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Towards More Accurate Trade Model Forecasts

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1. Introduction

Forecasts of the effects of free trade agreements (FTAs) are an important part of the US political process for evaluating proposed trade agreements. Under the Bipartisan Congressional Trade Priorities and Accountability Act 2015, the US International Trade Commission is required to carry out a modeling exercise and publish its results. The United States has signed 14 FTAs with a total of 20 nations since the first one in 1985 with Israel.

Since the NAFTA agreement, which was ratified by Congress in 1993, every one of these FTAs was accompanied by a modeling exercise. In more recent years, proposed trade agreements are modeled by the ITC and separately by private economists. Members of Congress and senior officials in the executive branch, up to the president, rely on and quote from these economic models to form and explain their views on proposed trade agreements. It is one of the areas of US government policies where economic analysis plays a prominent role as mandated by act of the Congress.

However, the results of these models have been consistently poor when compared to the actual outturns in the national economies involved several years after a trade agreement is implemented. In an authoritative study in 2018, Professor Timothy Kehoe commented "The average correlation between model prediction and post-reform data is 0.0—that is to say, the GTAP model had essentially zero prediction accuracy." (Kehoe, 2018). GTAP, for Global Trade Analysis Project, refers to the CGE (computable general equilibrium) model developed at Purdue University in the 1990s. It is the most widely used model for trade studies. It must be stated that GTAP developers (including one of the authors of this paper) do not intend for it to be a forecasting model. It is a model designed to illustrate the comparative impact of trade shocks, not macroeconomic forecasts. But it is consistently treated as a forecast in the political arena. And even if not a forecasting tool, its results could and should do a better and more comprehensive job of showing the likely impact of a trade shock.

In this paper, we offer two modifications to standard GTAP intended to improve its representation of the impact of trade shocks. The first modification is the introduction of nationally variable Armington elasticities, which reflect the fact that different nations react to changes in import prices differently. The second involves the introduction of unemployment as a predictable side effect of job change following a trade shock.

We use the US-South Korea KORUS trade agreement of 2012 as a retrospective test case. We show that these modifications enable the model to better capture the effects of the KORUS trade agreement on the US economy.

The paper is organized as follows: Section 2 is a Literature Review. Section 3 explains our modifications to the standard GTAP model. Section 4 summarizes the results of our KORUS exercise. Section 5 concludes.

2. Literature Review

There are multiple studies estimating the economic impact of the U.S. Korean free trade agreement (KORUS). In this review, many the studies on KORUS rely on computable general equilibrium (CGE) models, which allow for an economywide analysis that includes the interdependencies within and between countries. Most studies we consider utilize a CGE model called GTAP (Global Trade Analysis Project).[1]

Many models of international trade, including GTAP, make simplifying assumptions that have rendered highly inaccurate forecasts when evaluating free trade agreements such as KORUS. Kehoe (2003) evaluates the performance of 10 CGE models used to evaluate NAFTA and found that the average correlation between predicted and actual results for 2002 to 2015 trade changes is 0.0. Meaning that GTAP-AGE model had essentially zero predictive accuracy.[2]

Two crucial assumptions are the Armington assumption and the closure equation for the labor market. The Armington assumption differentiates commodities based on their country of origin. It takes a product of an industry which comes from different countries to be imperfect substitutes for each other. Furthermore, Armington (1969) assumed that the elasticity of substitution within groups of products was constant. In contrast, internationals trade models, such as the Heckscher-Ohlin model, treat all products of an industry to be perfect substitutes for one another.

Armington elasticities specify the degree of substitution in demand between similar products and are critical parameters for models for employing the Armington assumptions. GTAP employs two tiers (a macro and a micro level) of substitution between domestic and foreign products, thus requiring the estimation of multiply elasticities, dependent on the number of countries in the model. The first elasticity (the macro elasticity) establishes the allocation of expenditure between the home good and foreign good. The second elasticity (micro elasticity) captures the allocation of expenditure on goods between competing sources of imports. All these elasticities are estimated outside of the structure of the CGE model, consequently, elasticities based on old trade data or faulty estimates can have large impacts on model results. McDaniel and Balistreri (2003) argue that estimates of Armington elasticities vary dependent on the estimation technique.[3]

