Asian countries, AUS—Australia, NZL—New Zealand, MDE—Middle East including Cyprus, NAF—North Africa, SAF—
Since in the majority of studies only stock changes are of interest, this “conversion” should not affect data accuracy.

To estimate the trends in demand and supply changes the database also includes real GDP growth rate data. Real GDP growth includes both the population growth and GDP per capita change, and has been adjusted for inflation. Data are obtained from the World Bank, and are in percentage growth terms.

Trade policy and milk component data are not stored in Access because they are in rather aggregated forms and involve many calculations. These data are stored in a variety of Excel files instead.

Manipulating and Transforming the Data to Produce Updated Files in a Format Usable by the Model 120.

The data in the compiled database is manipulated to provide information in a form appropriate for use in the model. Country level data need tremendous data manipulation and processing to obtain regional level computer input data. The compiled database tables are queried to retrieve information of whatever sort is needed by the model, and/or further calculations are made to derive new information from the data. In this way, regional level data and other calculated data are prepared for input to the BASE model.

Queries may be constructed to retrieve information for regional milk production, milk price and milk composition, for example. Standardization and/or reconstitution parameters may also be derived. For example, the degree of intermediate dairy products (skim and whole milk powder, evaporated/condensed milks, dry whey protein concentrates, butter/analogue milk fat) and usage to make the final demand dairy products (cheese and residual category products such as fluid milk, frozen and soft products) may be calculated by country and/or region. Any number of additional queries are possible limited only by the imagination and requirements of the user. The results of the queries may also be exported in spreadsheet format, if desired.

Various calculations are also performed to determine other values for use by the model. For example, consumption is generally computed from a supply and demand balance worksheet where consumption is taken as the residual of Production + Imports - Exports + Beginning Stocks - Ending Stocks (•Consumption; if stocks data are missing, they are omitted in consumption). Another calculation is performed to increase the accuracy of FAO data on production and prices. A three-year average is calculated for any given year’s data (e.g. 1995-1997 data averaged to give year 1996 value). In this way the more recent year data of the older databases are updated using current year data. Interregional transportation costs (TC) are calculated as flat transportation costs (e.g., for non-refrigerated products (whole and skim milk powder, casein, evaporated & condensed milk and dry whey), TC=$0.018/MT/Nautical mile; for refrigerated products (cheese and butter), TC=$0.027/MT/Nautical mile; and a very high rate is used for fresh milk products (to characterize partially high trade barriers on fresh milk products)). As well, commercial sources can be used to obtain more detailed and country to country specific transportation costs. Distance data are derived from Defense Mapping Agency data.

Updating Supply/Demand Trends and Exchange Rates 125.

Naïve supply and demand trends are updated by choosing compound growth rates (by product and by coun-
try) to minimize forecast error over the 5 years prior to and including the current BASE year data. Annual quantity forecasts are generated from BASE data using compound growth rates for each product and region. Prices are adjusted to quantify forecasts by subtracting price changes/demand (supply) elasticity from the forecast demand (supply) changes. The GDP and population projections are used with income elasticities to forecast demand for product/region.

[0110] The BASE model is run to generate linear regional supply and demand curves using regional supply and demand elasticities (derived from USDA SWOPSIM data; see, Roningen, V., J. Sullivan, and P. Dixit, 1991, *Documentation of the Static World Policy Simulation (SWOPSIM) Modeling Framework*, Staff Report No. AGES 9151, Washington, D.C.: USDA/ERS) and base level prices and quantities. Regional income elasticity data are derived from USDA SWOPSIM for major countries, and is computed for other countries assuming that countries having similar development status have similar demand characteristics.

[0111] Updating the BASE Model Aggregated Data Files

[0112] Newly retrieved, manipulated and in some cases updated data (as described above) are merged with current BASE model files to update them. Once this is done, the model itself can be updated as per Step II below.

[0113] Updated data include (a) regional milk production, price and composition; (b) regional production, consumption, stocks, imports/exports and price for all commodities; and, (c) component balance at the regional level (milkfat, casein, whey protein, lactose). The updated component balance includes (a) production of milk components (using FAO data); (b) utilization of milk components (using FAO data); and, balance of the surplus/shortage on the residual (nontraded) product category.

[0114] The result of Step I is to transform the model’s files of world dairy sector information to accurately reflect the recent world economic conditions and to be usable by the model. In this way, the BASE scenario model is specified to provide an accurate representation of the world dairy markets and reflects recent world economic conditions.

