Studying the Effect of Import Restrictions on the Food Sector and its Consumers

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Abstract – *Nowadays, global trade is a necessary component of most economies. In recent years, numerous countries have put in place a variety of trade policies to regulate goods coming in and out of the country. Often, these policies cause other countries to react and change their trade policies, which can lead to the so-called 'wars'. Government changes in this area can affect organizations significantly if they rely on imports or exports within their supply chain. Moreover, customers are also affected by trade policy changes when they acquire goods that are either imported or have imported components. The scope of this article was limited to the food industry. Therefore, only the impact of new trade restrictions on this sector was studied. A mathematical model was developed to correlate changes in import tariffs with export reductions within this industry. Similarly, another model was created to better understand the impact of import tariffs on consumers and their households.*

Keywords *– Consumer Price Index (CPI), Food Sector, Imports, Tariffs.*

INTRODUCTION

The topic of increasing interest within the economic and financial world is the effects of taxes or tariffs on imports by any given country. Globalization enables an increase in trade between nations, facilitating economic growth and the sourcing of distinct goods and services that are not readily available in other countries. Recently, the U.S.–China trade war, that have been taking place, are shaping the macroeconomic world, making markets susceptible to the fluctuations that this may cause [1]. In 2019, the U.S. had 232 tariffs, including a 25% tariff on aluminum, which caused unexpected challenges for international corporations and the global supply chain [2]. Aggressive tariffs also spark retaliation from other countries through additional tariffs, which can impact consumers.

Most recently, after the 2018 new tariffs on Chinese imports, China retaliated with 25% tariffs on vehicles, oil, and other goods imported to the U.S. Import taxes, such as these, are typically paid through customs and go directly to the government, in the case of the U.S.A. After the government's cut is taken, they are sold to the consumer at times at a higher price due to import taxes [3]. Tariff changes can lead to currency depreciation, like what happened in Canada in the 1990s when the North American Free Trade Agreement (NAFTA) was implemented [4].

One of the sectors affected is the food industry and its products. The high cost of tariffs can directly affect social welfare, given their food needs, since it affects the budgetary availability of each family. Some products must be imported due to demand needs and because they can't be produced locally, any restrictions will have a differential impact on the consumer. For imported food products bought directly by consumers, American households will be more directly affected by pricing differences.

When food products are manufactured in the U.S., if they use ingredients or materials from other countries, the cost of the finished goods will change. Moreover, the effects of import restriction changes vary; some restrict foreign goods to incentivize the national economy by promoting domestic goods rather than imported ones. Other changes can increase market competitiveness, driving prices down by increasing trade and helping consumers maximize their money [5].

When prices change in the grocery store, market balance is also affected, causing new trends and implications that will impact volumes and profits for the manufacturers of these goods. Competition will

also be affected depending on the specific products, manufacturing companies' locations, and where they get their materials.

Scope of Work

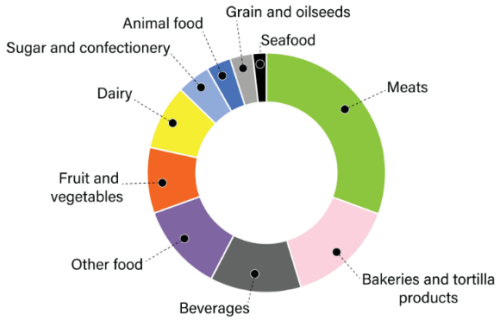
One of the main ideas behind this project is to analyze the tax effect on the exchange of goods and services in the economy of the United States, the impact on its citizens, and global competitiveness. Models and current theories will be presented to better understand the effect of more complex global economic policies on the food industries. For manufacturing companies to continue to be successful, they must capitalize on the potential advantages of tariffs while taking the necessary steps to reduce the impact of possible disadvantages. As a result of all the implications of increased taxation of imports, companies should research and anticipate this, as well as the average consumer household that will end up spending additional money to compensate for any tariffs on the products they buy.

The focus of this project will be to show in detail the potential challenges and cost consequences of new tariffs, not only on the food industry but also on consumers. Therefore, this study aims to understand the importance of U. S. tariffs on the food manufacturing sector. Data was gathered from historical tariffs along with the effect those had on consumers and organizations. This was leveraged to develop mathematical models to estimate the impact of additional tariffs.

