

U.S.-SOUTH KOREA TRADE

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EXECUTIVE SUMMARY

The benefits of free trade and trade agreements for American consumers and companies are evident in the United States-Korea Free Trade Agreement (KORUS-FTA), a treaty President Donald Trump has threatened to terminate. Americans gain from liberalized trade with South Korea as shown by an economic analysis of the treaty that finds eliminating the KORUS-FTA trade provisions would impose a consumption tax of \$196 over 5 years on the typical U.S. household.

Table 1: Effect of Trump Withdrawing from the KORUS-FTA and Imposing a 25% Tariff over Five Years

Item	All households (\$56,437 mean after-tax Income)	Lowest 10 % (\$5,348 mean after-tax Income)	Second 10 % (\$15,182 mean after-tax Income)	Fifth 10% (\$38,735 mean after-tax Income)	Ninth 10% (\$97,430 mean after-tax Income)	Highest 10% (\$172,669 mean after- tax Income)
Tariff burden of leaving FTA (\$)	196	132	141	178	249	260
The burden of imposing 25% Tariff on Korean Imports (\$)	916	474	507	753	1,365	1,676

Source: U.S. Bureau of Labor Statistics, Consumer Expenditure Survey, 2017. Calculation of cost increase for imported goods.

The analysis concludes:

- Assuming that imports from Korea would face tariffs under Most Favored Nation status in the absence of KORUS-FTA, our analysis finds that canceling the KORUS-FTA would manifest itself as a 10.7% increase in the price of competing domestically produced goods and, therefore, as a cut in real wages. Conversely, this means that the typical U.S. household benefits from Korean imports by that same \$196 over five years, due to the lower prices made possible by the agreement.
- President Trump has recently announced 25% tariffs on imported steel, automobiles and other goods (Premuk, 2018). Were President Trump to impose 25% tariffs on the \$73 billion in goods that the U.S. imports from Korea, the damage to households would be substantially greater. A 25% tariff on all imports from Korea would cost the typical U.S. household \$916 over five years.
- We find that ending the KORUS-FTA would cost U.S. consumers \$4.6 billion annually and \$22.8 billion over five years.

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- The analysis included calculations of the dead loss (net loss to the economy) of potential tariff increases using standard methodology. That included first estimating the reduction in U.S. imports from Korea for 97 categories of goods under the two-digit Harmonized Tariff Schedule (HTS) and utilizing the Armington elasticities for each of these 2 digit HTS category codes.¹ We used the increase in the tariff rates, the quantity of imports and the Armington elasticities to calculate the dead loss to the U.S. economy for each commodity category of imports from Korea. The methodology was also used to calculate the impact of a 25% tariff on U.S. imports from Korea.
- If the Trump Administration were to impose a 25% across-the-board tariff on imports from Korea, it would be certain to bring retaliation in the form of tariffs on U.S. exports, which would carry additional economic impacts.
- In total, ending the KORUS-FTA would impose a dead loss on the U.S. economy of \$411 million annually and \$2.1 billion over five years. U.S. consumers would suffer a total annual burden in the form of a \$4.6 billion loss in household purchasing power. The annual benefits to producers would be \$2.6 billion, or 56.7% of the loss experienced by consumers. These results show that consumers gain an additional \$4.6 billion in purchasing power as a result of implementing and preserving the KORUS-FTA.
- If the Trump Administration decided to impose a 25% tariff on all imports from Korea, then the damage would be much higher for households and the U.S. economy. The total burden on consumers would be \$28.3 billion annually. The dead loss to the U.S. economy would be \$6.1 billion annually.

The two countries recently agreed to changes in the agreement that have minimal consequences for trade (Gillespie, 2018). The Trump Administration's threatened 25% tariff on automobile parts is jeopardizing the deal by stalling ratification by the South Korean Parliament (Jun, 2018). Withdrawing from the trade deal in the next two years could still happen, if it is couched as a way to fulfill Trump's promises to crack down on what he considers unfair trade competition from other countries or part of a revisiting of all trade agreements with other countries (Paletta, 2017). Even if the treaty stays in place, an analysis of its impact makes the case that protectionism and higher tariffs are costly, while liberalized trade and lower tariffs bring great benefits to Americans.

