REGIONAL ECONOMIES

# A FREE TRADE AGREEMENT AMONG FORMER SOVIET REPUBLICS: A COMPUTABLE GENERAL EQUILIBRIUM MODEL

**Michael P. BARRY**

*J.D., an Associate Professor of Economics and Law at Mount St. Mary's University (Emmitsburg, Maryland, the U.S.)*

## *Introduction*

What would happen to the economies of the former Soviet Union if they finally implemented a full-fledged free trade agreement? How would this change sector output, GDP, prices, international trade, and the economic welfare of the nation? How would it affect the economies of the FSU's other trading partners? This paper attempts to address these and other issues through the use of a computable general equilibrium model (CGE). The model is a large, multi-regional, multi-sectoral, multi-factor system of simultaneous equations. It introduces the "shock" of zero tariffs between all FSU's trading partners, and solves for a new economic equilibrium. There are some political and practical obstacles to the completion of such a trade agreement, so this mathematical model in some ways is just a hypothetical experiment. But an analysis of trade effects can nonetheless be useful to any policymaker in the former Soviet space.

# 1. CGE Model for FSU Trade

How would a FSU free trade agreement change the FSU economies and those of the globe? This section will develop a computable general equilibrium model to quantify the macroeconomic effects of lowering all import tariffs between FSU trading partners to zero. The section is broken into several parts, including:

(a) a background of CGE models;

(b) the Global Trade Analysis Project (GTAP);

(c) the structure of this paper's model;

(d) model results;

(e) model limitations and future research.

## *1.1. Background of General Equilibrium Models*

General equilibrium, a concept which dates back to Leon Walras (1834-1910), is a pillar of modern economic thought. General equilibrium recognizes that there are many markets in an economy, and that these markets all interact in complex ways with each other. In rough terms, everything depends on everything else. Demand for any one good depends on the prices of all other goods and on income. Income, in turn, depends on wages, profits, and rents, which depend on technology, factor supplies and production, the last of which, in its turn, depends on sales (i.e., demand). Prices depend on wages and profits and vice versa.[1]

Computable General Equilibrium (CGE) modeling specifies all economic relationships in mathematical terms and puts them together in a form that allows the model to predict the change in variables such as prices, output and economic welfare resulting from a change in economic policies. To do this, the model requires information about technology (the inputs required to produce a unit of output), policies and consumer preferences. The key of the model is "market clearing," the condition that says supply should equal demand in every market. The solution, or "equilibrium," is that set of prices where supply equals demand in every market— goods, factors, foreign exchange, and everything else.[2]

A CGE model is a closed system. This means that no production or financial flow escapes the system and none are created outside of the system. In basic closure terms, we assume output will equal income. Households, businesses, the government, and the financial sector, and the foreign sector are all connected by real flows and financial flows. Intuitively, the idea of a "general" equilibrium is captured; any given market is connected to all of the other markets for the system.

Over the last 25 years, CGE models have become an important tool for analyzing economic issues, including trade policy, taxation policy, technological growth, energy policy, environmental issues, and even warfare. This development is explained by the ability of CGE models to provide an elaborate and realistic representation of the economy, including the linkages between all agents, sectors and other economies. While this complete coverage permits a unique insight into the effects

[1] See: T. Hertel, R. Keeney, M. Ivanic, A. Winters, "Distributional Effects of WTO Agricultural Reforms in Rich and Poor Countries," *Economic Policy*, April 2007, pp. 289-337.

[2] See: Ibidem.

of changes in the economic environment throughout the whole economy, single country, and especially global CGE models very often include an enormous number of variables, parameters and equations.[3]

CGE modeling is a very powerful tool, allowing economists to explore numerically a huge range of issues on which econometric estimation would be impossible; in particular, to forecast the effects of future policy changes. The models have their limitations, however.

- First, CGE simulations are not unconditional predictions but rather "thought experiments" about what the world would be like if the policy change had been operative in the assumed circumstances and year. The real world will doubtless have changed by the time we get there.
- Second, while CGE models are quantitative, they are not empirical in the sense of econometric modeling: they are basically theoretical, with limited possibilities for rigorous testing against experience.
- Third, conclusions about trade and other policies are very sensitive to data assumption.

