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Estimating Economic Impacts of the U.S.-South Korea Free Trade Agreement*

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Estimating Economic Impacts of the U.S.-South Korea Free Trade Agreement

Abstract

We analyze the economic impacts of the United States-South Korea Free Trade Agreement by applying the Global Trade Analysis Project (GTAP) computable general equilibrium model to highly disaggregated commodity flow data. The analysis calculates the impacts in terms of welfare effects, national economic indicators (such as GDP), and business performance metrics (such as profits or sales revenue), which can be used by a variety of decision-makers. Our results suggest several trade-offs among these measures. Positive welfare gains between the US and South Korea are about the same in absolute terms, but favor the latter in relative terms, and very heavily so for GDP gains. Moreover, the US is projected to incur a loss of gross output (sales revenue) in several major manufacturing sectors that are heavily concentrated in geographic areas that have been promised a return of jobs by the new Administration.

Keywords: Free Trade Agreement; United States; South Korea; Tariff Barriers; Computable General Equilibrium Modeling; GTAP

ESTIMATING ECONOMIC IMPACTS OF THE U.S.-SOUTH KOREA FREE TRADE AGREEMENT

I. INTRODUCTION

A free trade agreement (FTA) refers to a treaty established between two or more countries in order to reduce the trade barriers between them. Trade barriers, such as import tariffs, trade quotas, and import/export licenses and standards, are government established restrictions on international trade with the aims to protect domestic production and employment, tackle unfair trade practices (such as dumping), protect domestic infant industry, and ensure national security (Elwell, 2006). A FTA usually removes most of these trade barriers in order to improve overall economic efficiency.

As of January 2015, the U.S. had 14 FTAs in force with 20 countries (CBP, 2014). In addition, the Trans-Pacific Partnership (TPP) among 12 Pacific Rim countries (including Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, New Zealand, Peru, Singapore, Vietnam, and U.S.) reached an agreement in October, 2015. The U.S. is also negotiating with the European Union on the Trans-Atlantic Trade and Investment Partnership (ITA, 2015).

However, all these trade agreements are facing great uncertainties due to the inauguration of the new U.S. President, Donald Trump. According to the Trump Administration, U.S. trade policies will be renegotiated or reconsidered with the intent of creating American jobs, increasing American wages, and reducing America's trade deficit.[1] It is clear that the existing FTAs will be under increased scrutiny by the new Administration. In fact, Trump signed an

[1] Donald J. Trump for President, Inc. (2017).

Executive Order withdrawing the U.S. from the TPP immediately after he was sworn in as the President in January 2017. It is therefore important to reassess the economic impacts of the existing trade policies including FTAs to provide a better understanding of the issues in order to inform the policy debate. Most economic analyses in recent years have focused on the impacts of these agreements in terms of welfare effects, considered to be the best measure for evaluating policies, because they are comprehensive and focus on changes in the well-being of the aggregate of individuals in a society (see, e.g., Dixon and Rimmer, 2005; Burfisher, 2011). However, the current policy climate is likely to renew attention to other metrics. This includes national economic indicators, such as GDP, which are less arcane to policymakers and thus more likely to be the focus of attention by executive and legislative branch decision-makers. On the other hand, industry executives and stock market analysts are likely to be more interested in measures of business performance such as profits, sales revenue and market share.

In this study, we evaluate the economic impacts of FTA with considerations of all three of these metrics for the United States-South Korea FTA (US-Korea FTA). Specifically, our assessment is conducted in two steps. In the first step, the direct benefits of the US-Korea FTA are summarized, including the benefits of tariff reduction or elimination policies, as well as the benefits from reduction or removal of non-tariff barriers. In the second step, we present the methodology to analyze the indirect effects of tariff reduction or elimination using the Global Trade Analysis Project (GTAP) computable general equilibrium (CGE) model. Our paper advances the literature on the US-Korea FTA by analyzing both standard welfare measures and broader economic indicators, and by utilizing the most detailed commodity data available. We

decompose welfare effects into three components (allocation, commodity terms of trade, and investment-savings terms of trade effects) and present the macroeconomic impacts in terms of three indicators (GDP, gross output and imports). Both the tariff elimination phase-in schedule and import and export data are specified at the 10-digit Harmonized Tariff Schedule (HTS) level in order to calculate the *actual* (ex post) percentage tariff reduction of each individual commodity as of 2014. In contrast, earlier literature on the economic impacts of the US-Korea FTA have been based on various *assumed* tariff elimination schedules (see, e.g., Cheong and Wang, 1999; McDaniel and Fox, 2001; Choi and Schott, 2005; Lee and Lee, 2005; Schott et al., 2006), some of which are discussed in more detail below.

Our analysis indicates that the US-Korea FTA generates a divergence of outcomes. From the standpoint of the US, welfare gains are estimated to be $368 million, GDP gains are estimated to be $45 million, and total gross output (sales revenue) is estimated to incur a net *loss* of $143 million. Moreover, 34 out of 57 sectors of the US economy are estimated to incur gross output losses. This includes three advanced manufacturing sectors estimated to incur gross output reductions in excess of $175 million each. Ironically, the sectors that are estimated to gain the most are agriculture, mining, construction, and primary manufacturing. These results indicate the continued shift in comparative advantage away from US manufacturing with respect to rising economies such as that of South Korea. Note that the previous estimates of aggregate welfare gains are typically much higher than ours for both countries because most of prior studies focused on 100% tariff removal. Thus, we can consider our aggregate estimates to be on the conservative side. At the sectoral level, there is a strong similarity between ours and

previous studies, and the differences can readily be explained by the change in conditions between their year of analysis and ours.

The rest of this paper is organized as follows. Section II discusses the impacts of a free trade agreement in terms of both tariff reduction/elimination and the removal of other non-tariff trade barriers. Section III provides a summary of the CGE modeling approach of analyzing the impacts of tariff reduction/elimination of an FTA, as well as an overview of the GTAP Model. Section IV summarizes the major data used to compute the weighted average tariff reduction as of 2014 by GTAP sector on both the U.S. and Korea import sides. Section V presents the economic impacts of the US-Korea FTA using three groups of metrics. Section VI provides a summary of this study.

II. IMPACTS OF A FREE TRADE AGREEMENT

The benefits of FTAs can be measured as the prevented overall negative impacts caused by the existence of trade barriers. The direct impacts of government policy interventions on trade, such as an import tariff or quota, can be evaluated using welfare analysis, which analyzes the change in well-being of the population affected by a policy at the aggregate level.

1. Without the tariff, it is cheaper to import from the FTA partner country, and thus there is likely to be an increase in imports from it.

2. It is also likely that imports from non-FTA partner countries will be displaced.

3. U.S. import-competing producers may face a decrease of demand for their products domestically, and thus a potential decrease in producer surplus.

4. There will be a reduction of tariff revenue collected by the U.S. government, but this is simply a transfer rather than a real welfare change

5. There can also be *terms of trade effects*, both a commodity terms of trade effect and an investment-savings terms of trade effect, to be discussed in greater detail below.[2] If the U.S. net imports from the rest of the world decrease, the U.S. terms of trade can be improved, and vice versa (Abe, 2007).

On the U.S. export-side:

6. The elimination of a tariff on U.S. exports shipped to the U.S. FTA partner country will make it cheaper for U.S. firms to export their products, and thus increase U.S. exports. This will increase the overall output of the relevant U.S. exporting sectors directly.

7. There might be a decrease in U.S. exports to non-FTA partner countries.
8. There can also be a terms of trade effect. If the U.S. net exports to the rest of the world increase, the U.S. terms of trade can be improved, and vice versa.