BACKGROUND

Food Manufacturing

Manufacturing is a segment of any economy that substantially impacts most developed countries. Within the several types of manufacturing, some of the biggest ones are chemicals, textiles, automotive, food, and pharmaceuticals. The food sector was chosen to be studied further since goods in this sector tend to be recurrent expenses for most consumers, unlike other sectors. Moreover, this industry is also a major employer within the country. According to the U.S. Department of Agriculture (USDA) and the US Department of Commerce, as of the 2021 census, the food and beverage industry employed 1.7 million workers, making up over 15% of all U.S. manufacturing employment [6]. They also provide a breakdown of how employment is distributed within this sector, shown in Figure 1.



Source: USDA, Economic Research Service using data from U.S. Department of Commerce, Bureau of the Census, 2021 Annual Survey of Manufactures; data as of December 2022.

Figure 1
Food and Beverage Manufacturing Employees by Industry [6]

Another key aspect that shows the importance of the food industry is its impact on the economy and the efforts made to improve the company's performance, efficiency, and revenue. To achieve this, food manufacturing companies leverage strategies such as pricing, advertising, product differentiation, and sourcing initiatives [7]. These strategies correlate not only with employment opportunities but also with capital spending in the local economy and communities.

Global Supply Chain

The global supply chain within the food industry encompasses the steps needed to make products, from producing raw materials or ingredients to the consumer buying and eating the food. The steps can be summarized as follows: growing ingredients, sourcing ingredients, handling, processing, packaging, distribution, retail, and consumption. The implications of those changes across the food manufacturing sector will have ramifications across different levels of the supply chain.

Agriculture is at the base of the global food supply chain. Many of these products are imported

for U.S.-based food manufacturing companies and American households, and most products contain a combination of domestic and foreign materials or ingredients. Foreign value makes up 20% of the final manufacturing value of several countries and over 50% in others [8]. Moreover, the U.S. imports and exports agricultural products and finished product goods within the manufacturing industry; of all the food products that the country exports, the number of exports reached $174 billion, according to the USDA. On the other hand, U.S. imports totaled $195 billion as of 2023, and processed foods account for most of it, with $118 billion. Some major imports are fruits, nuts, vegetables, beverages, sugar, coffee, cocoa, and spices; the last four account for 15% of imports [9].

Import Tariffs

Tariffs are taxes imposed, usually by customs, on imports due to their country of origin, the nature of the goods themselves, or other characteristics. Most economists agreed that free trade allows companies to be more efficient and create a superior product for their consumers, according to a survey by the University of Chicago in 2012. However, by incentivizing consumers, tariffs can also help a country's domestic economy. Additional policies have also taken place, such as in 2018 when the U.S. imposed tariffs on China under the assumption that the country used the intellectual property of U.S. companies, thus violating international agreements. Similarly, President Trump imposed tariffs on other countries that allegedly used unfair practices, citing national security concerns and the need for specific industries and their workers [10].

Figure 2 shows the tariffs that the U.S. and China have on each other between 2018 and 2020, and how a change in one of the countries' tariffs consequently makes the other country increase its tariffs. Additionally, trade wars affect the broader supply chain. Whenever ingredients are imported to manufacture goods, the tariffs on the ingredients will make finished goods more expensive. Figure 3 gives an image of the disruptions in the supply chain by country as of 2022, showing how not all regions are affected equally when different tariffs are enacted. They can also impact competitiveness, consumer demand, and increase the volatility of stock markets as side effects [11].

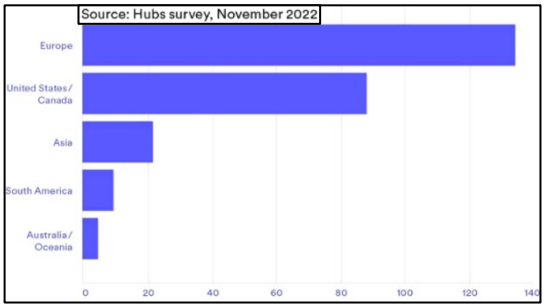


Figure 2
China and U.S. Tariffs on Each Other Between 2018 and 2020 [10]