[0115] Step II: Refining the Model

[0116] During this step of the method, the BASE model data are adjusted to be consistent with model specifications before the model is used to do other analyses: (a) the BASE model of the world dairy sector is run to generate preliminary world dairy sector attribute forecasts 210, (b) prices are calibrated and the model resolved with the price calibrations and updated ad-valorem tariff rates 220, and (c) the results are validated and the model parameters refined accordingly 230-250. This process is iterative and results in a refined model able to predict world dairy sector attributes accurately. Solving the resulting refined BASE model yields optimal regional values for milk/commodity production and consumption, commodity trade flows, milk/commodity prices and implicit component prices (fat, casein, whey protein and lactose). These resulting BASE values can then be used to measure changes that result when the model is resolved under various policy scenarios in order to determine their effects on the world dairy sector (see Step III).


[0118] Using the updated model files, the BASE model is run to generate a preliminary set of annualized forecasts. Output summary files are created for farm level prices and production, commodity prices, production and consumption by product and country/region; imports and exports by product and by country/region; commodity trade flows by product and by country/region; and producer and consumer surplus (welfare), net costs to treasury (tariff revenues minus export subsidy and intervention price expenditures).

[0119] Calibrate Prices and Resolve the Model with the Price Calibrations and Updated Ad-Valorem Tariff Rates 220.

[0120] Price calibrations are performed in order to address certain limitations of the data. FAO provides price data only for primary products (raw milk prices). The secondary dairy product price data is obtained from several other sources that, unfortunately, only provide information for major dairy countries and major dairy products. Moreover, very limited information is available on dairy manufacturing and distribution costs. Estimates are made of the manufacturing and distribution costs for major dairy products (cheddar cheese, butter, skim milk powder, and whole milk powder) in several countries (mostly OECD countries). To handle these data limitations, the model is used to compute unknown manufacturing and cost parameters while solving for the optimal base solution.

[0121] The basic idea of this calibration procedure is to search for the values for those unknowns that are consistent with the model specifications, equilibrium conditions and the parameters based on data that are available. This involves solving the model a number of times with the calibrated data updated in each run. The procedure can be divided into the following steps. Step one: “guess” the values of the unknown manufacturing and other cost parameters as the starting values and solve the model. Step two: compare the model solutions with the data, and include the original “guessed” data. Adjust those “guessed” data/parameters in the direction that will potentially reduce the deviation of model solutions from the data, and solve the model again. Step three: repeat step two until no further significant changes are needed to alter the model solution.

[0122] The goal of calibration via updating manufacturing costs is to replicate the data for regional milk price and production data by choosing region-specific adjustments on processing costs. Using the procedure described above we obtain region-specific price calibration wedges that make the regional milk prices in the model solution the same as observed price data.

[0123] Given that the milk supply curves are fixed, calibrating the milk price in this manner is equivalent to calibrating regional milk production because the calibration procedure is to move the equilibrium points along the fixed supply curves. As for the calibration of regional prices of secondary products, the position of the associated regional demand curves is adjusted to the points that are relatively consistent with milk supply curves and other demand curves, on which good information (generally the regions including OECD countries) is available. Using the procedure described above, the unknown prices, thus regional consumption, can be calibrated. The regional demand curves are then reset with the updated prices by re-computing prices intercepts and slopes under standard formulas using assumed demand elasticities, BASE quantity and calibrated...
price data. After sufficient iteration of the calibration process, BASE data is replaced with the current model solutions for all non-OECD prices.

[0124] Market prices are treated as endogenous in the calculation of tariffs. This is done by solving for market equilibrium iteratively, where each iteration uses updated specific duties equivalent of the ad valorem tariffs, until convergence is obtained. Upon convergence, the solution is identical to the one obtained from solving directly the associated mixed complementarity problem. Finally, most non-tariffs barriers influence import volume directly and can be introduced easily in spatial trade models by adding appropriate restrictions on quantities traded.

[0125] Validate Results and Refine the Model Parameters Accordingly 230-250.

[0126] Once price calibrations are complete, the model is resolved with the calibrated price data and updated endogenous ad-valorem tariff rates 230. The model solutions are validated by comparing them with actual data 240 and the model parameters refined accordingly 250 to better align the model results with the actual data.