Most of the above direct effects also result in indirect or, more broadly, general equilibrium effects. These include supply-chain pure quantity effects and substitution effects working through price changes in multiple markets. Our analysis measures these effects as well.[3]

[2] The commodity terms of trade refers to the purchasing power of a country's exports with respect to imports (Burfisher, 2011). The exchange rate in real terms is sometimes considered a proxy for the terms of trade, but the two are equivalent only if export and import prices are the same as consumer goods prices.
[3] Although tariff reduction or elimination is the major focus of FTAs, they also contribute to other aspects of trade liberalization. These can include a loosening of government procurement policies, reductions in non-tariff trade

III. CGE MODELING OF FTA IMPACTS

We utilize the computable general equilibrium (CGE) modeling approach to analyze the total economic impacts of the existence of bilateral or multilateral FTAs. Many analyses of policies and rules utilize partial equilibrium (PE) approaches with a focus on a single market. The prime example is standard benefit-cost analysis. However, many analysts have noted the limitations of PE approaches in failing to take into account standard indirect, or, in this case, general equilibrium (GE) effects of the price and quantity interactions of markets (see, e.g., Hertel, 1985; Dixon et al., 2005). Ordinary general equilibrium effects refer to upstream and downstream supply-chain effects in markets in which the good in question is indirectly rather than directly involved.

Overall, a CGE model represents the multi-market interactions of producers and consumers in response to price signals, regulations and external shocks, and within the limits of available capital, labor, and natural resources. Essentially, CGE models depict the economy as a set of interrelated supply chains. They are the most frequently used models to analyze both international trade and tax policy (Dixon and Jorgenson, 2013). The strength of these models is their multi-sector detail, focus on interdependencies, full accounting of all inputs (including intermediate goods and not just primary factors of production), behavioral content, reflection

barriers (NTB), such as import licensing and quotas, technical regulations, sanitary and phytosanitary measures, and other complex regulatory environment (Fugazza and Maur, 2008; Hayakawa and Kimura, 2014). The impacts of NTBs are not modeled here because they involve very different policy instruments, do not have a unified and straightforward approach to their measurement, and suffer from a lack of empirical data. Felbermayr et al. (2013) indicated that if such NTBs are quantified as an *ad valorem* equivalent, they can represent an additional 15-30% increase in trade costs. Therefore, the economic impacts of the U.S. entering a trade reform with a foreign trading partner presented in this study can be viewed as a conservative estimate of the benefits of the US-Korea FTA.

of the actions of prices and markets, nonlinearities, and incorporation of explicit constraints (Rose, 1995).

Also, with regard to analyzing FTAs, it is preferable to have a model with the following features:

- A high level of disaggregation to align with specific Harmonized Tariff Schedule (HTS) product categories.
- The latest elasticities of substitution between imports and domestically produced goods of the same type.

Because CGE provides a clear linkage between the microeconomic structure and the macroeconomy, this modeling approach is adept at reflecting the interrelationship among multiple industrial sectors and markets. More importantly, it can be used to assess both direct and indirect effects from a change of public policy on various economic variables such as output, employment, prices, income, and economic welfare.

The GTAP Model was originally developed by Hertel (1997) based on the ORANI Model, a single country general equilibrium model for the Australian economy (Dixon et al., 1997). The theoretical basis of the model has been extended to allow international trade between different countries in the global economy through the introduction of transport margins and savings institutions (Mukhopadhyay and Thomassin, 2010). The theoretical framework of the GTAP model is primarily based on two types of equations. The first type encompasses equations that represent economic behaviors of different agents (producers, consumers, and

institutions such as trade). The second type of equations measures the accounting relationships within and among different agents.

In this study, we adopted the standard GTAP Model and the latest GTAP 9 Data Base. The model consists of 129 country economies, each of which is comprised of 57 industry commodity groupings, and incorporates the import/export trade linkages between them. To analyze the economic impacts of the US-Korea FTA, we set the U.S., South Korea, and the rest of the world as three separate regions in the model.

An "uncondensed" version of the GTAP Model is adopted, as it includes more tax and productivity parameters than the default, condensed version. The model consists of four sets of institutions: production, household, government, and foreign trade. Each institution interacts with others while maximizing its utility or profit under relevant constraints.

The production structure is an overall constant elasticity of substitution (CES) form for aggregate factors of production, whereas fixed coefficient relationships are used for intermediate inputs. Value added from primary factors, together with intermediate inputs, generate the final output. The model specifies that goods produced in different countries are imperfect substitutes (the standard Armington assumption that trade substitution elasticities are not infinite). The allocation of goods between exports and domestic markets is set to maximize revenue from total sales.

Household consumption in the GTAP model is represented by constant-difference of elasticities (CDE) functional form, whereas the household's preferences over consumption, government

spending and saving are characterized by a Cobb-Douglas relationship. All the elasticity parameters are based on the most recent estimates collected from the literature.

International trade and transport in the model are represented by merchandise goods and "margin" services (e.g., transport costs), respectively. The rest of the world is treated like any other region in the model, with explicit production, consumption, and trade behavior.

The GTAP Model, which is a multi-region and multi-sector CGE model developed by Hertel (1997), has been extensively applied in the literature to evaluate the economic impacts of free trade agreements and other preferential trade treaties (see, e.g., Hertel et al., 2001; Brown et al., 2005; Siriwardana, 2007; Abe, 2007; Fugazza and Maur, 2008). Modeling the impacts of reductions or eliminations of import tariff is relatively straightforward. The data used for the GTAP Model are the GTAP Data Base, which represents the world economy and is utilized by many analysts worldwide as a key input into CGE modeling of global economic issues. It also provides data on import shares and tariff rates between trading partner countries. The percentage change in import tariff under an FTA can be first calculated. The shocks to tariff rate for different types of commodities can then be entered in the GTAP model to simulate the impacts of tariff reduction or elimination. This approach has been used in many studies in the literature, such as Abe (2007) analyzing economic impacts of various FTAs of Japan and Siriwardana (2007) estimating economic impact of the Australia-U.S. FTA.

Several studies have analyzed US-Korea FTA, in anticipation of an agreement, but none since it was implemented. These include studies by Cheong and Wang (1999), McDaniel and Fox

(2001), Choi and Schott (2001, 2004), Lee and Lee (2005), and Schott et al. (2006), which all use various forms of CGE models but primarily the GTAP Model.

IV. DATA

To analyze the macroeconomic impacts of the tariff reduction or elimination under US-Korea FTA, the following data are used:

- Import tariff by commodity type before and after the establishment of the FTA. These include the U.S. tariffs on imports from South Korea and the tariffs on imports from U.S. in South Korea
- The phase-in schedule of the tariff reduction or elimination by commodity type at the 10-digit HTS level
- Level of imports and exports by commodity type at the 10-digit HTS level

The U.S.-Korea FTA entered into force in May 2012. In 2014, total imports to the U.S. from Korea were $69.5 billion, and the total exports from the U.S. to Korea were $44.5 billion. Appendix B presents the top traded commodities between the U.S and Korea and how they compare to the trading between the two countries and the rest of the world (ROW). The trade data indicate that the bilateral trading between the two countries is more specialized in Electrical Equipment and Machinery on the U.S. export-side, and Motor Vehicles & Parts and Electrical Equipment on the U.S. import-side.