¹ The Armington method is based on an assumption that the country of origin of a product distinguishes it from other countries.

BACKGROUND ON KORUS-FTA

On June 5, 2006, the United States and the Republic of Korea began talks with the intent to complete a free-trade agreement between the two allies. The negotiations progressed quickly and led to the signing of the United States-Korea Free Trade Agreement on June 26, 2007 (BlueText, 2018). However, between the initiation of negotiations and the signing of the KORUS-FTA, the fast-track trade status of President George W. Bush expired, and the Democratic Party, which had become more hostile to the President and less enthusiastic about free-trade agreements, won control of Congress (Palmer, 2007). Democrats in Congress called for changes to the treaty provisions covering automobiles and then, in addition, demanded labor protections. The KORUS-FTA remained unratified through the end of the Bush presidency.

The Obama administration set out to renegotiate provisions of the KORUS-FTA, especially covering automobiles. On June 26, 2010, President Obama and Korean President Lee Myung-bak expressed confidence that the remaining obstacles would be settled by November 2010. The countries finalized a revised agreement on February 10, 2011. The agreement was ratified by the U.S. Senate on October 12, 2011, and the Korean National assembly followed suit a month later. The governments of Korea and the United States brought the treaty into force on February 21, 2012 (BlueText, 2018).

Presidential candidate Donald Trump made trade a central theme of his election campaign. He threatened to impose a 45 percent tariff on goods and services produced in China (Campbell, 2016). He also pledged, if elected, to impose a 35 percent tariff on selected goods from Mexico (Grodén, 2015) and, by implication, a tariff on Japan. In a Republican debate in 2015, Trump declared, "Our country is in serious trouble. We don't win anymore. We don't beat China in trade. We don't beat Japan, with their millions and millions of cars coming into this country, in trade. We can't beat Mexico, at the border or in trade" (On the issues, 2016).

As president, Donald Trump has remained hostile to free-trade agreements and, last fall, threatened to leave the KORUS-FTA. The two countries recently agreed to changes in KORUS-FTA that will likely have minimal consequences on trade between the two countries. The new provisions allow the U.S. to export 50,000 cars (up from 25,000) to Korea that are exempt from Korean safety rules. This is unlikely to benefit U.S. automakers, whose exports to Korea have yet to reach the previous cap. South Korea will cap its steel exports to the United States at 70% of their current annual average volume. Both countries also agreed not to devalue their respective currencies to gain trade advantage (Gillespie, 2018). The Trump administration declared victory and moved on to other areas.

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The Trump Administration recently announced a flurry of tariff increases. President Trump imposed 25% tariffs on imported steel, automobiles, and other goods and, in June 2018, imposed a 10% tariff on aluminum from Canada, Mexico, and the European Union. Tariffs imposed on 818 items imported from China and worth about \$34 billion went into effect on July 6, 2018 (Pramuk, 2018). The affected countries then retaliated by imposing tariffs on U.S. exports of agricultural products, motorcycles, and whiskey.

The Trump Administration did not exempt Korean imports from the new 10% U.S. tariff on aluminum imports but did exempt Korean imports from the 25% tariff on steel (Gillespie, 2018). Given the flurry of activity on trade, the Trump administration could revisit the KORUS-FTA and decide to end the treaty. The pressure may grow to leave the KORUS-FTA agreement, particularly if the ongoing negotiations to revise the North American Free Trade Agreement fail and the Trump Administration leaves that agreement. Even if the U.S. does not withdraw from KORUS-FTA, examining the treaty allows us to understand the benefits of trade with America's friend and ally South Korea.

WHAT THIS REPORT ADDRESSES

We estimate the burden that ending the KORUS-FTA would impose on U.S. consumers in the aggregate and on U.S. consumers by income decile. We estimate the economic effects that would follow if the Trump Administration ends the KORUS-FTA and increases the average tariff on goods imported from Korea from the current 2.9% to 13.5%, as required for Most-Favored-Nation (MFN) status countries and by World Trade Organization rules. We offer a second possibility, that upon ending the KORUS-FTA, the Trump Administration imposes a 25% tariff on all imported goods from Korea, similar to the recent tariff increases announced or threatened by the administration. We next provide a review of the economics literature as it bears on tariffs.