[0127] Some of the model parameters refined by the process include (a) domestic policy parameters (e.g. intervention prices, production/consumption subsidies, quota rents, fluid/manufacturing milk price wedges), (b) trade policy parameters (e.g. GATT commitments (import quotas, two-tiered import tariffs (within and over quota), export subsidies (quantity and expenditure)), and (c) standardization/reconstitution parameters (e.g., the degree of intermediate dairy products usage (skim and whole milk powder, evaporated/condensed milks, dry whey protein concentrates, butter/anhydrous milk fat) to make final demand dairy products (e.g., cheese and residual category (fluid milk, frozen and soft products) by country/region).

[0128] As an example of the validation procedure, consider the following. The BASE model is run to forecast annually to 2000 using only information available in 1995. Native supply/demand shapers based on 1989-1994 data and annual exchange rate forecasts are employed. The resulting annual forecasts are then compared with actual annual data from 1996, 1997, 1998, and 1999 for farm prices, milk and commodity production, trade, etc. The accuracy of the model can then be assessed and the model assumptions (e.g., supply/demand trends) refined accordingly. The focus is on near-term assumptions as these will affect the accuracy of the shorter-term forecasts.

[0129] The model is run again with the refined parameters and the validation process repeated until the model solutions conform acceptably to the actual data. When this occurs, the model is deemed to be refined sufficiently for its forecasts to be used for comparison with model results under various policy scenarios. The refined BASE model 310 yields forecasted optimal regional milk/commodity production and consumption, commodity trade flow, milk/commodity prices and implicit component prices (fat, casein, whey protein and lactose), among other forecasted world dairy sector attributes.

[0130] The validated model is run to forecast out 5 years, updating the next year forecast with the current model solution (see, e.g., FIG. 3 sample output table, also including validations). Thus the model produces five years worth of annual forecasts that can be updated periodically as new data are acquired.

[0131] Step III: Running the Updated Model Under a Plurality of Scenarios to Forecast the Effects of Each of the Scenarios on the World Dairy Sector Attributes 300.

[0132] The BASE simulation described in the previous section, provides a reasonably good representation of world dairy markets. For that reason, it may be used as a benchmark to compare results from other simulations 340. The model is modified to reflect various policy scenarios and run to generate world dairy sector attributes under each of the policy scenarios 320, and these forecast results 330 are then compared with those of the BASE run in order to determine the effects of each of the policies on the world dairy sector 340.


[0134] The policy parameters of the BASE model are adjusted according to each policy scenario and the model solved (examples of several domestic and trade policy scenarios are given above in the section on the model and policy scenarios). The model is run to simulate the effects of a policy and generates annualized (and optionally also longer-term) forecasts of various attributes of the world dairy sector including supply and demand trends and exchange rate changes.

[0135] Compare Forecast Results with those of the BASE Run to Determine Policy Effects 340.

[0136] Output files are generated from each policy scenario 330 run and compared with the BASE solutions 340 in order to solve for the effects of the policy scenario. Sample output tables are given in FIGS. 4 and 5, by way of example of the effects of various policy scenarios on the world dairy sector attributes of farm milk prices and maximum allowable subsidized exports (note that the output may be summarized in a variety of ways beside of table format, including graphs and the like). Other attributes may be likewise summarized. Please note that though FIG. 1 depicts the forecasting of three policy scenarios at 330, any number of scenarios may be run.

[0137] Other Embodiments

[0138] While the above description contains many specificities, these should not be construed as limitations on the scope of the invention, but rather as an exemplification of various embodiments thereof. The above-described embodiments are set forth by way of example and are not for the purpose of limiting the present invention. It will be readily apparent to those skilled in the art that obvious modifications, derivations and variations can be made without departing from the scope of the invention. For example,

[0139] a) the database of the present invention may include private sources of information in addition to the publicly available sources;

[0140] b) other public sources of data may be used in addition to those described above;

[0141] c) regions may be formed by aggregating countries differently than described herein;
[0142] d) dairy components may be aggregated in different ways to the various categories of commodities; and,

[0143] e) the parameters of the model may be modified to reflect a variety of policy, as well as non-policy scenarios.

[0144] Accordingly, the scope of the invention should be determined not by the examples given, but by the appended claims and their legal equivalents.

We claim:

1. A method of forecasting the effects of a plurality of trade policy and supply and demand scenarios on a plurality of attributes of the world dairy sector across a plurality of regions, the method comprising:
   creating a database of world dairy sector data, the data comprising a plurality of factors pertaining to dairy primary, intermediate and processed commodities including components thereof;
   refining an hedonic spatial equilibrium model of the world dairy sector using the world dairy sector data; and,
   running the refined model under the plurality of scenarios to forecast the effects of each of said scenarios on the world dairy sector attributes on at least an annualized basis.