According to the US-Korea FTA, the tariffs on the imports from the partner country are scheduled to be eliminated within a timeframe of 15 years from the date that the FTA entered into force. Different commodities have different time paths and corresponding stages of tariff elimination/reduction. Based on the tariff elimination/reduction stage as of 2014 for each individual commodity at the 10-digit Harmonized Tariff Schedule (HTS) level, we first calculated

the weighted average tariff reduction percentage (using import or export values as weights) in both countries for each relevant GTAP sector. The results are presented in Table 1.

Note that Table 1 only lists the first 42 GTAP sectors. GTAP Sectors 43 to 57 are service sectors, which are not typically involved in international trade. The weighted average tariff reductions of all sectors range from 0% to 100%. There are three possible reasons that a GTAP sector has a zero weighted average tariff reduction as of 2014. First, the commodities were duty free before the FTA, and remained so after the FTA. Second, as of 2014, the tariff reduction process has not kicked in for the commodities under the GTAP sector. Third, in the cases that no commodities were imported or exported for a GTAP sector in 2014, we assume the tariff level remains same.

Our simulations were implemented by changing the power of the tax on imports of affected tradable commodities from source country to destination country according to the tariff reduction information presented in Table 1. The simulations were implemented in three groups: a) adjusting the tariff on import side only (goods imported from Korea to the U.S.); 2) adjusting the tariff from the export side only (in other words, goods imported from the U.S. to Korea); and 3) shocking tariff on both the import and export side simultaneously. The default closure rules of the GTAP Model were adopted for all the simulations. Specifically, the factor endowments (e.g., the total supply of labor, capital and land) are fixed, whereas factor prices are adjusted to restore full employment. In addition, the saving rate is assumed to be exogenous and constant; hence, the quantity of savings changes as income changes.

TABLE 1. TARIFF REDUCTION UNDER US-KOREA FTA AS OF 2014

Description	Weighted Avg Tariff Reduction for U.S. Imports from Korea	Weighted Avg Tariff Reduction for Korea Imports from U.S.
Paddy Rice	100.0%	0.0%
Cereal Grains	8.6%	0.0%
Vegetables	8.1%	36.7%
Crops	28.7%	4.1%
Animal Products	0.5%	9.2%
Raw Milk	0.0%	13.0%
Wool Silk	0.0%	100.0%
Forestry	0.0%	1.0%
Fishing	0.0%	23.0%
Gas	0.0%	100.0%
Minerals	0.5%	12.6%
Meat	0.0%	0.1%
Meat Product	56.3%	0.3%
Vegetable Oil	98.6%	73.7%
Dairy Product	33.4%	13.8%
Processed Rice	100.0%	0.0%
Sugar	20.3%	0.0%
Food Products	55.4%	9.6%
Beverage and Tobacco	61.4%	55.1%
Textiles	44.2%	37.2%
Wearing Apparel	82.5%	44.2%
Leather Products	88.0%	10.7%
Wood Products	3.2%	4.4%
Paper	0.0%	0.5%
Petroleum	23.4%	25.1%
Chemical	29.0%	19.9%
Mineral Products	38.5%	44.6%
Ferrous Metals	2.7%	14.5%
Metals	45.1%	37.2%
Metal Products	58.9%	24.5%
Auto Parts	81.0%	2.6%
Transport Equip.	6.8%	0.4%
Electronic Equip.	0.8%	0.2%
Machinery	33.5%	7.2%
Other Manufactures	12.3%	9.0%

Source: Calculated by the authors based on Tariff Schedule of U.S., Tariff Schedule of South Korea, US-Korea FTA Tariff Elimination Schedule as of 2014, 2014 US-Korea Import and Export data.

V. AGGREGATE AND SECTORAL IMPACTS OF US-KOREA FTA

A. Aggregate Impacts

There are several metrics that are often used to evaluate policies and practices. Two widely-cited macroeconomic indicators are Gross Domestic Product (GDP) and employment. However, when federal government agencies evaluate the economic impacts of change in their policies or programs, they are directed by the Office of Management and Budget (OMB) to use different measures, referred to as "economic welfare," that better capture changes in the economic well-being of the U.S. public. These measures are also used by agencies such as the U.S. International Trade Commission (ITC) to evaluate the impacts of trade policies. On the other hand, businesses and financial analysts are more likely to focus on individual firm or industry profits or sales revenue, the latter being equivalent to gross output.

The economic benefits of tariff reduction under the US-Korea FTA were evaluated in three scenarios. The first evaluates the impacts from reductions of the U.S. import tariffs on commodities from Korea as shown in the second column of Table 1. The second scenario evaluates the impacts from reductions of Korea's tariffs on the commodities imported from the U.S as shown in the last column of Table 1. The third scenario measures the aggregate impacts of the FTA involving reductions of import tariffs in both countries.

Many factors affect the overall impacts of tariff reductions under an FTA, which include relative price changes of import and export, domestic demand and supply elasticities, trade elasticities, and changes in relative competitiveness of domestic industries. Changes in import tariffs have direct effects on sectors in which the tariffs are changed and indirect effects (to be discussed

further below) on other sectors and the economy as a whole. Our simulation results indicate that whenever there is a tariff reduction on Korean imports into the U.S. or U.S. imports into Korea, the imports or exports of the relevant U.S. sectors will increase, respectively, while the imports and exports of nearly all other sectors decrease. This decrease is attributable to the substitution effect stemming from the tariff reductions exceeding the output effect. Sectoral variations depend on the key factors mentioned earlier, especially the import and export elasticities, given that we are focusing on trade.

Table 2 presents the impacts on Gross Output (in real terms) of all sectors for both the U.S. and Korea for the reduction of import tariffs as a result of the implementation of the FTA between the two countries. The total GDP impacts are presented in the last row of the table. Total GDP increases for the U.S. and Korea are $45 million and $162.3 million, respectively. However, the results indicate a potential Gross Output loss of $142.7 million for the U.S., but a $322.3 million gain for Korea.

Table 3 presents the sectoral impacts for both the U.S. and Korea in relation to direct changes in imports. The results indicate that the reduction of import tariff increases the total imports in the U.S. and Korea, with level changes of $1.56 billion and $1.2 billion, respectively, in 2014. Although changes in total imports on net from the reduction of tariffs of all the directly affected sectors are positive, imports by some sectors decline as a result of the dominating output effect over the substitution effect.

Table 4 presents the total Economic Welfare (EW) impacts of tariff reductions in terms of Equivalent Variation, which represents an approximation of consumer surplus changes. In the

GTAP model, economic welfare is expressed in terms of changes in consumption and savings (approximately equal to disposable personal income) in billions of 2011 dollars. The implementation of the FTA between the U.S. and Korea is projected to result in a positive impact in terms of EW changes on the order of well over $300 million for each country.

B. Decomposition Analysis of Welfare Impacts

The results can be further explained by a decomposition of the overall EW effect into various components. The GTAP model offers an option of separating six causal factors, though for our analysis three of them would change imperceptibly and thus are held constant. Of the remaining three factors, which are presented in Table 4, the first is the Allocation Effect, which pertains to the price distorting effects of the duties. The second causal factor is the standard Commodity Terms of Trade Effect. The third is an Investment-Savings Terms of Trade Effect. Table 4 presents not only the decomposed welfare effects for the U.S. and Korea, but also the spillover effects on Rest of the World. On both the import and the export sides, the Allocation Effect is positive for both the U.S. and Korea, since tariff reduction represents the correction of price distortions caused by import taxes. However, the impacts are negative for Rest of the World as a whole because the FTA increases trade between the two signatories and reduced their trade with Rest of the World. The negative impacts to Rest of the World slightly more than offset the positive impacts for the U.S. and Korea on the import side, but are lower than the positive impacts to the two countries on the export side.