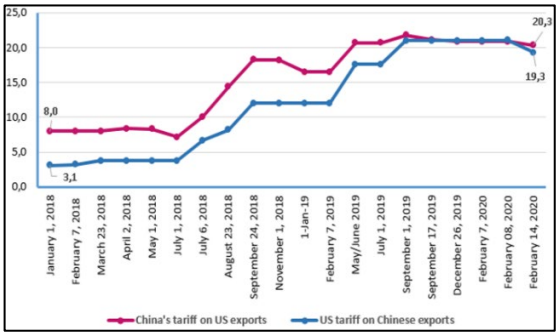


Figure 3
Affected Regions by Supply Chain Disruptions from 2022 [11]

Consumers

Usually, exporters will set restrictions, and importers will set tariffs to offset any broader changes, which can have a multiplier effect. In some markets, governments are not fighting trade wars to safeguard consumers. If food prices are high, a country could increase import subsidies and set export taxes, reducing the cost of imported goods for consumers while incentivizing industries to sell the product domestically. Conversely, when food prices are low, the country could subsidize exports or impose import tariffs to maintain prices [12].

The U.S. has implemented several trade policies intending to protect consumers. Those have led to higher incomes, lower prices, and more choices of products for consumers in the short term. However, long-term consumers end up paying for part of the

change in the cost of imports. Furthermore, grocery stores may choose to offer the most profitable products, taking away choices for their customers [13].

Employment is another factor to consider, as the U.S. increases import tariffs, countries will respond with retaliatory tariffs that will hurt U.S. exports, affecting the nation's broader manufacturing sector. Figure 4 shows how U.S. counties are affected by counter-tariffs imposed by multiple nations. Some countries saw a decline in their exports of up to 27% [14]. This is critical because a decrease in sales might cause lower volumes and productivity, which can lead to stagnant salaries for their employees or even layoffs if the company is losing significant profits from the tariffs.

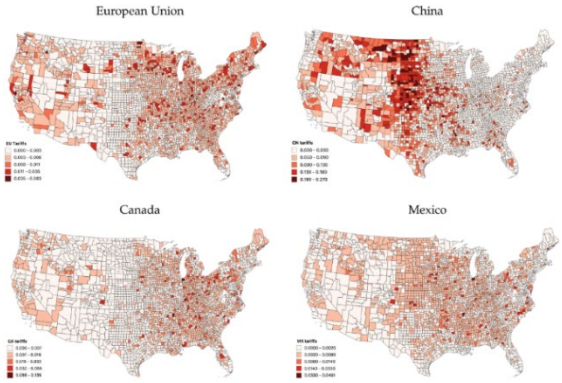


Figure 4
County-Level Share of Exports in the U.S. Affected by Retaliatory Tariffs [14]

U.S. Tariffs and Retaliatory Restrictions

Between March and April 2025, the United States announced a plethora of reciprocal tariffs for several countries, including Mexico, China, and Canada. These tariffs were based on calculations from trade barriers and currency manipulations as defined by the government using the following formula:

$$\Delta\tau_i = \frac{x_i - m_i}{\varepsilon * \varphi * m_i} \quad (1)$$

The Office of the United States Trade Representative (USTR) defines the terms as the change in tariff rate ($\Delta\tau_i$), the elasticity of imports with respect to import prices (ε), the passthrough from tariffs to import prices (φ), the total imports from the country (m_i), and the total exports (x_i). The price elasticity of demand was set at 4, and the elasticity of prices was set at 0.25. The total imports and exports can be found from the U.S. Census database for trade in goods by country, and the reciprocal tariffs can be calculated. Here, an example is presented with data from China, one of the largest importers from the U.S [15].

$$\Delta\tau_{China} = \frac{\$143{,}545.7 - \$438{,}947.4}{4 * 0.25 * \$438{,}947.4} = -67.3\%$$

With this result, the U.S. divided it in half and set that number as their discounted tariffs of 34%. Mexico and Canada have an agreement under the United States-Mexico-Canada Agreement (USMCA) that excludes several goods from tariffs, and others have predetermined tariffs. However, the ones not included here had proposed tariffs of 25% by the United States.

Quickly after the country enacted its tariffs, countries responded with their own. Canada imposed 25% retaliatory tariffs on the U.S. These applied to CAD 29.8 billion imported products excluded from the USMCA, effective March 13th [16]. China matched the 34% imposed by the U.S., effective April 9th. Mexico has yet to announce any tariffs.