2. The method of claim 1, wherein said plurality of attributes of the dairy sector comprise prices, production, consumption, trade flows and welfare of producers, consumers and taxpayers.

3. The method of claim 1, wherein said plurality of regions comprise the United States, Mexico, China (including Hong Kong, Taiwan, Macao and Mongolia), India, Japan, Australia, New Zealand, western Europe (all western European countries including Malta), eastern Europe, the former Soviet Union countries, Korea (north and south), Southeast Asia (countries to the east of and including Myanmar), Other South Asian countries, Middle East (excluding Cyprus), North Africa, Republic of South Africa, Canada, South America (excluding Argentina, Chile, Uruguay), South America (Argentina, Chile, Uruguay), Central America and Caribbean countries (excluding Mexico) and a remainder category of mostly Sub-Saharan Africa countries.

4. The method of claim 1, wherein said primary commodities comprise cow, buffalo, camel, sheep and goat milk and said components comprise fats, casein proteins, whey proteins, other nonfat solids and further fractionations thereof.

5. The method of claim 1, wherein said processed commodities comprise cheeses, butters, whole milk powders, skim milk powders, dry wheys, caseins, condensed milks, evaporated milks and other dairy products.

6. The method of claim 1, wherein said intermediate commodities comprise butters, skim milk powders, whole milk powders, condensed milks, evaporated milks, caseins, dry wheys, milk protein concentrates and other products embodying fractionated milk components.

7. The method of claim 1, wherein one of said plurality of scenarios comprises a base scenario to reflect recent world economic conditions.

8. A method of forecasting the effects of a plurality of trade policy and supply and demand scenarios on a plurality of attributes of the world dairy sector across a plurality of regions, the method comprising:
   creating a database of world dairy sector data, the data comprising a plurality of factors pertaining to dairy primary, intermediate and processed commodities including components thereof, creating the database comprising:
   compiling the data;
   transforming the data to be usable by an hedonic spatial equilibrium model of the world dairy sector; and,
   updating the data;
   refining the model using the world dairy sector data, refining the model comprising:
   running the model under a base scenario to forecast the plurality of world dairy sector attributes under a set of recent world economic conditions;
   calibrating a portion of the data, said portion comprising at least price data;
   re-running the model using the calibrated data; and,
   validating the model; and,
   running the refined model under the plurality of scenarios, comprising the base scenario and a plurality of non-base scenarios, to forecast the effects of each of said non-base scenarios on the world dairy sector attributes on an annualized basis as a difference between a scenario’s forecast and the base forecast.

9. The method of claim 8, wherein said plurality of attributes of the dairy sector comprise prices, production, consumption, trade flows and welfare of producers, consumers and taxpayers.

10. The method of claim 8, wherein said plurality of regions comprise the United States, Mexico, China (including Hong Kong, Taiwan, Macao and Mongolia), India, Japan, Australia, New Zealand, western Europe (all western European countries including Malta), eastern Europe, the former Soviet Union countries, Korea (north and south), Southeast Asia (countries to the east of and including Myanmar), Other South Asian countries, Middle East (excluding Cyprus), North Africa, Republic of South Africa, Canada, South America (excluding Argentina, Chile, Uruguay), South America (Argentina, Chile, Uruguay), Central America and Caribbean countries (excluding Mexico) and a remainder category of mostly Sub-Saharan Africa countries.

11. The method of claim 8, wherein said primary commodities comprise cow, buffalo, camel, sheep and goat milk and said components thereof comprise fats, casein proteins, whey proteins, other nonfat solids and further fractionations thereof.

12. The method of claim 8, wherein said processed commodities comprise cheeses, butters, whole milk powders, skim milk powders, dry wheys, caseins, condensed milks, evaporated milks and other dairy products.

13. The method of claim 8, wherein said intermediate commodities comprise butters, skim milk powders, whole milk powders, condensed milks, evaporated milks, caseins, dry wheys, milk protein concentrates and other products embodying fractionated milk components.
14. The method of claim 8, wherein one of said plurality of scenarios comprises a base scenario to reflect recent world economic conditions.