TABLE 2. OUTPUT AND GDP CHANGES IN THE U.S. AND KOREA FROM REDUCTION OF IMPORT TARIFFS ON ALL AFFECTED SECTORS

Sector	Baseline Output (in 2011 million$)		Output Impact (in 2011 million$)					
			Tariff Reduction (U.S. Import-Side)[a]		Tariff Reduction (U.S. Export-Side)[b]		Tariff Reduction (Both U.S. Import- & Export-Side)[c]	
	USA	KOR	USA	KOR	USA	KOR	USA	KOR
Paddy Rice	2	7	0.2	0.1	-3.4	9.9	-3.2	10
Wheat	21	0	0.6	0	-21.2	0.2	-20.6	0.2
Cereal Grains	73	0	1.2	0	-3.5	0.2	-2.3	0.2
Vegetables	70	13	0.1	-1.4	152	-108.1	152.2	-109.5
Oil Seeds	37	1	-0.1	-0.5	-15.1	5.5	-15.2	5
Sugar Cane	3	0	0	0	-0.1	0	-0.2	0
Plant Fibers	10	0	2.6	0	-8	0.1	-5.5	0.1
Crops	19	5	0.1	-0.5	-1.1	9.1	-1	8.6
Cattle	50	3	0.5	-0.8	-10.5	5	-10	4.2
Animal Products	55	8	3.6	0.5	-7.4	12	-3.8	12.5
Raw Milk	39	2	-1	1	17.8	-6.4	16.8	-5.5
Wool Silk	0	0	0	0	2.2	-0.6	2.2	-0.6
Forestry	23	1	0.6	-0.2	-2	0	-1.4	-0.1
Fishing	8	6	0	0.8	0.1	-0.5	0.2	0.3
Coal	78	0	0.9	0	-3.7	0	-2.8	-0.1
Oil	222	0	2.2	-0.1	-15.7	0	-13.5	-0.2
Gas	22	0	0.4	0	-2	0	-1.6	0
Minerals	51	3	0.7	-1.4	2.2	-0.6	2.9	-2
Meat	120	7	1.1	-2.3	-20.4	15.6	-19.3	13.3
Meat Product	98	9	2.2	0.5	-23.4	15.1	-21.2	15.6
Vegetable Oil	25	2	0.4	0.7	21.9	15	22.3	15.7
Dairy Product	102	6	-2.8	3.7	56.6	-26.9	53.8	-23.3
Processed Rice	6	6	0.1	0.7	-1.8	3.5	-1.8	4.2
Sugar	15	1	-0.2	0.1	-0.5	-0.4	-0.7	-0.2
Food Products	389	44	-11	37.7	89.6	-25.5	78.7	12.2
Beverage & Tobacco	156	10	-3.1	11.4	16.8	-0.1	13.7	11.3
Textiles	172	22	-115.1	330	56	34.5	-58.3	365.7
Wearing Apparel	122	22	-20.3	154.9	68.9	-18.6	48.8	136.8
Leather Products	17	5	-2.3	41.6	0.2	1.4	-2.1	43
Wood Products	295	7	18	-5.9	-14.3	0.5	3.7	-5.5
Paper	524	36	7	-23.1	-41.9	-3.7	-35	-26.8
Petroleum	729	158	-11.9	47.1	30.6	-8.1	18.8	39.1

Chemical	1086	215	-23.4	126.4	168.6	22.1	145.4	148.7
Mineral Products	162	33	0	-16.1	88.5	-23.8	88.5	-39.9
Ferrous Metals	213	166	9.2	-192.8	-57.9	-4.9	-48.8	-197.8
Metals	180	44	7.4	-20.4	39	0.5	46.1	-19.9
Metal Products	392	77	-37.7	52.8	14.3	-26.3	-23.4	26.5
Auto Parts	618	142	-111.1	603.5	-119.4	33.8	-230.6	637.6
Transport Equip.	277	60	79.7	-235.4	-145.4	33.8	-65.9	-201.8
Electronic Equip.	563	217	118.7	-613.8	-294	176.3	-175.8	-438.5
Machinery	1158	191	67.6	-305.1	-267.6	3.4	-200.6	-302.1
Other Manufactures	119	43	8.1	16.5	-5.7	-12.4	2.4	4.1
Electricity	421	48	-2.8	17.2	6.5	1.6	3.7	18.8
Gas	74	0	-0.4	0.2	-0.2	0	-0.7	0.1
Water	143	7	-1.1	3.7	1.5	-0.1	0.4	3.6
Construction	1798	179	85.5	65	200.9	95.8	286.8	160.8
Trade	3187	254	3	37.9	16	29.4	19	67.3
Transport Nec	692	88	7.3	-23.4	-10.4	-1.5	-3.1	-24.9
Sea Transport	84	30	1	-10.2	-2.3	-0.1	-1.3	-10.3
Air Transport	266	21	7.7	-9.6	-21.9	0.2	-14.3	-9.4
Communication	588	54	-2.2	0.4	-8.3	-1.2	-10.4	-0.8
Financial Service	1745	83	2.9	-8.4	-35.4	-7	-32.5	-15.5
Insurance	609	37	-4.8	2.9	-22.1	-3.5	-26.9	-0.6
Business Service	2333	169	26.8	-54.2	-91.8	6.8	-65.3	-47.4
Recreation	1360	54	-11.3	2.2	11.3	-2.9	0	-0.7
Public Service	5115	293	-69.5	58.8	48	-21.8	-21.5	37
Dwellings	1536	78	-23.1	20.6	14.4	-17.5	-8.8	3.1
Total Output Impact	**28275**	**2970**	**11.8**	**113**	**-154.4**	**208.5**	**-142.7**	**322.3**
Total GDP Impact	**15534**	**1202**	**11**	**92.3**	**35**	**70.3**	**45**	**162.3**

a. The scenario includes the shocks of reductions of US import tariffs for commodities from Korea in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.

b. The scenario includes the shocks of reductions of Korea import tariffs for commodities from the U.S. in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.

c. The scenario includes reductions of import tariffs in both the U.S. and Korea.