Zhang (2006) demonstrated the sensitivity of CGE model results to the Armington elasticities as they impact the terms of trade. Increasing the foreign first-tier elasticities or reducing the home first-tier elasticities lowers the terms of trade effect of lowering a home tariff. Increasing the foreign second-tier elasticities lower the terms of trade gain from a home tariff. Varying the

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[1] GTAP Model: Corong, E., Hertel, T., McDougall, R., Tsigas, M., & van der Mensbrugghe, D. (2017). The Standard GTAP Model, Version 7. *Journal of Global Economic Analysis*, 2(1), 1-119. doi:dx.doi.org/10.21642/JGEA.020101AF

[2] Kehoe, Timothy J., "An Evaluation of the Performance of Applied General Equilibrium Models of the Impact of NAFTA, Federal Reserve Bank of Minneapolis, Research Department Staff Report 320 (August 2003).

[3] McDaniel Christine A. and Edward Balistreri. 2003. " A review of Armington Trade Substitution Elasticities." *Economie International*, 23(3): 301-313.

home country second-tier elasticities does not change the terms of trade effect of its own tariff.[4]

Kehoe (2003) states that "Simply imposing large elasticities of substitution between different types of goods in a sector is capable of generating large increases in trade flows in response to tariff changes, but it is likely to do so in the wrong sectors. Modelers are likely to find high elasticities of substitutions unattractive and/or implausible for other reasons. High elasticities of substitution imply that trade liberalization has very small welfare consequences, for example. Furthermore, in international real business cycle models, such high elasticities imply impossibly large volatilities of the trade balance."[5]

Boeters and Savard (2013) point out that GTAP and other CGE models assume that long-run outcomes are achieved when studying trade liberalization. The labor market is assumed to return to a full-employment equilibrium and a uniform flexible exchange rate balance labor supply and labor demand. They note that researchers must extend this basic labor market specification if they are interested in evaluating policy changes such as trade liberalization on labor markets, which does directly impact labor markets.[6]

In his 2019 paper, Peterson addresses Boeters and Savards suggestion by introducing frictional unemployment into the standard GTAP model to create the GTAP-LAB model. This new model specification allows for changes to employment levels for skilled and unskilled labor in all sectors contained in the standard GTAP model. The value of this contribution to CGE modeling is that the impact on the labor market in response to trade policy such as tariffs can be estimated.[7]

The USITC estimated the effects of the KORUS using a CGE model called Global Trade Analysis Project (GTAP). CGE models allow for an economywide analysis that includes the interdependencies within and between countries. They found that over ten years following the implementation of the KORUS exports to South Korea would increase by $9.7 billion to $10.9 billion, while imports from South Korea would increase by an estimated 6.4 billion to $6.9 billion.[8] No specific employment estimates were included in the study. However, the study claims that Aggregate U.S employment changes would be negligible, primarily because of the size of the U.S. economy relative to the Korean economy and sectors exhibiting the largest increases in employment (bovine meat products, cattle, meat products n.e.c., cereal grains n.e.c., dairy products, and animal products .n.e.c.) would be offset by sectors (Among the largest are paddy and processed rice, oilseeds, plant-based fibers, manufacturers n.e.c., electronic equipment, wearing apparel, wheat, and textiles) that show a decline because of the agreement.

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[4] Zhang, X. G. 2006, *Armington Elasticities and the Terms of Trade Effects in Global CGE Models.* Productivity Commission Staff Working Paper. Melbourne, January.

[5] Kehoe, Timothy J., "An Evaluation of the Performance of Applied General Equilibrium Models of the Impact of NAFTA, Federal Reserve Bank of Minneapolis, Research Department Staff Report 320 (August 2003)

[6] Boeters, Stefan and Savard, Luc, The Labour Market in CGE models (October 1, 2011). ZEW – Centre for European Economic Research Discussion Paper No.11-079,

[7] Peterson, Everett B. 2019, Incorporating Unemployment into the GTAP Model. Journal of Global Economic Analysis, Volume 4 (2019), No.2, pp. 67-109.

[8] U.S. – Korea Free Trade Agreement: Potential Economy-wide and Selected Sectoral Effects. (Investigation No. TA-2104-24. USITC Publication 3949, September 2007 (pp xix).