Models

Food Manufacturing Sector

The U.S. has several manufacturing companies that operate within and outside the country. Most manufacturers produce goods within and export part of their products to foreign countries, the principal ones being Canada (USD 356.5 billion), Mexico (USD 324.3 billion), and China (USD 150.4 billion) [17]. Proposed new tariffs are sparking retaliatory tariffs from these countries, which will impact sales and revenues of U.S. manufacturing companies that rely on consumers within and outside the country.

Canada and Mexico are in a unique situation given the USMCA trade agreement, which excludes them from any tariffs. The USMCA was predicted to increase U.S. agricultural exports by USD 2 billion, which, in theory, would increase gross domestic income by USD 65 billion [18]. Products covered

under USMCA won't be affected even with the new tariffs. Therefore, a significant part of the sector won't see a drastic change with the proposed import tariffs. However, goods non-compliant with this agreement will be subject to a 25% tariff.

Conversely, China has no similar trade agreement to the U.S., and most goods will be subject to the new 34% tariff. The food industry will likely see a reduction in exports due to the retaliatory tariffs mentioned previously. To estimate the effect of U.S. tariffs on the export of goods, an equation from Figure 5 was created.

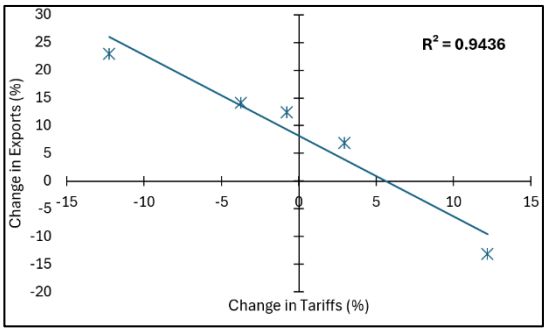


Figure 5
Correlation Between Significant Tariff Changes by the U.S. and the Percentage Change in Exports [19][20]

For this graph, the relationship between significant changes in tariffs (>0.5%) and exports was presented. When obtaining the export values, the percentage change for the following year was used to account for the lag when countries impose retaliatory tariffs and reflect on exports. This number is from the Foreign Trade Division of the U.S. Census Bureau. Tariff values were obtained from the World Bank Organization as a weighted average. To assess the impact on the exports of the food industry, a weighted average of 11.51% was used as the incremental percentage change of the U.S. new tariffs. Then, a linear equation based on the data from Figure 5 was calculated, as shown below.

$$\Delta Ex_{US} = -1.4572 * \Delta Tf_{US} + 8.1447 \quad (2)$$

Equation 2 describes the correlation between the change in U.S. Exports (Ex_{US}) as a function of the change in U.S. tariffs (Tf_{US}). Two constants were obtained empirically based on data from 1989 to 2022. The negative value of the first term (-1.4572) shows an inversely proportional correlation between exports and tariffs. The coefficient of determination (R^2) was used as a descriptive statistic that represents how well the dependent variable, in this case, the change in exports, can be explained by the independent variable, the change in tariffs, within this model. This value ranges from 0 to 1, which denotes no correlation between the variables when the value is 0, and a perfect correlation between the variables explained by the model when the value is 1. Here, the R2 value obtained was 0.9436, which shows that 94.36% of the variation can be explained by equation 2. Applying the weighted average value for the new import tariffs imposed by the U.S., a theoretical change in exports can be calculated based on the empirical model (3).

$$\Delta Ex_{US} = -1.4572 * 11.51 + 8.1447 = -8.6\% \quad (3)$$

This number shows that with the current tariffs, a decrease in exports of 8.6% can be expected. Moreover, the total export loss for the food manufacturing sector can be obtained using the total value of exports for the industry in 2024 from the U.S. International Trade Commission (USD 142.6 billion). By multiplying this value and the change in exports, a loss of USD 12.3 billion is estimated because of the decrease in exports from the U.S. to countries where tariffs increased.

Consumer Implications

Besides the impact on the broader economy and organizations, consumers tend to bear the cost of changes in the price of their products. To analyze the potential effects on consumers from new U.S. tariffs, a similar plot was made to compare the overall food sector consumer price index (CPI) with tariffs to understand if there is any correlation between the two. Once more, only significant changes in tariffs (>0.5) were used in Figure 6 to filter out any noise that might cause the CPI of the food sector to fluctuate besides tariffs.