MEASURING EFFECTS

A tariff has five principal economic effects:

1. It shifts demand away from imported goods and toward domestically produced substitutes for the same goods, putting upward pressure on prices and downward pressure on the real wages (wages adjusted for inflation) of workers. The resulting higher prices and lower real wages impose a burden on consumption.
2. It confers benefits on domestic producers and their workers.
3. It causes the home-currency to appreciate, and thereby shrinks exports.
4. It raises some revenue for the government (as long as it isn't so high as to drive imports to zero).
5. It imposes a "dead loss" or excess burden on the economy.

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Dead loss is a net loss to the economy. It equals the burden imposed on consumers minus the benefit to home-country producers and minus the tax revenue raised by the government. This dead loss consists of a consumption cost and a production cost, the first equal to the value to consumers of goods that they no longer consume because of the tariff and the second equal to the cost to society of replacing imported goods with higher cost domestic goods.

Dead loss equals $\frac{1}{2}t^2\eta M$, where t is the tariff rate, η is the elasticity of imports with respect to domestic price and M is the pre-tariff dollar value of imports. The import elasticity equals the percentage shrinkage in imports for every one percentage point by which domestic price increases as a result of the tariff. Expressed as a fraction of imports, the dead loss equals 1/2 the tariff rate multiplied by the percentage by which imports fall as a result of the tariff. If a 20% tariff causes imports to fall by 50%, then the dead loss is 5% of imports.

It is important to understand that the dead loss measures only the combined consumption and the production costs. It does not measure the cost to consumers from having to pay higher prices for goods produced at home.

The dead loss does not account, either, for the benefits that might accrue to the country through protectionism. It does not account for any wage increases and improved job prospects that U.S. workers might enjoy as the tariff shifts production to more labor-intensive goods. Nor does it account for the gains that might result from an improvement in the country's terms of trade or from a temporary improvement in its trade balance or in its strategic advantage over other countries. The difference is that these benefits are typically small (if they exist at all) relative to the harm done to consumers.

Suppose, for example, the United States imposes a tariff of 20% on widget imports from some other country – call it Glaustark. U.S. widget imports from Glaustark before the tariff equal \$1 million. Assuming that elasticity is 2.5, dead loss equals \$50,000 ($= 1/2 \times .2 \times .2 \times 2.5 \times \$1,000,000$), which is 5% of \$1 million.

Again, we need to keep in mind that this is the net loss to society after we take into account the gains to producers and the revenue collected by the government as a result of the tariff. Those gains impose costs on consumers that outweigh the dead loss by several factors. To see why let's consider just how producers benefit. In this example, producers benefit in two ways. First, they get a higher price for what they were selling U.S. consumers before the tariff. If they were providing 50,000 widgets at \$5 apiece they now sell those same widgets at \$6 apiece, for a gain of \$50,000. If they produce an additional 25,000 widgets because of the tariff, that's another \$25,000 in benefits, for a total of \$75,000 in benefits. These benefits plus the tariff revenue collected by the government come entirely at the expense of consumers. In this example, also, the government collects \$100,000 in tariff revenue, which, when combined with the \$75,000 in benefits to producers and the dead loss, brings the total loss to consumers to

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\$225,000, which is 4.5 times the dead loss alone.² The formula assumes that a tariff on a particular product is a tariff on that product, whatever its origin. The formula breaks down if importers can get the same product tariff-free from other countries.

ECONOMIC IMPACTS OF EXITING THE KORUS-FTA

In this section, we assume that the termination of the KORUS-FTA is effective in the way presumably intended, in that U.S. importers do not replace goods any longer imported from Korea with goods imported from the rest of the world. There is, to be sure, ample evidence to the contrary, that in fact, tariff increases simply shift imports from the target importing country to another importing country (Tuerck, Bachman, & Conte, 2016). We assume that President Trump would declare victory as U.S. producers (including their workers) captured the benefits of this shrinkage in imports. We estimate the dead loss assuming a 10.7 percent tariff increase on Korean imports and a new 25% across the board tariff rate on Korean imports.

In order to accomplish the task, we must make a few calculations.