One can readily do sensitivity analysis on the parameter values assumed for economic behavior, although less so on the data, because altering one element of the base data requires compensating changes elsewhere in order to keep the national accounts and social accounting matrix in balance. Of course, many of these criticisms apply to other types of economic modeling, and therefore, while imperfect, CGE models remain the preferred tool for analysis of many global issues.

## 1.2. The Global Trade Analysis Project

One of the most widely-used CGE models is the GTAP Model. The Global Trade Analysis Project (GTAP), with headquarters at Purdue University, has organized a consortium of national and international agencies which provide guidance and base-level support for the Project.[4]

GTAP is a multi-regional CGE model which captures world economic activity in 57 different industries of 66 regions. The underlying equation system of GTAP includes two different kinds of equations. One part covers the accounting relationships which ensure that receipts and expenditures of every agent in the economy are balanced. The other part of the equation system consists of behavioral equations which based upon microeconomic theory. These equations specify the behavior of optimizing agents in the economy, such as demand functions.[5] Input-output tables summarize the linkages between all industries and agents.

The mathematical relationships assumed in the GTAP model are simplified, though they adhere to the principle of "many markets." The simplification is that thousands of markets are "aggregated" into groups. For example, "transport and communications services" appear as a single industry. In principle all the relationships in a model could be estimated from detailed data on the economy over many years. In practice, however, their number and parameterization generally outweigh the data available. In the GTAP model, only the most important relationships have been econometrically estimated. These include the international trade elasticities and the agricultural factor supply and demand elasticities. The remaining economic relationships are based on literature reviews.

[3] See: M. Brockmeier, "A Graphical Exposition of the GTAP Model," *GTAP Technical Paper*, No. 8, October 1996, Minor Edits, January 2000, Revised, March 2001.

[4] See: *Global Trade Analysis Project (GTAP)*, Department of Agricultural Economics, Purdue University, 2008, available at [https://www.gtap.agecon.purdue.edu/about/consortium.asp].

[5] See: M. Brockmeier, op. cit.

### 1.3. Structure of This Paper's Model

The model employed in this paper is that of the GTAP project. While the core database has 57 sectors and 66 regions, we have aggregated the matrices to simplify the world into just nine sectors (plus capital investment goods), nine regions, and five factors of production. This aggregation is described in Table 1.

*Table 1*

**Aggregation Used in the Model**

| Regions | Sectors | Factors |
|---|---|---|
| Russia | Grain Crops | Land |
| Armenia | Meat and Livestock | Unskilled Labor |
| Azerbaijan | Extraction Industries | Skilled Labor |
| Georgia | Processed Food | Capital |
| Kazakhstan | Light Manufacturing | Natural Resources |
| Kyrgyzstan | Heavy Manufacturing | |
| Ukraine | Utilities and Construction | |
| Rest of Former Soviet Union | Transport and Communication | |
| Rest of World | Other Services | |
| | Capital Goods | |

*Source:* Generated by the author.

The data is, first, "calibrated," meaning the model is solved for its original equilibrium prices and volumes in all markets. This baseline is meant to represent the economy as is, before any shock takes place. Thousands of equations are created, each representing supply and demand conditions in markets inside each region, including markets for goods, services, factors of production, savings, government expenditure, and more. Equations are also generated for trade of all goods between each of the regions, separately created for each industry. The calibrated result is a large set of simultaneous equations, of which the solution matches the existing prices and quantity levels of the economy.

A "shock" is then introduced to system. Mathematically, a "shock" is the alteration of a single parameter or variable in the giant system. That change acts like a stone thrown in a pond, with waves created throughout every one of the thousands of equations in the system. The model is re-solved with the one autonomous change, and the effects on the system are then measured.

The "shock" in this model is the elimination of all tariffs between the trading partners of the former Soviet Union. The change in relative prices can lead to shifting production between sectors, lower production costs, increased output, and many more effects. Effects include changes in production and allocation efficiencies, GDP, employment, consumption, imports, exports, and overall eco-

nomic welfare. The role of a CGE model is to trace and quantify the direction and magnitude of these changes.[6]

# 2. Model Results

A computable general equilibrium model can generate an enormous array of matrix results. In this model, results are grouped into the following sections:

(1) market prices;

(2) output and income

(3) factor markets;

(4) international trade; and

(5) welfare effects.