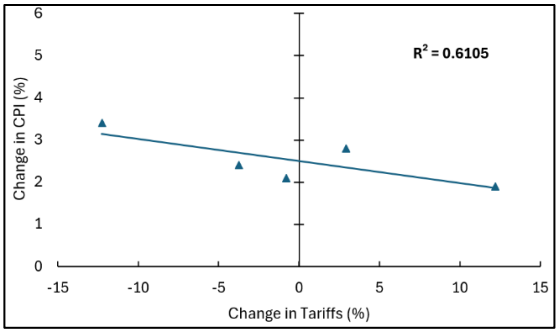


Figure 6
Correlation Between Significant Tariff Changes by the U.S. and Percentage Change in the Food Sector CPI [20][21]

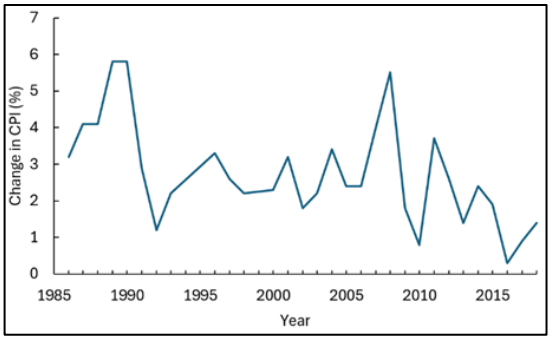


Figure 7
Percentage Change in CPI of the Food Sector for Years without a Significant Change in U.S. Tariffs [21]

For these values, the tariff values from the U.S. by year, according to the World Bank Organization, and the CPI percentage change for food were obtained from the Economic Research Service of the USDA. The same descriptive statistic determination coefficient, R^2, from the previous section was obtained with a value of 0.6105. This shows that equation (4) can only account for 61.05% of the variation in the change of CPI. A mathematical model for the relationship between the variables can be obtained with these data points as follows.

$$\Delta CPI_{F,US} = -0.0521 * \Delta Tf_{US} + 2.5027 \quad (4)$$

This equation correlates the changes in CPI for the food sector of the U.S. ($CPI_{F,US}$) as a function of changes in tariffs (Tf_{US}). The negative coefficient means there is a negative relationship between the two variables, but the low value of 0.0521 shows that for each percentage change in the tariffs, the CPI will not change much. Using this equation as in the previous section, the change in the consumer price index can be expected based on the current proposed tariffs.

$$\Delta CPI_{F,US} = -0.0521 * 11.51 + 2.5027 = 1.9\% \quad (5)$$

Moreover, the CPI percentage change for previous years was studied in Figure 7. Here, this value tends to be between 0% and 3% after 2010. This puts into perspective the result of 1.9% obtained with the new tariffs, as within the range of the CPI increase in years without a significant change in tariffs.

According to the U.S. International Trade Commission (USITC), the total food sector imports for consumers had a total value of imports to the U.S. in 2024 of USD 186.1 billion. Applying the previous CPI increase to this value, the cost for American consumers can be estimated at USD 1.9 billion [22]. As a percentage of the total imports of the U.S., this number is relatively small, and to understand why, a further dive into these imports should be taken.

RESULTS

Domestic Food Sector Impact

For this study, an emphasis was given on the three countries where the U.S. exports the most (Canada, Mexico, and China). These countries account for USD 831.2 billion of the total exports. Given the considerable value of imports, trade restrictions or policies affecting other countries will significantly impact on the domestic manufacturing industry. The USMCA provides a benefit to imports that meet specific requirements that enable the trade of goods with a predetermined duty rate. Most products under this agreement have little to no duty rates within the food industry. However, most international food manufacturers operating within the U.S. export outside these two countries.

To account for the effect tariffs might have within the manufacturing sector, an equation was developed (2). This correlation showed that the change in exports strongly correlated with changes in tariffs greater than 0.5%. The accuracy of this mathematical equation in modeling the behavior of

the change in exports was validated with the R^2. This statistical measurement proved with a 0.9436 value that significant changes in tariffs have a great correlation to changes in exports. Later, this equation was used to obtain a theoretical decrease in exports of 8.6%.

To extrapolate these results, a couple of assumptions were made. For example, the equation shows the relationship between tariffs and all exports. It was assumed that this relationship could be extrapolated to the food industry, particularly with high accuracy. Another assumption for this section is that the data set from 1989 to 2022 is representative whenever changes in tariffs of more than 0.5% occur. If those are true, the food manufacturing sector will likely see a reduction in exports totaling around USD 12.3 billion.