A study by the Economic Policy Institute (EPI) used the impacts of the NAFTA FTA and China's entry into the WTO on the U.S. to estimate the impact of KORUS on the U.S[9]. Economists at EPI specifically reject use of forecasting models like GTAP and argued that it is better to make analogies to the US experience with China and NAFTA. According to EPI, " A particular source of concern is that the U.S. International Trade Commission (ITC), which generates official estimates of the likely impacts of proposed trade agreements, has generate many erroneous forecasts of the impacts of those agreements on U.S trade, employment, and GDP." EPI found that it would boost the U.S. trade deficit with South Korea by $13.5 billion over seven years. Due to the rise in the trade deficit, the U.S. would shed approximately 159,000 jobs. Although this methodology is unconventional, its results were generally more accurate than most other studies. KORUS went into effect in March 2012. Seven years later the US bilateral goods trade deficit with South Korea was $4.3 billion higher than it was in 2012.

The U.S. Chamber of Commerce commissioned a study based on a GTAP model that estimates the impact on the U.S. economy if the U.S. FTA's with Columbia and South Korea are not implemented. They estimated the impacts on the U.S. of the implementation by the EU and Canada of FTA's with Korea and Colombia, and U.S. implementation of FTA's with Korea and Colombia. In this study, wage rates were held constant, allowing employment to adjust to clear the labor market. The simulations include bilateral tariff reductions, reductions in trade costs related to administrative costs, and reductions in services trade costs. They then compare these results to those obtained by estimating the impacts on the U.S. of implementation of the EU and Canada FTA's but not the U.S. FTA's. As a result, U.S. exports of goods and services fall by 2.2 percent, U.S. GDP declines by 0.31 percent, national income falls $28.3 billion, and total U.S. employment drops by 0.3 percent. Based on 2008 exports of goods and services ($1.8 trillion) and GDP ($14.4 trillion) these results translate into lost exports totaling $40.2 billion and a decline in GDP of $44.8 billion. Employment in in 2008 was 127.8 million workers, thus a 0.3 percent decline means the negative impact on U.S. employment could be as high as 383,400 jobs lost.[10]

The Institute for International Economics conducted an applied general equilibrium study of the Korea – U.S. FTA consisting of 22 sectors, five factors of production (unskilled labor, skilled labor, capital, land, and natural resources), and four regions (Korea, the U.S., Japan, and the rest-of-the-world. They found that overall, in the medium term (assumes capital stock is fixed), the net welfare gains to South Korea would be $27.6 billion in net gains (3.51 percent of GDP), and $51.8 billion (6.6 percent of GDP) in the long term (capital stock increases). The impact on the U.S. is predicted to be much smaller for three reasons. First, the U.S. economy is 15 times larger than South Korea's. Second, the U.S. has much lower initial barriers than South Korea. Third, the model does not have detailed data on trade in services or on barriers to trade and investment, thus, likely underestimating the gains from an agreement. The model estimates

[9] Economic Policy Institute (EPI): Trade Policy and Job Loss: U.S. trade Deals with Columbia and Korea Will be Costly. (2010)

[10] Baughman, Laura M., NS Francois, Joseph F., Trade Action – or Inaction: The Cost for American Workers and Companies, 2010. U.S. Chamber of Commerce.

that U.S. would experience net welfare gains of $0.8 billion in the medium term (0.01 percent of GDP) and $8.8 billion in the long term (0.07 percent of GDP).[11]
Economists at the University of Michigan used a CGE model that included 27 economic sectors in 30 countries or regions. They found that total U.S. exports to South Korea would increase by $9.2 billion and U.S. imports from South Korea would increase by $6.9 billion. The change in the number of jobs is assumed to be zero because the model assumes full employment. They did, however, offer estimates of percentage changes in various sectors of the economy. They predict 85% percent of the expected job gains would be in agriculture and 90 percent of jobs losses would occur in six industrial sectors: government services, trade and transportation services, manufactured textiles and apparel, transportation equipment, metal products, and machinery equipment.
Using a CGE model, the U.S. – Korea Business Council conducted a study that estimated that failure to implement a free trade agreement between the U.S. and South Korea would lead to a decline of $35.1 billion in U.S. exports to the world and GDP growth would suffer by $40.4 billion. The loss in export and GDP growth will result in 345,017 lost jobs.[12]

3. Modifications to the Model

GTAP assumes that all nations have the same elasticity of demand for imports. These are known as Armington elasticities. They tell the model by how much imports of a product will rise when the tariff is reduced, in other words how consumers respond to lower prices. Experience shows that a tariff-driven price cut will produce different reactions in different countries. For example, in the US, we often see a surge in imports when we conclude a trade agreement with another country. It may be because of the lower tariffs, and it may be because the effect of the tariff is dramatically magnified when US multinationals shift production to that country, thus increasing our imports.