TABLE 3. IMPORT CHANGES IN THE U.S. AND KOREA FROM REDUCTION OF IMPORT TARIFFS ON ALL AFFECTED SECTORS

Sector	Baseline Imports (in 2011 million$)		Impact on Imports (in 2011 million$)					
			Tariff Reduction (U.S. Import-Side)[a]		Tariff Reduction (U.S. Export-Side)[b]		Tariff Reduction (Both U.S. Import- & Export-Side)[c]	
	USA	KOR	USA	KOR	USA	KOR	USA	KOR
Paddy Rice	0.0	0.0	0.0	0.9	0.1	-8.0	0.1	-7.1
Wheat	1.0	2.0	0.0	1.5	0.8	-1.0	0.7	0.6
Cereal Grains	1.0	14.0	0.0	10.9	0.6	-6.1	0.6	4.9
Vegetables	23.0	3.0	-0.6	2.8	22.0	100.2	21.5	103.1
Oil Seeds	1.0	6.0	0.0	3.2	1.2	0.6	1.2	3.8
Sugar Cane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plant Fibers	0.0	1.0	0.0	9.0	0.1	0.8	0.1	9.9
Crops	14.0	2.0	0.0	2.4	10.7	-3.5	10.7	-1.1
Cattle	2.0	0.0	0.0	0.2	0.9	-0.1	0.9	0.0
Animal Products	2.0	1.0	-0.2	6.3	0.8	0.8	0.6	7.2
Raw Milk	0.0	0.0	0.0	0.0	0.1	-0.1	0.1	-0.1
Wool Silk	0.0	0.0	0.0	0.1	0.2	1.1	0.2	1.2
Forestry	1.0	1.0	0.0	-0.4	0.2	-0.2	0.2	-0.5
Fishing	3.0	1.0	-0.1	1.0	0.9	0.1	0.7	1.1
Coal	1.0	17.0	-0.1	4.9	0.3	-0.4	0.2	4.6
Oil	324.0	104.0	-11.1	31.2	38.4	-5.3	27.3	25.9
Gas	17.0	16.0	-0.6	7.4	1.9	0.4	1.3	7.9
Minerals	11.0	28.0	0.0	-22.2	2.5	-0.6	2.5	-22.9
Meat	4.0	3.0	-0.2	6.4	3.8	-9.5	3.6	-3.2
Meat Product	3.0	2.0	0.0	10.3	2.5	-7.4	2.5	2.8
Vegetable Oil	8.0	3.0	-0.3	2.3	5.1	-9.2	4.8	-6.9
Dairy Product	3.0	1.0	2.5	2.9	2.9	28.3	5.4	31.2
Processed Rice	1.0	0.0	0.1	0.3	0.3	-2.2	0.4	-1.9
Sugar	4.0	1.0	-0.1	0.2	1.6	-0.2	1.5	-0.1
Food Products	49.0	11.0	14.1	11.3	20.7	60.1	34.9	71.5
Beverage & Tobacco	22.0	2.0	4.6	2.3	5.5	8.1	10.2	10.5
Textiles	60.0	8.0	105.9	102.1	37.3	18.9	143.7	121.4
Wearing Apparel	78.0	6.0	39.8	18.3	36.2	27.3	76.1	45.6
Leather Products	41.0	4.0	5.3	6.9	12.3	1.2	17.6	8.2
Wood Products	52.0	4.0	-3.6	2.1	27.0	0.6	23.4	2.7
Paper	30.0	5.0	-2.6	5.7	14.2	-0.4	11.6	5.3
Petroleum	91.0	21.0	13.1	9.8	11.3	9.5	24.5	19.3
Chemical	276.0	61.0	79.4	64.4	130.6	160.5	210.4	225.2
Mineral Products	23.0	7.0	6.1	3.1	11.4	38.9	17.5	41.9

Ferrous Metals	41.0	27.0	-4.3	-1.3	11.6	7.0	7.3	5.7
Metals	66.0	21.0	10.3	-2.5	24.7	30.7	35.0	28.2
Metal Products	46.0	8.0	51.9	13.5	25.6	46.4	77.6	60.0
Auto Parts	225.0	13.0	199.1	51.5	81.6	7.6	280.8	59.1
Transport Equip.	53.0	9.0	0.6	10.3	21.1	3.0	21.7	13.4
Electronic Equip.	289.0	54.0	-17.6	1.7	89.0	10.6	71.6	12.2
Machinery	367.0	76.0	85.6	72.5	198.7	100.1	284.5	172.6
Other Manufactures	85.0	4.0	-2.9	8.0	35.3	20.2	32.4	28.3
Electricity	4.0	0.0	-0.2	0.0	1.9	0.0	1.7	0.0
Gas	1.0	0.0	0.0	0.2	0.4	0.0	0.4	0.2
Water	0.0	0.0	0.0	0.3	0.2	0.0	0.2	0.3
Construction	4.0	3.0	-0.5	2.6	1.8	-0.1	1.3	2.5
Trade	27.0	15.0	-1.6	25.0	10.9	-3.1	9.3	21.9
Transport Nec	51.0	12.0	-2.1	14.8	12.5	0.7	10.4	15.4
Sea Transport	3.0	7.0	-0.1	-2.4	0.6	0.0	0.6	-2.4
Air Transport	42.0	9.0	-1.9	2.7	6.8	0.2	5.0	3.0
Communication	13.0	2.0	-0.7	2.5	4.6	0.2	3.9	2.6
Financial Service	41.0	3.0	-3.5	4.8	15.7	0.5	12.3	5.3
Insurance	41.0	2.0	-1.4	1.7	14.4	0.0	13.0	1.7
Business Service	101.0	21.0	-7.2	30.6	34.5	7.7	27.3	38.3
Recreation	15.0	6.0	-0.8	8.8	5.1	-0.2	4.3	8.6
Public Service	47.0	7.0	-2.0	9.8	8.3	2.2	6.3	12.0
Dwellings	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Impact on Imports	**2,706.0**	**633.0**	**552.2**	**562.6**	**1,009.3**	**636.8**	**1,563.9**	**1,200.9**

a. The scenario includes the shocks of reductions of US import tariffs for commodities from Korea in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.

b. The scenario includes the shocks of reductions of Korea import tariffs for commodities from the U.S. in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.

c. The scenario includes reductions of import tariffs in both the U.S. and Korea.

TABLE 4. WELFARE DECOMPOSITION OF REDUCTIONS OF IMPORT TARIFFS ON ALL AFFECTED SECTORS IN FY 2014 DUE TO US-KOREA FTA (million 2011 dollars)

Welfare Decomposition	IMP[a]			EXP[b]			BOTH[c]		
	USA	KOR	ROW	USA	KOR	ROW	USA	KOR	ROW
Allocation Effect	10.8	92.2	-142.1	34.7	70.2	-46.7	45.3	162.3	-189.1
Commodity Terms of Trade	-78.3	317.0	-238.9	330.2	-70.1	-260.1	252.6	247.0	-499.7
Invest.-Savings Terms of Trade	-42.2	-12.2	54.4	112.2	-2.3	-109.9	70.1	-14.4	-55.7
Total	**-109.6**	**397.1**	**-326.6**	**477.1**	**-2.2**	**-416.7**	**368.1**	**394.9**	**-744.5**

a. This set of columns summarizes the impacts of reductions of US import tariffs for commodities from Korea in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.
b. This set of columns summarizes the impacts of reductions of Korea import tariffs for commodities from the U.S. in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.
c. This set of columns summarizes the impacts of reductions of import tariffs in both the U.S. and Korea.

The two Terms of Trade effects are negative for the U.S. from an import tariff reduction, but are positive if the reduction of the tariff is on U.S. exports to Korea. Since the positive Terms of Trade effects on the export side for U.S. exports to Korea exceed the negative effects on the import side from Korea to the U.S., the combined Terms of Trade impacts for the U.S., presented in the third to last column of Table 3, are positive ($253 million and $70 million, respectively). Similar to the Allocation Effect, the Terms of Trade Effect is found to be negative for the Rest of the World in all three scenarios.

The overall EW gains from tariff reductions of all related products implemented under the US-Korea FTA are estimated to be $368 million for the U.S. and $395 million for Korea. Conversely, the Rest of the World would experience an EW loss of $745 million due to the implementation of the US-Korea FTA. The overall negative impacts on the Rest of the World result from the displacement and diversion of trade flows between the two US-Korea FTA partner countries

and all the other countries as an aggregate. However, we note that this study is a comparative static analysis that only focuses on the impacts of the US-Korea FTA. Trading agreements either between the U.S. or Korea and other countries (such as the on-going negotiation of the China-Japan-South Korea FTA) might mute or enhance the impacts of the US-Korea FTA on the U.S. or Korean economy. However, the net impacts of multiple bilateral trade agreements that involve the U.S. or Korea are beyond the scope of this study.