## 2.1. Market Prices

According to the model results, a regional free trade agreement among former Soviet republics would raise aggregate prices in most of the countries involved. The greatest aggregate price increases would occur in Kyrgystan (9.79 percent), Georgia (5.75 percent), and Armenia (1.64 percent). Aggregate prices would decrease in Ukraine (–1.15 percent) and in the rest of the former Soviet Union as a whole (–1.11 percent). Aggregate price changes are presented in Table 2.

*Table 2*

**Aggregate Price Index**

| pgdp | Percent change |
|---|---|
| Russia | 0.18 |
| Armenia | 1.64 |
| Azerbaijan | 0.16 |
| Georgia | 5.75 |
| Kazakhstan | 0.15 |
| Kyrgyzstan | 9.79 |
| Ukraine | –1.15 |
| Rest of FSU | –1.11 |
| Rest of World | –0.01 |

*Source:* Generated by the author.

[6] For more on economic efficiency and taxation, see: C.R. McConnell, S.L. Brue, *Economics: Principles, Problems, and Policies*, 16th Ed., McGraw Hill Publishing, 2006.

Free trade agreemetns can affect prices in all sectors. Many former Soviet republics have already embraced freer trade. In this model, the largest trade effects captured are those among Soviet successor-states and in sectors where tariffs are not already zero. Ukraine and the Rest of FSU are making the largest tariff concessions, yet the largest price changes appear in Kyrgystan and Georgia. This appears to be a case of trade diversion, where, for example, Ukrainian imports shift from the rest of the world to sources within the former Soviet Union.

Price effects can be seen across regions. It is striking that in almost all sectors, prices would increase in all regions, except for Ukraine. Perhaps more striking is how little overall market prices change in most sectors. The largest changes appear to be price rise in Kyrgystan and Georgia. In Kyrgystan, for example, large price increases are seen in utilities and construction (8.09 percent), meat and livestock (7.92 percent), other services (7.41 percent), grains and other crops (7.06 percent), and transport and communications (7.02 percent). Large price increases in Georgia appear in meat and livestock (5.85 percent), grains and other crops (5.54 percent), other services (5.43 percent), and transport and communications (5.02 percent). Market prices across regions are presented in Table 3. Prices of imports across regions are shown in Table 4.

*Table 3*

**Market Price of Output**
**(*percent change*)**

| pm | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| GrainsCrops | 0.32 | 1.58 | 0.66 | 5.54 | 0.45 | 7.06 | –0.26 | 1.03 | –0.01 |
| MeatLstk | 0.23 | 1.5 | 0.49 | 5.85 | 0.27 | 7.92 | –0.8 | 1.19 | –0.01 |
| Extraction | 0.06 | 0.43 | 0.06 | 0.87 | 0.06 | 2.5 | 0.04 | 0.18 | 0.03 |
| ProcFood | 0.2 | 1.41 | 0.31 | 4.83 | 0.11 | 6.18 | –1.47 | –2.28 | 0 |
| LightMnfc | 0.16 | 1.23 | 0.11 | 4.07 | 0.09 | 4.29 | –0.43 | 0.5 | 0 |
| HeavyMnfc | 0.14 | 0.53 | 0.06 | 3.85 | 0.09 | 6.59 | –0.13 | 0.16 | 0 |
| Util_Cons | 0.17 | 1.42 | 0.09 | 4.04 | 0.12 | 8.09 | –0.02 | 0.58 | 0 |
| TransComm | 0.2 | 1.29 | 0.13 | 5.02 | 0.13 | 7.02 | 0 | 0.63 | –0.01 |
| OthServices | 0.21 | 1.42 | 0.13 | 5.43 | 0.11 | 7.41 | –0.04 | 0.8 | –0.01 |
| CGDS | 0.13 | 1.12 | 0.07 | 1.79 | 0.12 | 4.91 | –0.53 | –0.25 | 0 |

*Source:* Generated by the author.