First, we estimate the reduction in U.S. imports from Korea for 97 categories of goods under the two-digit Harmonized Tariff Schedule (HTS). Congress enacted the HTS in 1988 to replace the previous tariff list. The HTS is a hierarchical system of identifying all traded goods that enter the United States that could be subject to a duty or quota. It is based on the international Harmonized Commodity Description and Coding System (HS). The hierarchy ranges from two-digit codes which apply to a broad category of goods, to ten digit codes for very specific goods and contain over 11,000 individual goods (USITC, 2016).

We need the current tariff rate for each of these products that apply to Korea in order to calculate the tariff rate increase. The United States International Trade Commission (USITC) provides a list of tariff rates for over 11,000 products with an eight-digit HTS code (USITC, 2015). We calculate the weighted average tariff for the two-digit HTS code by taking the tariff revenue generated for that category and dividing it by the dollar value of total imports for that category. We take the average tariff for all products within the 2 digit HTS category code to yield an average

² The tariff is assumed to cause widget imports to fall from 200,000 to 100,000 units. Suppose that Americans consumed 250,000 widgets before the tariff and now consume only 200,000. Imports still account for half of these units, the other half coming from domestic production. If U.S. producers previously supplied 50,000 units, they now supply 100,000 units. They gain from the higher price they get for the units previously sold plus what they gain from selling an additional 50,000 units. The gain on these additional units is only a fraction of what producers get by selling these new units at the new price of \$6, inasmuch as producer costs rise as production expands. We assume that the gain is only one-half what they would get if costs didn't rise. Then their total gain is \$75,000 (= \$50,000 + 1/2 \$50,000). The government gets to collect \$100,000 in tax revenue. The total loss to consumers is \$225,000 (= the benefit to producers + government revenue + dead loss = \$75,000 + \$100,000 + \$50,000). The loss is 4.5 times the dead loss.

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tariff rate of 2.9 percent for imports from Korea, and then subtract the current tariff rate from the U.S. Most Favored Nation (MFN) ad valorem tariff rate, which is the rate charged to members of the World Trade Organization (WTO).

Next, we find the Armington elasticities for each of these 2 digit HTS category codes. The Armington method is based on an assumption that the country of origin of a product distinguishes the product from similar products produced by other countries. This methodology implies that similar products from different countries are imperfect substitutes for each other (Armington, 1969). We use import or Armington elasticities for three-digit HTS code from C. Broda, J. Greenfield and D. Weinstein for the United States. We calculate an average of the three-digit HTS codes that fall under each two-digit HTS code (Broda, Greenfield, & Weinstein, 2006).

Once we have the Armington elasticities for each of our HTS commodity categories, we are almost ready to calculate the reduction in imports that would result from ending the KORUS-FTA. To do so, we need to convert our dollar value data into quantitative data and then apply the Armington elasticities by HTS category. Since we are in essence calculating the value of price x quantity using the data for expenditure, we can assume a price and the quantity follows (expenditure/price = quantity). The total value of expenditure does not change with different price assumptions. For simplicity, we assume a price of \$1 for all goods before the tariff increase.

Armington elasticities do not strictly measure the direct relationship between the price increase and change in imports, but rather the change in the ratio of imports to domestically produced goods that result from a change in the ratio of imported prices to the domestic prices. The equation: $\ln(M / D) = \sigma \ln[\beta / 1 - \beta] + \sigma \ln[P_D / P_M]$

Whereas the M is the quantity of the imported good, D is the quantity of the domestic good, β is the current weight of the imported good relative to the domestic good and σ is the Armington elasticity (Blonigen & Wilson, 1999). We have estimates of Armington elasticities (see above). We use these estimates to estimate the change in imports from Korea that would result from ending the KORUS-FTA. See the Appendix for further detail.

Finally, we calculate the dead loss to the U.S. economy for each commodity category and country (see appendix). We find that that exiting the KORUS-FTA would impose a dead loss of \$411 million annually, or \$2.053 billion over five years.

As pointed out, however, this does not account for the total burden on consumers. That burden comes to \$4.569 billion annually when we add to dead loss, the benefits that producers and government extract from consumers. The benefit to producers is \$2.592 billion. The government collects \$1.566 billion in revenue from the tariff increases but suffers a loss tariff revenue loss of \$441 million due to the drop in imports from Korea for a net revenue gain of \$1.125 billion.