C. Sensitivity Analysis

In order to validate our findings of the welfare impacts of the US-Korea FTA, we also performed sensitivity analysis to evaluate how the modeling results vary in response to the changes in the value of key parameters of the GTAP model. The sensitivity analysis was conducted based on the aforementioned three scenarios with respect to variations in two key parameters in the GTAP model: Armington elasticities of substitution between domestic and imported commodities (ESUBD) and elasticities of substitution between primary factors in production (ESUBVA). The base case simulation was based on the original parameters provided by the GTAP data base (see Appendix A), whereas the sensitivity analysis examines the variations of the welfare impacts with the same level of shocks for each scenario, but varied by adjusting the parameters for each sector down and up by 50%, independently and respectively. For instance, the value of ESUBD for wool manufacturing varied in the range from 2.025 (a 50% decrease) to 6.075 (a 50% increase). The sensitivity analysis for each policy simulation scenario for the ESUBD and ESUBVA was executed 114 times and 116 times, respectively. Hence, 690

simulations were conducted in total with variations in three scenarios and two key parameters. The result, which is illustrated in Table 5, summarizes the mean, standard deviation and confidence interval of the aggregate welfare impacts. The results show that the mean estimates of welfare changes for each country are generally consistent with the base case simulations. Specifically, the results appear to be more sensitive to the variations of the Armington elasticities than the CES elasticity of factor input substitution. In addition, the results also suggest that the simulation results for US import tariff reduction tend to be less sensitive to the changes in elasticity parameters than that of the Korea import tariff reduction.

Table 5. Sensitivity Analysis of Different Elasticity Parameters for the Welfare Impacts

		IMP[a]			EXP[b]			BOTH[c]		
		USA	**KOR**	**ROW**	**USA**	**KOR**	**ROW**	**USA**	**KOR**	**ROW**
Sensitivity analysis of the elasticities of Armington CES for domestic /imported allocation	Base Case	-109.6	397.1	-326.6	477.1	-2.2	-416.7	368.1	394.9	-744.5
	Mean	-110.3	400.0	-329.4	479.7	-2.8	-418.7	370.1	397.2	-749.4
	S.D.	8.6	34.1	31.1	28.9	9.5	26.7	27.7	33.1	46.1
	CI_lower[d]	-148.7	247.6	-468.4	350.5	-45.3	-538.0	246.3	249.2	-955.5
	CI_upper[d]	-71.9	552.4	-190.4	608.9	39.7	-299.4	493.9	545.2	-543.3
		IMP[a]			**EXP[b]**			**BOTH[c]**		
		USA	**KOR**	**ROW**	**USA**	**KOR**	**ROW**	**USA**	**KOR**	**ROW**
Sensitivity analysis of the CES elasticities between primary factors in production	Base Case	-109.6	397.1	-326.6	477.1	-2.2	-416.7	368.1	394.9	-744.5
	Mean	-109.8	397.0	-326.5	477.0	-2.3	-416.7	368.0	394.8	-744.4
	S.D.	1.0	0.7	1.2	0.9	0.8	1.6	0.6	1.0	1.0
	CI_lower[d]	-114.3	393.9	-331.9	473.0	-5.9	-423.9	365.3	390.3	-748.9
	CI_upper[d]	-105.3	400.1	-321.1	481.0	1.3	-409.5	370.7	399.3	-739.9

a. This set of columns summarizes the impacts of reductions of US import tariffs for commodities from Korea in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.
b. This set of columns summarizes the impacts of reductions of Korea import tariffs for commodities from the U.S. in the selected sectors (see Table 1). The figures in the table represent the macroeconomic impacts on all sectors of tariff reduction in the above selected sectors.
c. This set of columns summarizes the impacts of reductions of import tariffs in both the U.S. and Korea.
d. The confidence interval (CI) was calculated based on the Chebyshev's inequality, a standard approach for sensitivity analysis of parameters in CGE models (Haddad and Hewings, 2005). The range indicates that we can be 95% confident that the welfare result lies within 4.5 standard deviation of the mean.

D. Sectoral Impacts

Our analysis indicates that the US-Korea FTA generates a divergence of outcomes, especially for the U.S. From the standpoint of the U.S., welfare gains are estimated to be $368 million, GDP gains are estimated to be $45 million, and total gross output (sales revenue) is estimated to incur a net *loss* of $143 million. Moreover, 34 out of 57 sectors of the US economy are estimated to incur gross output losses. This includes three advanced manufacturing sectors estimated to incur gross output reductions in excess of $175 million each. Ironically, the sectors that are estimated to gain the most are primary sectors in agricultural and mining, construction, and primary manufacturing. These results indicate the continued shift in comparative advantage away from US manufacturing with respect to rising economies such as that of South Korea.

The sectors incurring the greatest gross output losses, in descending order, are Auto Parts, Machinery, and Electronic Equipment, all with decreases in excess of $175 million. Other sectors with losses in excess of $50 million are Business Services and Textiles. On the other hand, the biggest winners, in descending order, are Construction, Vegetable Crops, Chemicals, Mineral Products, Food Processing, and Dairy Products, all with gains in excess of $50 million. There is symmetry in these results between the U.S. and Korea, in that in nearly all cases the gains or losses are reversed for the two countries.[4] The biggest gains for Korean sectors are

[4] There are a couple of notable exceptions to this statement, such as the case of Transportation Equipment, of Electronic Equipment, and of Machinery, where the gross output declines in both countries. However, this can be explained for the first two sectors by the fact that there is hardly any tariff reduction for these goods at all in either country (see Table 1). Therefore, resources will shift away from them and move to other sectors that benefit from high tariff reductions. In case of the Machinery sector there is a significant tariff decrease applicable to imports from Korea to the US. However, it is still modest compared to many other sectors.

estimated to be in Auto Parts and Textiles, with gross output increases of $638 million and $366 million, respectively. Of course, in relative terms, the changes in gross output in U.S. industries is relatively small, with only four sectors experiencing changes in excess of one-tenth of one percent. On the South Korean side, however, the majority of sectors experience changes in gross output in excess of this threshold.

With reductions in tariffs, inter-country trade expands. On the U.S. side, all sectors will experience an increase in imports. Sectors that are expected to have the biggest increases in imports, in descending order, are Machinery, Auto Parts, Chemicals, and Textiles, all with increases in excess of $140 million. On the South Korean side, the sectors that are expected to have the biggest increase in import are similar as those in the U.S. The sectors with an import increase in excess of $100 million are, in descending order, Chemicals, Machinery, Textiles, and Vegetables. A few sectors are expected to have a decline in imports. However, except for Minerals (with a reduction of $23 million), all other sectors will only experience a decrease of less than $7 million. Similarly, the import changes in the U.S. are relatively small in percentage terms, with only four sectors exceeding a one-tenth of one percent increase. For South Korea, however, the majority of sectors experience changes in imports in excess of this threshold, with six sectors experiencing a change of more than one percent.

Thus, the results indicate various trade-offs. First, while both countries are estimated to receive welfare gains, the South Korean gains are slightly higher in absolute terms and more than 12 times higher in relative terms, which is proxied by personal income changes. In a possible new era of “America first”, this relative imbalance may be viewed by the new Presidential

administration as being problematic. The divergence becomes even more extreme from a U.S. perspective if one considers GDP gains being more than 3.5 times higher for Korea in absolute terms and nearly 50 times higher in relative terms. In terms of gross output impacts, the outcome may be even more problematic from a U.S. standpoint, because the impacts on this indicator are overall negative. This means that total industry revenues, and likely profits as well, will fall, with 36 of 57 sectors expected to experience losses, including several major manufacturing industries located primarily in geographic areas of the country that have been promised special help by the new Presidential Administration. Table 6 presents the distribution of sectoral GDP of the three most negatively impacted sectors by the US-Korea FTA across the 8 BEA Regions. The Great Lakes Region accounts for nearly one-third and over 50% of the total sectoral GDP of Machinery Manufacturing sector and Auto & Parts Manufacturing sector, respectively. For the Electronic Equipment Manufacturing sector, the Far West Region accounts for 44% of the total sectoral GDP. These two regions are thus likely to be more vulnerable to the expected negative outcomes from the US-Korea FTA.