*Table 4*

**Market Price of Aggregate Imports**
**(*percent change*)**

| pim | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| GrainsCrops | 0.17 | 1.21 | 0.36 | 0.2 | 0.11 | 0.23 | –3.46 | –0.96 | 0 |
| MeatLstk | –0.04 | 0.08 | 0 | 0.02 | 0.08 | 0.04 | –0.38 | –0.6 | 0 |
| Extraction | 0.04 | 0.04 | 0.06 | 0.06 | 0.1 | 0.1 | 0.06 | –0.03 | 0.03 |
| ProcFood | –0.09 | –0.2 | –0.1 | –0.18 | 0.01 | –0.04 | –21.72 | –44.55 | –0.01 |
| LightMnfc | –0.02 | 0.06 | 0.02 | –0.38 | 0.01 | 0.01 | –0.99 | –0.13 | 0 |
| HeavyMnfc | 0 | 0.08 | –0.2 | –0.21 | 0.05 | 0.04 | –1.23 | –2.19 | 0 |
| Util_Cons | 0.05 | 0 | 0.01 | 0.46 | 0.53 | 0.15 | –0.01 | 0.47 | 0.01 |
| TransComm | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OthServices | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Source:* Generated by the author.

## 2.2. Factor Prices

According to the model results, a regional free trade agreement among former Soviet republics would also affect the prices of factors of production. The largest factor price increases (in prcentage terms) appear in Kyrgyzstan and Georgia. In Kyrgystan, the model suggests that the price increases include those for capital (11.97 percent), skilled labor (10.9 percent), unskilled labor (10.34 percent). In Georgia, price increases include those for land (8.86 percent), unskilled labor (7.1 percent), skilled labor (6.44 percent), and capital (6.15 percent). In both Geogria and Kyrgystan, prices on natural resources are estimated to decrease significantly (34.34 percent and 20.50 percent, respectively). The land price changes are the result of a significant increase in agricultural imports in both Kyrgystan and Georgia (as refelected in a later section). Factor prices in all regions are presented in Table 5.

*Table 5*

**Market Price of Factors of Production**
**(*percent change*)**

| pm | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| **Land** | **0.56** | **1.58** | **1.75** | **8.86** | **3.16** | **1.44** | **0.97** | **1.97** | **–0.01** |
| **UnSkLab** | **0.28** | **2.03** | **0.42** | **7.1** | **0.19** | **10.34** | **0.19** | **2.43** | **–0.01** |
| **SkLab** | **0.22** | **1.9** | **0.24** | **6.44** | **0.11** | **10.9** | **–0.03** | **2.24** | **–0.01** |
| **Capital** | **0.23** | **1.69** | **0.22** | **6.15** | **0.1** | **11.97** | **0.12** | **2.25** | **–0.01** |
| **NatRes** | **–0.41** | **–7.56** | **–0.31** | **–34.34** | **–0.2** | **–20.5** | **0.77** | **–3.18** | **0.15** |

*Source:* Generated by the author.

## 2.3. Output and Income

Results of the model suggest significant output changes in selected sectors across regions. Georgia and Kyrgyzstan expereince the largest sectoral shifts in output. In Georgia, given significant trade diversion, large output decreases are seen in heavy manufacturing (19.85 percent decrease), light manufacturing (–14.87 percent), and the extraction industries (–7.49 percent). Georgia experiences a large increase in the processed food sector (36.50 percent).

Output decreases in Kyrgystan include those in light manufacturing (–12.1 percent), processed food (–8.28 percent), grains and other crops (–4.65 percent), and extraction (–3.76 percent). Factors of production in Kyrgyzstan shift to other industries, where output significantly increases, including heavy manufacturing (8.28 percent). Output changes are presented in Table 6 and Table 7.