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If the Trump Administration were to go a step further after ending KORUS-FTA and impose a 25% tariff on all imports from Korea the loss would increase by over ten-fold. A 25% tariff would impose a dead loss of \$6.029 billion annually and \$30.144 billion over five years.

Under a 25% tariff on imports from Korea, the burden on consumers skyrockets to \$28.345 billion annually. The federal government collects \$3.622 billion in tariff revenue, for a gain of \$1.570 billion. The benefit to domestic producers is \$18.694 billion.

We can distribute the burden on consumers by income deciles by using Consumer Expenditure Survey (CES) data from the Bureau of Labor Statistics of the U.S. Department of Labor. The CES data provides average annual household spending amounts for over one-hundred categories and divides households into ten income levels, from those falling into the lowest ten percent of all incomes to those the falling into the highest ten percent of all incomes (U.S. Department Labor, 2015).

We assume that the prices of goods from Korea would rise by the entire tariff increase if the KORUS-FTA were ended, or by 10.67%. We also know that imports from Koreas make up a fraction of total U.S. imports and only 1.8% of total U.S. Personal Consumption Expenditures (PCE) for the applicable sectors. Therefore, we know that the increase in the price of imports from Korea will not directly translate into an increase in the prices faced by U.S. households for that sector. Thus, we need to adjust the calculation of consumer harm to reflect the importance of imports from Korea relative to total U.S. consumption of the affected products. The Appendix provides the calculation details (U.S. Bureau of Economic Analysis, 2015).

First, we map the each HTS commodity category to a PCE product code and then to a CES spending category. The USITC's U.S. model has 128 commodities/sectors and maps them to the 41 commodities in the USITC's Global Trade Analysis Project computable general equilibrium model. We map the 128 elasticities from the USITC model to our 97 HTS commodity categories using the commodity descriptions (Donnelly, Johnson, & Tsigas, 2004). Table 2 displays the results for households organized into income deciles.

By our calculation, ending the KORUS-FTA would cost the average U.S. household \$196 over a five-year period. The tariffs would cost households in the lowest income deciles \$132 over five years and households in the highest income decile \$260 over five years.

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Table 2: Effect of Trump Withdrawing from the KORUS -FTA and Imposing a 25% Tariff over Five Years

Item	All households (\$56,437 mean after-tax Income)	Lowest 10 % (\$5,348 mean after-tax Income)	Second 10 % (\$15,182 mean after-tax Income)	Fifth 10% (\$38,735 mean after-tax Income)	Ninth 10% (\$97,430 mean after-tax Income)	Highest 10% (\$172,669 mean after-tax Income)
Tariff burden of leaving FTA (\$)	196	132	141	178	249	260
Tariff burden of imposing 25% Tariff on Korean Imports (\$)	916	474	507	753	1,365	1,676

Source: U.S. Bureau of Labor Statistics, Consumer Expenditure Survey, 2018. Calculation of cost increase for imported goods on households.

Upon ending the KORUS_FTA, were the Trump Administration to impose a 25% tariff on all imports from Korea, the average household would see their expenditures increase to \$916 over five years. The lowest income households would pay \$474 over the period.

There are other effects to consider. Our analysis assumes that ending the KORUS-FTA would manifest itself as a 10.67% spike in the price of competing domestic producer goods and therefore as a cut in real wages for consumers of those goods.

What About U.S. Exports to Korea?

Thus far, we have focused on the effect ending the KORUS-FTA would have on U.S. imports from Korea. However, the tariffs also would affect U.S. exports to Korea. See (Tuerck et al., 2016) for a review of the economic theory.

Assuming the elimination of the KORUS-FTA would be effective and imports from Korea fall, then the supply of U.S. dollars used to pay for the imports in the foreign exchange market will fall, in turn, causing the dollar to appreciate, or become stronger, against foreign currencies.

The stronger dollar will cause the price of U.S. tradable goods to rise relative to similar goods from other countries, and thus become less competitive in global markets. As a result, U.S. exports will fall if the Trump administration terminates the KORUS-FTA.

We estimate that the value U.S. exports would decrease by the same percentage that imports from Korea would decrease under the new trade regime. Table 3 displays the results.

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U.S. exports to Korea totaled \$48.276 billion in 2017, according to the Comtrade database from the United Nations (*U.N. Comtrade*, 2017). We estimate that eliminating the KORUS-FTA would cause U.S. exports to fall by a total of \$14.757. If the Trump Administration imposed a 25% tariff on the imports from Korea, U.S. exports would fall by \$37.243 billion.