Table 6. Regional Distribution of GDP of Three Top Negatively Impacted Sectors by US-Korea FTA

	Machinery Manufacturing	Electronic Equipment	Auto and Parts
New England	3.5%	8.0%	0.7%
Mideast	8.9%	9.0%	2.8%
Great Lakes	30.6%	5.9%	50.7%
Plains	12.8%	5.3%	5.5%
Southeast	17.0%	10.5%	27.0%
Southwest	16.4%	13.6%	9.1%
Rocky Mountain	1.4%	3.6%	0.8%
Far West	9.4%	44.0%	3.6%
Total	100.0%	100.0%	100.0%

In Appendix C, we further examined the percentage changes in sectoral real GDP of the three sectors that are predicted to be most negatively affected by the US-Korea FTA over the period of 2012 to 2015.

E. Comparison to Other Studies

We now compare our results with those of other analysts of the US-Korea FTA. First, we point out that this comparison is made difficult by the fact that all previous studies were performed before 2008, did not necessarily reflect the current FTA provisions, and simulated a full reduction of tariffs. We refer the reader back to Table 1 to note that our evaluation pertains to the impacts of the FTA as in force in 2014, a time at which the average tariff elimination ratio was about 50%. On the other hand, the comparison is facilitated by the fact that all of the previous studies used a CGE model, and all but one used an earlier (but thus more sectorally aggregated) version of the GTAP Model.

Cheong and Wang (1999) estimated welfare gains of up to $4.8 billion for Korea and $3.7 billion for the U.S. annually for a 100% tariff reduction in all sectors. McDaniel and Fox (2001) estimated welfare gains of $19.6 billion for the U.S. and $3.9 billion annually for Korea from a 100% elimination of the bilateral trade barriers. Choi and Schott (2001) estimated that the net welfare gains would be evenly allocated across both Korea and the U.S., in the range of $1.5 billion to $8.9 billion for the U.S. and $1.7 billion to $10.9 billion for Korea. Schott et al. (2006) estimated the welfare gains of a full FTA as $20.2 billion for Korea and $0.8 billion for the U.S. Kiyota and Stern (2007) used a multiregional CGE model with 27 economic sectors, known as the “Michigan Model”. They estimated that the FTA would increase Korea’s welfare by $9.3

billion, with $4.48 billion coming from the bilateral removal of manufacturing sector barriers and $5.46 billion from bilateral removal of services sector barriers. U.S. economic welfare was estimated to increase by $25.1 billion, with $7.3 billion coming from elimination of manufacturing sector tariffs and $19.2 billion from elimination of services sector barriers.

At the sectoral level, McDaniel and Fox (2001) estimated that Agriculture would incur the biggest output increase, while Textiles and Apparel would incur the biggest decline in the U.S. Korea was estimated to experience the reverse of these sectoral impacts. Schott et al. (2006) generated similar sectoral findings. Our results are similar in finding the major sectoral expansion for the U.S. being in various types of Agricultural commodity sectors, and the Textile sector experiencing relatively large losses. However, we also estimated large losses in various Machinery and Equipment sectors. This might be explained by the ascendance of the Korean auto industry and by rapid technological innovations in Korean cell phones that have made them much more competitive than 10 to 15 years prior.

Again, overall, the previous estimates of aggregate welfare gains are typically much higher than ours for both countries, though our results are similar to the range found in studies by Choi and Schott (2001) and Schott et al. (2016). Thus, we can consider our aggregate estimates to be on the conservative side. At the sectoral level, there is a strong similarity between ours and previous studies, and the differences can readily be explained by the change in conditions between their year of analysis and ours.

VII. CONCLUSIONS

Free Trade Agreements aim to eliminate trade barriers between partner countries, increase trade flows of goods and services between them, and improve overall economic efficiency. An increasing number of FTAs and preferential trade programs have been established between the U.S. and other countries and regions.

In this study, we evaluated the economic impacts of the U.S.-Korea FTA. We adapted a state of the art methodology and applied the latest version of GTAP Model in the economic impact analysis, with a focus on the impacts of the tariff reduction/elimination provisions in the FTA. The results indicate that the bilateral tariff reductions of import commodities under the FTA result in an increase in U.S. welfare (approximately equivalent to personal income) by about $368.1 million, reflecting a combination of substitution and output effects, as well as the net effects in relation to the terms of trade. Among the two effects, the Terms of Trade effect accounts for over 87% of the total welfare increase stemming from the reduction of import tariffs between the two countries.

However, the current policy climate in the U.S. is likely to renew attention to other metrics. Therefore, we have measured the impacts of the U.S.-Korea FTA on GDP, which is of interest to many decision makers, and estimated expected total impacts on this indicator for the U.S. economy to be only $45 million. On the other hand, since industry executives and stock market analysts are likely to be more interested in measures of business performance, such as sales revenue and profits, we measured sectoral Gross Output impacts and found mixed results, with

the largest increases expected to be in U.S. sectors that had their tariffs reduced the most by Korea.

Overall, the results are ambiguous, suggesting several trade-offs. Positive welfare gains between the U.S. and South Korea are about the same in absolute terms, but favor the latter in relative terms, and very heavily so in terms of GDP gains. Moreover, the U.S. is projected to incur an overall total loss of Gross Output (sales revenue), with 34 of 57 sectors experiencing losses, including several major manufacturing sectors that are heavily concentrated in geographic areas that have been promised "job return" by the new Presidential Administration. The fact that so many U.S. sectors are estimated to suffer decreases in Gross Output, and hence employment, is also likely to be problematic from a political standpoint in terms of potential widespread opposition by so many sectors estimated to lose jobs.

We note the tariff elimination process involves different tariff reduction phase-in stages for different types of commodities over the course of the future decade or so. Therefore, a dynamic CGE model might be needed to fully capture time-related features of the trade liberalization process. In addition, this paper only focuses on the modeling of removals of merchandise trade barriers. Since other aspects of trade liberalization, such as service trade and foreign investment liberalization, are not covered in the analysis, the economic impacts of the U.S. entering into trade reforms with foreign trading partners presented here can be viewed as a conservative estimate of the potential impacts of an FTA.