Real GDP changes appear the largest (in percentage terms) in Georgia (0.62 percent increase) and Kyrgyzstan (0.84 percent). Private consumption also increases the most in Kyrgyzstan (6.15 per-

*Table 6*

**Change in Output**
**(*percent change*)**

| qo | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| GrainsCrops | 0.12 | –0.14 | 0.42 | –0.24 | 1.87 | –4.65 | –0.07 | –0.97 | 0 |
| MeatLstk | –0.1 | 0.04 | –0.44 | 1.25 | –0.11 | 1.7 | 0.88 | 2.11 | 0 |
| Extraction | –0.08 | –1.57 | –0.07 | –7.49 | –0.04 | –3.76 | 0.07 | –0.61 | 0.02 |
| ProcFood | 0.38 | 3.56 | –0.12 | 36.5 | –1.24 | –8.28 | 1.61 | 17.83 | –0.03 |
| LightMnfc | 0.53 | –6.32 | 0.07 | –14.87 | 0.03 | –12.1 | 1.06 | –0.64 | 0 |
| HeavyMnfc | 0.11 | –2.16 | 0.25 | –19.85 | 0.25 | 8.28 | –0.1 | –1.16 | 0 |
| Util_Cons | 0.03 | 0.16 | 0.04 | 2.02 | 0.07 | –0.94 | 0.17 | 0.49 | 0 |
| TransComm | –0.04 | –0.52 | –0.05 | –2.09 | –0.08 | –0.45 | 0 | 0.69 | 0 |
| OthServices | –0.06 | –0.19 | –0.06 | –0.34 | –0.05 | –1.03 | –0.46 | –0.49 | 0 |
| CGDS | 0.08 | 0.95 | 0.1 | 5.59 | –0.04 | 16.38 | 1 | 2.04 | –0.01 |

*Source:* Generated by the author.

*Table 7*

**Change in Output**
**(*millions of dollars*)**

| | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| **GrainsCrops** | **29.9** | **–0.7** | **4.9** | **–1.7** | **69.0** | **–21.0** | **–4.1** | **–31.1** | **–6.5** |
| **MeatLstk** | **–39.3** | **0.2** | **–1.5** | **11.4** | **–6.9** | **7.2** | **38.4** | **48.9** | **–26.9** |
| **Extraction** | **–113.2** | **–3.1** | **–2.8** | **–19.1** | **–7.6** | **–1.8** | **3.5** | **–81.7** | **357.0** |
| **ProcFood** | **131.1** | **34.7** | **–1.1** | **233.5** | **–59.9** | **–14.4** | **125.2** | **146.3** | **–779.3** |
| **LightMnfc** | **288.1** | **–27.2** | **0.2** | **–49.4** | **1.0** | **–20.5** | **102.7** | **–8.9** | **–319.0** |
| **HeavyMnfc** | **214.6** | **–7.5** | **5.7** | **–145.0** | **39.7** | **75.8** | **–36.9** | **–66.6** | **–107.0** |
| **Util_Cons** | **44.6** | **2.3** | **2.4** | **17.6** | **8.6** | **–13.6** | **58.3** | **50.1** | **–104.0** |
| **TransComm** | **–78.3** | **–4.5** | **–1.3** | **–38.4** | **–17.6** | **–2.9** | **–0.3** | **36.3** | **154.0** |
| **OthServices** | **–110.9** | **–1.5** | **–1.3** | **–5.1** | **–8.7** | **–5.6** | **–120.5** | **–26.7** | **130.0** |
| **CGDS** | **81.8** | **7.1** | **5.1** | **74.9** | **–3.8** | **51.9** | **134.6** | **78.1** | **–454.0** |

*Source:* Generated by the author.

cent) and Georgia (2.84 percent). Real GDP changes are shown in Table 8. Changes in private consumption are presented in Table 9.

*Table 8*

**Real GDP**

| qgdp | Percent change |
|---|---|
| Russia | 0 |
| Armenia | 0.08 |
| Azerbaijan | 0.01 |
| Georgia | 0.62 |
| Kazakhstan | 0 |
| Kyrgyzstan | 0.84 |
| Ukraine | –0.01 |
| Rest of FSU | 1.19 |
| Rest of World | 0 |

*Source:* Generated by the author.

*Table 9*

**Private Consumption**

| ypev | Percent change |
|---|---|
| Russia | 0.02 |
| Armenia | 0.67 |
| Azerbaijan | 0.07 |
| Georgia | 2.84 |
| Kazakhstan | 0.01 |
| Kyrgyzstan | 6.15 |
| Ukraine | –0.26 |
| Rest of FSU | 1.37 |
| Rest of World | 0 |

*Source:* Generated by the author.