Table 3: The Effect of Eliminating KORUS-FTA and a 25% Tariff on Imports from Korea on U.S. Exports

Scenario	Pre-Tariff U.S. Exports (\$, 000s)	Change under Trump Tariff (%)	Drop in U.S. Exports (\$, 000s)	Post-Tariff U.S. Exports (\$, 000s)
KORUS-FTA	\$48,276,321	-31%	(\$14,757,087)	\$33,519,234
25% Tariff	\$48,276,321	-77%	(\$37,243,130)	\$11,033,192

Source: United Nations Comtrade database, 2017

CONCLUSION

This report opened with the observation that President Trump has begun to keep his campaign promises by imposing draconian tariffs on imports from a variety of countries. Last year President Trump called for ending the KORUS-FTA. Although the two countries recently agreed to modest changes, the administration could still decide to end the agreement.

What would ending the KORUS-FTA do to the U.S. economy and more specific, to U.S. consumers? We found that ending the agreement would impose far larger burdens on consumers than they would confer in the way of benefits to import-competing domestic firms and their workers. Looked at a different way, the KORUS-FTA confers a much larger benefit to consumers than the harm done to domestic firms and their workers that results from not terminating the trade agreement. We recognize that the benefits and costs of the FTA are distributed asymmetrically, as the costs are felt by a modest number of firms and their workers, while the benefits are enjoyed by all U.S. consumers.

Economists have long recognized how a capital-abundant country like the United States would be likely to experience decreases in real wages as it opened up trade with other, more labor-abundant countries. And, while this factor-equalization argument seemed at first not to describe a genuine problem for the United States, it has gathered more force with shrinkage in import-competing industries. The evidence of distress among low-wage workers brings back to life the concern that, while trade may be “theoretically” good for the country as a whole, it can produce problems for low-wage workers in competing sectors.

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The U.S. economy would suffer a total burden in the form of a \$4.569 billion loss in household purchasing power by the termination of the KORUS-FTA. On the plus side, a portion of this burden would be redistributed to U.S. producers, who would benefit from the new tariffs. But that leaves a dead loss of \$411 million of consumer surplus that would simply vanish owing to the distortions in the price system created by higher tariffs on imports from Korea. And, on the negative side, it is not clear that a substantial new tax on household income would simply transfer purchasing power from consumers to beleaguered workers.

What if President Trump decided to impose a 25% tariff on all imports from Korea, as he has done with steel and threatens China? Then the results would be multiplied by a factor of 11. The total burden on consumers would be \$28.345 billion annually.

APPENDIX

Equation (1) below is the standard equation to estimate Armington elasticities. However, we already have Armington elasticities from Blonigen & Wilson, and therefore, we transform the equation and make some simplifying assumptions to calculate the number of imports after the tariff increase (see below).

$$(1) \ln\left[\frac{M}{D}\right] = \sigma \ln\left[\frac{\beta}{1-\beta}\right] + \sigma \ln\left[\frac{P_D}{P_M}\right].$$

$$(2) \ln M - \ln D = \sigma[(\ln(\beta) - (\ln(1-\beta)))] + \sigma[\ln(P_D) - \ln(P_M)].$$

(3) Let $P_D = P_M$ before t is imposed.

(4) Now let $P_M' = (1+t)P_D$. So

$$(5) \ln M' - \ln D' = \sigma[(\ln(\beta) - (\ln(1-\beta)))] + \sigma[\ln(P_D) - \ln((1+t)P_D)]. \text{ Subtracting (2) from (5),}$$

$$(6) (\ln M' - \ln M) - (\ln D' - \ln D) = \sigma[\ln(P_D) - \ln((1+t)P_D)]. \text{ Because we can calculate } \sigma[\ln(P_D) - \ln((1+t)P_D)], \text{ we can also calculate } (\ln M' - \ln M) - (\ln D' - \ln D). \text{ So let}$$