15. A method of forecasting the effects of a plurality of trade policy and supply and demand scenarios on a plurality of attributes of the world dairy sector, the method comprising:

running an hedonic spatial equilibrium model of the world dairy sector, the model inputting data from a database of world dairy sector data, the data comprising a plurality of factors pertaining to a plurality of dairy commodities, said commodities including primary, intermediate and processed dairy commodities and components thereof;

refining the model using the world dairy sector data, refining the model comprising:

running the model under a base scenario to forecast the plurality of world dairy sector attributes under a set of recent world economic conditions;

calibrating a portion of the data, said portion comprising at least price data;

re-running the model using the calibrated data; and,

validating the model; and,

running the refined model under the plurality of scenarios, comprising the base scenario and at least one of a plurality of non-base scenarios, to forecast the effects of the at least one non-base scenarios on the world dairy sector attributes on an annualized basis as a difference between said at least one non-base scenario’s forecast and the base forecast.

16. The method of claim 15, wherein running the spatial hedonic model comprises:

calculating an amount of surplus across the plurality of dairy commodities and a plurality of geographic regions by adding producer and consumer surplus;

subtracting a cost of transporting and processing said plurality of dairy commodities across the regions;

subtracting a value reflecting the net effects of a plurality of classical trade distortions;

modifying the foregoing analysis by a set of values reflecting price distortions and quantity restrictions generated by the at least one non-base scenario; and,

subjecting the preceding calculations to at least one of a plurality of constraints dependent on the at least one policy scenario.

17. In a method of forecasting the effects of a plurality of trade policy and supply and demand scenarios on a plurality of attributes of the world dairy sector by running an hedonic spatial equilibrium model of the world dairy sector, an improvement to further optimize the model results comprising:

incorporating into the model a plurality of factors pertaining to a plurality of intermediate dairy commodities that may be reconstituted for use in the production of a plurality of final dairy commodities, the plurality of factors comprising:

cost of processing the intermediate commodities into the final commodities;

shipments of the intermediate commodities under within and over quota tariffs and export subsidies;

expanded component balance incorporating the conversion of the intermediate commodities into final commodities; and, expanded trade balance, import quota, export subsidy and non-negativity constraints of the model that include the intermediate and reconstituted final commodities and trade flows;

whereby milk reconstitution technology is reflected in the model.

18. A method of modeling the regional effects of a plurality of trade policy and supply and demand scenarios on a plurality of attributes of the world dairy sector by solving for a market equilibrium value over a plurality of regions under at least one of said policy scenarios, the method comprising:

calculating an amount of surplus across a plurality of dairy commodities and the plurality of regions by adding producer and consumer surplus, the plurality of dairy commodities comprising primary, intermediate and processed commodities;

subtracting a cost of transporting and processing said plurality of commodities across the regions;

subtracting a value reflecting the net effects of a plurality of classical trade distortions;

modifying the foregoing analysis by a set of values reflecting price distortions and quantity restrictions generated by the at least one of said policy scenarios; and,

subjecting the preceding calculations to at least one of a plurality of constraints dependent on the at least one policy scenario.

19. The method of claim 18, wherein said plurality of regions comprise the United States, Mexico, China (including Hong Kong, Taiwan, Macao and Mongolia), India, Japan, Australia, New Zealand, western Europe (all western European countries including Malta), eastern Europe, the former Soviet Union countries, Korea (north and south), Southeast Asia (countries to the east of and including Myanmar), Other South Asian countries, Middle East (including Cyprus), North Africa, Republic of South Africa, Canada, South America (excluding Argentina, Chile, Uruguay), South America (Argentina, Chile, Uruguay), Central America and Caribbean countries (excluding Mexico) and a remainder category of mostly Sub-Saharan Africa countries.

20. The method of claim 18, wherein said primary commodities comprise cow, buffalo, camel, sheep and goat milk and said components thereof comprise fats, casein proteins, whey proteins, other nonfat solids and further fractionations thereof.

21. The method of claim 18, wherein said processed commodities comprise cheeses, butters, whole milk powders, skin milk powders, dry whey, caseins, condensed milks, evaporated milks and other dairy products.

22. The method of claim 18, wherein said intermediate commodities comprise butters, skin milk powders, whole milk powders, condensed milks, evaporated milks, caseins,
dry wheys, milk protein concentrates and other products embodying fractionated milk components.

23. The method of claim 18, wherein said cost of transporting and processing is calculated by adding a cost of transforming said primary commodities into said intermediate commodities, a cost of processing said intermediate commodities into said processed commodities, a cost of transporting and marketing said primary commodities between regions, and a cost of transporting and marketing said intermediate and said processed commodities between regions.

24. The method of claim 18, wherein said plurality of classical trade distortions comprise within and over quota tariffs, export subsidies and production and import quotas.

25. The method of claim 18, wherein said plurality of constraints dependent on the at least one policy scenario comprise component balance, trade balance, import quotas, export subsidies, trade flows and non-negativity constraints.