## *2.4. International Trade*

According the CGE model results, regions with the largest decreases in trade balances include Ukraine (–$141.80 million), Kyrgyzstan (–$113.30 million), Georgia (–$113.35 million). Trade bal-

ance improvements shifted to Russia ($96.50 million) and the rest of the world ($322.10 million). Trade balance changes are presented in Table 10 and Table 11.

*Table 10*

**Change in Trade Balance**

| DTBAL | Millions of Dollars |
|---|---|
| Russia | 96.51 |
| Armenia | –18.32 |
| Azerbaijan | –7.08 |
| Georgia | –113.35 |
| Kazakhstan | 8.54 |
| Kyrgyzstan | –113.38 |
| Ukraine | –141.8 |
| Rest of FSU | –43.2 |
| Rest of World | 332.1 |

*Source:* Generated by the author.

*Table 11*

**Change in Trade Balance by Sector (*millions of dollars*)**

| DTBALi | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| GrainsCrops | 3.09 | –1.58 | 4.85 | –31.75 | 69.17 | –24.61 | –42.82 | –49.33 | 67.05 |
| MeatLstk | –22.76 | –1.77 | –0.95 | –9.47 | –0.88 | –6.47 | 18.6 | –4.41 | 25.46 |
| Extraction | –223.68 | –0.84 | –5.94 | –3.52 | –13.43 | –5.26 | –5.58 | –68.91 | 325.73 |
| ProcFood | 117.63 | 27.18 | –0.42 | 210.54 | –55.01 | –22.44 | 27.25 | 273.9 | –605.72 |
| LightMnfc | 248.19 | –20.76 | –0.61 | –53.17 | 2.71 | –50.39 | 15.1 | –48.01 | –111.78 |
| HeavyMnfc | 185.73 | –7.62 | 3.27 | –143.22 | 15.05 | 79.89 | –168.26 | –88.81 | 68.21 |
| Util_Cons | –36.41 | –2.52 | –3.62 | –4.56 | 0.15 | –30.74 | –0.82 | –25.39 | 103.92 |
| TransComm | –89.97 | –5.99 | –1.66 | –43.48 | –3.33 | –26.25 | 2.43 | –14.41 | 294.24 |
| OthServices | –85.31 | –4.43 | –2.01 | –34.72 | –5.87 | –27.1 | 12.3 | –17.83 | 164.99 |

*Source:* Generated by the author.

Exports by region and by sector are presented in Table 12, and imports by region and by sector are shown in Table 13.

*Table 12*

**Exports by Sector (*percent change*)**

| qxw | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| GrainsCrops | 2.41 | –2.21 | 5.17 | –12.83 | 8.47 | –25.53 | 1.56 | –3.91 | 0.01 |
| MeatLstk | 0.49 | –4.82 | –2.32 | 60.97 | –1.12 | –40.52 | 5.74 | –7.23 | 0.02 |
| Extraction | –0.3 | –4.4 | –0.29 | –7.55 | –0.16 | –19.34 | 0.05 | –1.37 | 0.05 |
| ProcFood | 3.57 | 40.41 | 1.38 | 141.11 | –19.84 | –21.43 | 25.92 | 651.71 | –0.17 |
| LightMnfc | 2.49 | –7.82 | 0.2 | –22.28 | 4.05 | –14.68 | 2.92 | –0.7 | –0.01 |
| HeavyMnfc | 0.41 | –2.38 | 1.43 | –22.95 | 0.66 | 23.23 | 0.9 | 3.15 | 0 |
| Util_Cons | –0.65 | –4.32 | –0.24 | –16.7 | –0.42 | –19.92 | 0.17 | –2.48 | 0.12 |
| TransComm | –0.54 | –3.43 | –0.31 | –11.55 | –0.26 | –21.71 | 0.02 | –1.73 | 0.03 |
| OthServices | –0.81 | –5.24 | –0.51 | –18.21 | –0.44 | –23.79 | 0.14 | –2.99 | 0.01 |

*Source:* Generated by the author.