(7) $P_D = 1$. Then

$$(8) EXPM = 1 * M.$$

$$(9) EXPM' = 1(1+t)M'.$$

$$(10) M = EXPM.$$

(11) $M' = EXPM' / (1+t)$. Substituting into (6),

$$(12) \ln(EXPM' / (1+t)) - \ln EXPM - (\ln D' - \ln D) = \sigma[\ln(P_D) - \ln((1+t)P_D)].$$

$$(13) \ln(EXPM' / (1+t)) = \ln EXPM + (\ln D' - \ln D) + \sigma[\ln(P_D) - \ln((1+t)P_D)]. \text{ We know}$$

- $\ln EXPM$, and
- $\sigma[\ln(P_D) - \ln((1+t)P_D)]$. Assuming $(\ln D' - \ln D) = .5(\ln M' - \ln M)$, we can calculate $\ln(EXPM' / (1+t))$ and therefore $M' - M$ and $D' - D$. Then

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$$(14) (\ln D' - \ln D) = .5 [\ln (EXPM' / (1+t)) - \ln EXPM]$$

$$\ln (EXPM' / (1+t)) = \ln EXPM + .5 [\ln (EXPM' / (1+t)) - \ln EXPM] + \sigma [\ln(P_D) - \ln((1+t)P_D)]$$

$$(15) .5 \ln (EXPM' / (1+t)) = .5 \ln EXPM + \sigma [\ln(P_D) - \ln((1+t)P_D)]$$

$$\ln (EXPM' / (1+t)) = 2 [.5 \ln EXPM + \sigma [\ln(P_D) - \ln((1+t)P_D)]]$$

Substituting (11) into the left side of (15)

$$(16) M' = EXP \left\{ 2 [.5 \ln EXPM + \sigma [\ln(P_D) - \ln((1+t)P_D)]] \right\}.$$

We calculate equation (16) to obtain the reduction in imports from Korea that result from the tariff increase.

We assume that the reduction in the volume of imports from Korea is split evenly between a reduction in U.S. consumption and an increase in domestic production of import-competing products. To calculate the deal loss, we multiply the tariff increase (our price increase) by one-half the reduction in consumption and one-half of the increase in domestic production.

The total burden on consumers consists of the dead loss, the increase in government tariff revenue and the gain to domestic producers. We calculate these effects individually and sum them to obtain the total burden on consumers.

The gain to domestic producers derives from two sources: (1) the increase in domestic supply due to the tariff increase, and (2) price increase for existing domestic production of the tradeable goods. The gain to domestic producers from (1) is reduced because domestic production cost (marginal cost) increases as domestic production increases along the upward sloping domestic supply curve, which accounts for half of the dead loss. Therefore, we multiply the increase in domestic production by the tariff rate increase and then by $\frac{1}{2}$ to account for the increase in marginal costs.

Domestic producers gain from the higher price due to the tariff under (2). However, as outlined above, Korean imports make up a small fraction of total U.S. Imports and an even smaller fraction of domestic production. Moreover, some imports from Korea, are focused on a very narrow product within the two-digit HTS code. For example, for the HTS code 2: Meat and edible meat, all imports from Korea are within HTS code 2089025: Frog legs, fresh, chilled or frozen. It is unlikely, that an increase in tariffs on frog legs imported from Korea will have an impact on the price of other meats, such as pork and chicken. Furthermore, there is no data source for production of frog legs in the United States. Therefore, we adjust the price increase due to the tariff by the ratio of imports from Korea to total domestic production for each HTS code and multiply the result by the quantity of domestic production. We need comparable data for U.S. domestic production for each two-digit HTS code.

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We use the product descriptions to match the Personal Consumption Expenditures (PCE) products to the HTS codes and used the PCE dollar value as a proxy for domestic supply (U.S. Bureau of Economic Analysis, 2015). For capital type goods, we used the Private Fixed Investment (PFI) by Product Type as our proxy for domestic supply (BEA, 2018). For Korean imported goods that were not a good match either the PCE or PFI, we used the value of total shipments from the U.S. Census Bureau's Annual Survey of Manufacturers ("U.S. Census Bureau," 2016). From each consumption, investment or shipment figures, we subtracted the total U.S. imports for each HTS category using Comtrade data to obtain our estimate of domestic production (*U.N. Comtrade*, 2017).

The increase in tariff revenue is straightforward. We multiply the new quantity of imports from Korea by the tariff increase for each of the HTS codes and sum the total.

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