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Appendix A. Key Elasticity Parameters in the GTAP Model

Table A. Various Elasticities of Substitutions Adopted in the GTAP Model

Sector	Armington elasticity of substitution	Factor elasticity of substitution
Paddy Rice	5.05	0.26
Wheat	4.45	0.26
Cereal Grains	1.3	0.26
Vegetables	1.85	0.26
Oil Seeds	2.45	0.26
Sugar Cane	2.7	0.26
Plant Fibers	2.5	0.26
Crops	3.25	0.26
Cattle	2	0.26
Animal Products	1.3	0.26
Raw Milk	3.65	0.26
Wool Silk	6.45	0.26
Forestry	2.5	0.2
Fishing	1.25	0.2
Coal	3.05	0.2
Oil	5.2	0.2
Gas	17.2	0.2
Minerals	0.9	0.2
Meat	3.85	1.12
Meat Product	4.4	1.12
Vegetable Oil	3.3	1.12
Dairy Product	3.65	1.12
Processed Rice	2.6	1.12
Sugar	2.7	1.12
Food Products	2	1.12
Beverage & Tobacco	1.15	1.12
Textiles	3.75	1.26
Wearing Apparel	3.7	1.26
Leather Products	4.05	1.26
Wood Products	3.4	1.26
Paper	2.95	1.26
Petroleum	2.1	1.26
Chemical	3.3	1.26
Mineral Products	2.9	1.26
Ferrous Metals	2.95	1.26
Metals	4.2	1.26
Metal Products	3.75	1.26

Auto Parts	2.8	1.26
Transport Equip.	4.3	1.26
Electronic Equip.	4.4	1.26
Machinery	4.05	1.26
Other Manufactures	3.75	1.26
Electricity	2.8	1.26
Gas	2.8	1.26
Water	2.8	1.26
Construction	1.9	1.4
Trade	1.9	1.68
Transport Nec	1.9	1.68
Sea Transport	1.9	1.68
Air Transport	1.9	1.68
Communication	1.9	1.26
Financial Service	1.9	1.26
Insurance	1.9	1.26
Business Service	1.9	1.26
Recreation	1.9	1.26
Public Service	1.9	1.26
Dwellings	1.9	1.26
Capital goods (CGDS)		1.00

Source: GTAP Model.

Appendix B. Comparison of Trade between the U.S. and Korea to Overall Trade with the Rest of the World

In Table B1 and Table B2, we provide trade statistics to examine how specialized the trade between the U.S. and Korea is compared to the each individual country's overall trade with the rest of the world (ROW). Table B1 presents the top 10 commodities that the U.S. imported from Korea in 2014 dollar values. The proportion of each type of imported commodity with respect to total imports from Korea is presented in the second numerical column. More than two-thirds of the total imports from Korea are Motor Vehicles and Parts, Electrical Equipment, and Industrial Machinery. This proportion is much higher than the percentage these three types of commodities represent in total U.S. imports from the ROW, which is only 38% (see Column 4 of Table B1). The last two columns of Table B1 present the dollar values of Korean exports of these commodities to the ROW, as well as the percentages with respect to Korean total exports to the ROW. The numbers indicate that Korea exports more Electrical Equipment to ROW than to U.S. in percentage terms, but the U.S. has been the major exporting country for Korean manufactured Motor Vehicles & Parts and Industrial Machinery.

Table B2 presents the trade data on the U.S. export-side (or Korea import-side). The first two numerical columns present the top 10 U.S. exported commodities to Korea in dollar values and their corresponding percentage with respect to total U.S. exports to Korea. The top 5 commodities are Industrial Machinery, Electrical Equipment, Aircraft, Precision Instruments, and Oil & Mineral Fuels. Compared to the data presented in Columns 3 and 4, which pertain to U.S. exports of these commodities to the ROW, the U.S. exports proportionally more Industrial Machinery and Electrical Machinery, but less Oil & Mineral Fuels to Korea than to the ROW.

However, the difference between the trade with Korea and the trade with the ROW is not as substantial as on the import-side. The last two columns of Table B2 present the dollar values of Korea import of these commodities from the ROW, as well as the percentages with respect to Korea total imports from the ROW. The numbers indicate that Korea imports more Electrical Machinery and Oil & Mineral Fuels from the ROW than from the U.S. in percentage terms, but more Industrial Machinery, Aircraft, and Precision Instruments from the U.S.

Table B1. Comparison of U.S. Imports from Korea vs. U.S. Imports from the ROW

Commodity (at 2-digit HTS level)	US Imports from Korea (Korea Exports to US)		US Imports from ROW		Korea Exports to ROW	
	billion $	% of total imports from Korea	billion $	% of total imports from ROW	billion $	% of total exports to ROW
87 Motor Vehicles & Parts	19.4	27.9%	242.2	11.1%	43.2	12.6%
85 Electrical Equipment	15.5	22.2%	300.4	13.4%	118.8	27.1%
84 Industrial Machinery	11.5	16.5%	313.6	13.8%	46.7	11.8%
73 Iron & Steel Articles	3.3	4.8%	34.4	1.6%	7.8	2.2%
27 Oil & Mineral Fuels	3.0	4.4%	344.7	14.8%	24.5	5.5%
72 Iron & Steel	2.1	3.0%	32.1	1.5%	16.6	3.8%
39 Plastics	1.8	2.6%	46.1	2.0%	25.8	5.6%
40 Rubber	1.8	2.6%	25.8	1.2%	5.1	1.4%
29 Organic Chemicals	1.4	2.1%	52.2	2.3%	16.5	3.6%
90 Precision Instruments	1.1	1.6%	74.3	3.2%	26.5	5.6%

Table B2. Comparison of U.S. Exports to Korea vs. U.S. Exports to the ROW

Commodity (at 2-digit HTS level)	US Exports to Korea (Korea Imports from US)		US Exports to ROW		Korea Imports from ROW	
	billion $	% of total exports to Korea	billion $	% of total exports to ROW	billion $	% of total imports from ROW
84 Industrial Machinery	7.6	17.1%	212.3	13.5%	38.4	10.6%
85 Electrical Equipment	5.9	13.3%	166.4	10.6%	69.2	19.1%
88 Aircraft	2.9	6.4%	122.4	7.8%	1.2	0.3%
90 Precision Instruments	2.9	6.4%	82.1	5.2%	14.6	4.0%
27 Oil & Mineral Fuels	2.0	4.4%	154.5	9.8%	79.8	22.0%
29 Organic Chemicals	1.9	4.2%	40.4	2.6%	9.1	2.5%
87 Motor Vehicles & Parts	1.6	3.6%	134.4	8.5%	13.6	3.8%
39 Plastics	1.6	3.5%	61.6	3.9%	8.5	2.3%
10 Cereals	1.5	3.4%	21.3	1.4%	1.7	0.5%
02 Meat	1.4	3.1%	16.3	1.0%	2.5	0.7%

Appendix C. Real GDP Changes for the Top Negatively US-Korea FTA Affected Sectors

We examined the percentage changes in sectoral real GDP of the three sectors that are predicted to be most negatively affected by the US-Korea FTA over the period of 2012 to 2015 to evaluate whether there is empirical evidence to indicate whether the findings from our GTAP simulations for the year 2014 were aberrations or not. Table C indicates that the Machinery Manufacturing sector has been experiencing a decline in sectoral GDP over the three years after the implementation of the FTA. Although the GDP of the Motor Vehicles and Parts Manufacturing sector has been increasing over the years, there has been a decrease in the growth rate. Between 2014 and 2015, the sectoral GDP growth rate (0.2%) is much lower than the weighted average GDP growth rate (2.7%) across all sectors in the U.S. The Electronic Equipment Manufacturing sector had a similar GDP growth rate as the sectoral weighted average over the years. Therefore, the GDP data of these three sectors support our findings from the GTAP simulations to some extent: although some sectors are predicted to be negatively affected by the US-Korea FTA, overall, the U.S. economy benefits from the FTA. However, we reiterate that we are performing a comparative static analysis, which only examines the difference made by the US-Korea FTA, holding all the other economic conditions constant. The changes in sectoral GDP presented in Table C can be caused by multiple economic factors, which are difficult to separate out from the impacts of the US-Korea FTA.

Table C. Percent Real GDP Change from Preceding Year for the Top Three Negatively Impacted Sectors

	2013	2014	2015
Motor Vehicles and Parts Manufacturing	5.1	4.3	0.2
Electronic Equipment Manufacturing	0.8	2.5	3.5
Machinery Manufacturing	-1.8	-0.3	-8.7
Total U.S.	1.5	2.4	2.7