*Table 13*

**Imports by Sector (*percent change*)**

| qim | Russia | Armenia | Azerbaijan | Georgia | Kazakhstan | Kyrgyzstan | Ukraine | RestFSU | ROW |
|---|---|---|---|---|---|---|---|---|---|
| GrainsCrops | 0.37 | 0.82 | 0.52 | 15.39 | 0.69 | 18.97 | 7.51 | 8.57 | –0.02 |
| MeatLstk | 0.73 | 4.29 | 0.93 | 18.56 | 0.55 | 33.48 | –0.85 | 7.05 | –0.01 |
| Extraction | 0.18 | –0.61 | 0.04 | –2.3 | –0.08 | 3.03 | –0.04 | 1.1 | –0.01 |
| ProcFood | 0.56 | 3.97 | 0.59 | 10.58 | 0.15 | 11.27 | 45.34 | 100.66 | 0 |
| LightMnfc | 0.4 | 0.49 | 0.09 | 5.63 | 0.08 | 6 | 1.05 | 1.93 | 0 |
| HeavyMnfc | 0.4 | 0.34 | 0.33 | 3.59 | 0.25 | 12.53 | 2.17 | 4.95 | –0.01 |
| Util_Cons | 0.33 | 3.07 | 0.22 | 7.75 | –0.71 | 25.32 | 0.49 | 0.48 | –0.04 |
| TransComm | 0.38 | 2.58 | 0.24 | 10.02 | 0.21 | 15.42 | –0.07 | 2.18 | –0.01 |
| OthServices | 0.35 | 2.51 | 0.18 | 11.36 | 0.13 | 12.35 | –0.36 | 1.28 | –0.01 |

*Source:* Generated by the author.

### 2.5. Welfare Decomposition

Table 14 presents the overall welfare decomposition from the CGE simulation. The welfare decomposition is essentially a consumer surplus concept, broken down by gains or losses to consumers from efficiency gains, factor endowments, technological improvements, terms of trade effects, and the savings-investment mechanism. According the CGE model results, regions experiencing the largest welfare gains would include the rest of the former Soviet Union ($266 million), Kyrgyzstan ($120.70 million), Russia ($119.90 million), and Georgia ($114.0 million). Sigificantly, Ukraine would experience a net welfare loss of $144.80 million, mostly due to a deterioration in its terms of trade. A terms of trade loss means the relative price of exports to imports would decrease for Ukraine. This essentially signifies that Ukraine would receive fewer imports in exchange for the exports it sells abroad.

*Table 14*

**Welfare Decomposition by Region (*millions of dollars*)**

| WELFARE | Allocative Efficiency | Factor Endowment | Technological Change | Terms of Trade | Savings and Investment | Total |
|---|---|---|---|---|---|---|
| Russia | –26.4 | 0.0 | 0.0 | 242.1 | –95.8 | 119.9 |
| Armenia | 2.7 | 0.0 | 0.0 | 8.8 | 8.6 | 20.1 |
| Azerbaijan | 0.9 | 0.0 | 0.0 | 1.7 | 2.5 | 5.1 |
| Georgia | 27.7 | 0.0 | 0.0 | 64.8 | 21.5 | 114.0 |
| Kazakhstan | –0.4 | 0.0 | 0.0 | 7.7 | –3.3 | 4.1 |
| Kyrgyzstan | 19.0 | 0.0 | 0.0 | 73.4 | 28.3 | 120.7 |
| Ukraine | –7.8 | 0.0 | 0.0 | –119.7 | –17.3 | –144.8 |
| Rest of FSU | 240.3 | 0.0 | 0.0 | 16.6 | 9.3 | 266.2 |
| Rest of World | –78.1 | 0.0 | 0.0 | –299.1 | 45.1 | –332.1 |
| TOTAL | 178.0 | 0.0 | 0.0 | –3.7 | –1.2 | 173.2 |

*Source:* Generated by the author.

# 3. Model Limitations and Future Research

This experiment raises several methodological questions. The first is aggregation of several of the former Soviet republics. A better model would allow for disaggregation of all 15 former republics.

A second issue is the static nature of this CGE model. It is a counterfactual simultaneous equations model which introduces a one-time shock to an economic equilibrium, and then measures a new equilibrium. A more dynamic model would better capture effects over time, such as the accumulation of capital stock, investment flows, and economic growth over a longer period of time.