On the other hand, a country like Korea is heavily resistant to imports. Partly this is due to non-tariff measures, regulatory standards, and other technical impediments to imports. Partly this may be due to a perennially undervalued currency. In my view, all of these factors are embraced by understanding that Korea has been heavily committed to export-led growth for the past 50 years and will not allow anything to get in the way of it running an export surplus with as many countries as it can, and in particular with a large consumer market like the US.

The ITC seems to recognize this fact of life. It mentions several times in its study that Korea has an “anti-import bias.” But it does not attempt to integrate this into its GTAP model. We have done just that. The GTAP model has an average cross-industry Armington elasticity of 6.2 for each country. Analyzing the actual post-KORUS data, we found that Korea should have an Armington elasticity of 2, while the US should have one of 15. In other words, for any tariff reduction of 1%, the US will import some 7 ½ times more of that good than Korea would.

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[11] Schott, J., Bradford, S., and Moll, T. Negotiating the Korea-United States Free Trade Agreement. Policy Briefs in International Economics Number PB06-4, Institute for International Economics
[12] Baughman, L., and Francois, J. (2009): Failure to Implement the U.S.-Korea Free Trade Agreement: The Cost for American Workers and Companies. U.S. Chamber of Commerce

We made one more critical change to the model. As I mentioned, the GTAP model assumes static employment. In GTAP, any reduction in revenue or output by an industry is accommodated by an immediate small reduction in wages throughout the industry. This is of course not how the real-world economy works. In the real world, when jobs are lost due to imports, a significant percentage of those workers remain unemployed for months or years. We altered the model to allow for this. The GTAP model divides the US labor force into 86 million so-called "unskilled" workers and 79 million so-called "skilled" workers. Those terms are better understood as highly educated and less highly educated. In the case of KORUS, the model finds that some 582,000, or 0.66% of the "unskilled" workers make a job transition into a different job as a result of the shock of the new trade agreement. We make the assumption that one third of those workers do NOT get re-employed quickly and this reduces US GDP. We derive that one third figure from the latest Bureau of Labor Statistics survey on Worker Displacement[13] which found that some 70% of workers who lost their jobs were re-employed two years later. The figure for production occupations was lower, at 66%. In other words, 34% were NOT re-employed two years later. So our model suggests that the KORUS agreement would have caused 193, 859 workers to become unemployed for a substantial period of time as a result of the trade agreement.

4. Results

When we run our model with these two modifications, we find the results seen in Table 2. In our model, the US-Korea trade deficit has now deteriorated by $9.9 billion or 72%. GDP has fallen by $4.4 billion, a small fall in US GDP but one that now reflects the worsening trade balance with Korea. Equally important, our model shows that 194,000 people lost jobs and remained unemployed for a sustained period as a result of the KORUS trade deal. You can think of these unemployed individuals as working in the automotive, machinery, electronics and similar industries. Those are all industries where our bilateral industry-specific trade deficit worsened as a result of KORUS. In fact in the non-electrical machinery industry we went from a small surplus with Korea pre-KORUS to a small deficit in the 2015-2019 period.

Table 1. KORUS Model: ITC model vs. CPA Model

Economic Indicator	ITC forecast	CPA forecast	Actual result (2006 vs. 2015-2019)
Change in merchandise trade balance	+$3.5B	-$9.9B	-$10B
Change in GDP	+$11B	-$4.4B	NA
Change in employment (000)	nm	-194	NA
Source: USITC report, Authors' calculations			

5. Conclusions

Two modifications to the standard GTAP model enable the model to deliver more accurate forecasts. This methodology is generalizable to other trade agreement shocks between any

[13] https://www.bls.gov/news.release/archives/disp_08272020.htm

bilateral country pair. Elasticity of demand for imports varies from country to country and may vary over time too. The employment effects of trade shocks also vary over time and country. They can be accounted for in modeling exercises. Further research on these effects is warranted.

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