Consumer Impact

The impact of tariffs on U.S. consumers within the food sector was also theorized by performing a similar analysis to the one previously discussed. The consumer price index (CPI) for food was used to indicate how the sector changes affect consumers and their households. The mathematical model obtained (3) shows the proposed relationship between changes in tariffs and changes in the CPI. For this linear model, the R^2 value calculated was 0.6105. This value indicates that there is a correlation between the two factors. However, this only accounts for about 60% of the variation, meaning that the change in tariffs does not explain a significant part of the change in CPI.

A more holistic view of the CPI behavior was taken in Figure 7 to understand this implication further. This image shows the fluctuation in the CPI over the last two decades, in years when there wasn't a significant change in tariffs. Here, it is seen that the fluctuations during these years go up to almost 6%, which would be explained by external factors not related to tariffs. This further validates the suggestion from the coefficient of determination, also alluding to some relationship, but showing that the factors that play into CPI changes are more complex than the model theorized.

With the change in the value of CPI in the food industry caused by changes in tariffs from the model, an increase of 1.9% can be expected. This number is within the range of CPI changes from previous years. A potential explanation for why consumers won't see an impact as high as the one in the food manufacturing sector is the USMCA. From the total of USD 186.1 billion, USD 72.9 billion are imports from Canada and Mexico, which account for 39.2% of all imports [23]. As previously discussed, several of the products from the food sector imported and exported from these two countries have little to no taxes under the USMCA. This likely mitigates the proposed tariffs' impact on consumers since almost 40% of imports in this industry won't be affected by further changes in tariffs. Coincidentally, these would show that tariffs will only impact approximately 60% of imports within the food sector. However, validating or disproving this theory will require additional considerations and is beyond the scope of this study. Further analysis and research should be done to determine if the USMCA agreement truly has a direct correlation to the CPI and, if so, to what extent.

CONCLUSION

Over the last few decades, countries have become increasingly interdependent. Goods and commodities sometimes need to travel between numerous countries with different trade policies that impact producers and the final consumers. Here, the potential impact of trade restrictions in the form of import tariffs was analyzed. First, the tariffs proposed by the U.S. Government in early April 2025 were presented. These restrictions range from 10% to almost 50%, depending on the country. These "discounted reciprocal tariffs" were calculated based on the trade deficit by the U.S. with each country, as shown in (1), and then divided by half. A weighted average from these tariffs was then used to hypothesize the impact these tariffs can have on manufacturers and consumers.

For this study, the analysis was focused on the food industry because it is relatively inelastic.

Meaning that when prices fluctuate, demand is not affected much; consumers will need to buy roughly the same food products, independent of a shift in pricing, in contrast with other goods or services with an elastic demand, or other commodities that most consumers can choose not to purchase.

The potential effect of the tariffs on food products was discussed. An average increase of 11.51% in tariffs by the U.S. can cause a reduction of 8.6% in exports from food manufacturers based in the country. This is likely caused by retaliatory tariffs that other countries will impose as a response to tariffs by the U.S. Based on the current exports of the food manufacturing industry, this represents a USD 12.3 billion decrease. However, this could be upset by an increase in domestic gains caused by higher prices of imports within this sector. Moreover, the impact of said tariffs on consumers was also studied. Here, the CPI was used as a measurement of how the consumer would be affected, as it is the price index of goods. Specifically, the CPI for food products was correlated with tariffs, and the effect these will have on the budget of American households was theorized. Equation (5) shows a change in this index of 1.9%, which is on par with previous years without significant tariff changes. The leading explanation for the relatively low impact on food products is that when it comes to imported food products consumers buy, almost 40% come from Canada and Mexico, and several products from these countries are included in the USMCA.

Overall, the most significant changes will be felt in companies and organizations that rely more on exports within the food industry. For consumers, the impact appears negligible since the increase caused by tariffs is like years without significant changes in tariffs.

Limitations and Recommendations

The equations and conclusions derived might not apply to other sectors of the economy, given that others might have higher elasticity than food products, which will affect the accuracy of the models. Other factors are likely to affect exports and CPI, given the complex nature of analyzing economic changes in the international landscape. Still, an assumption was made that these were either constant or had a negligible impact. Moreover, the determination coefficient of the CPI model (4) is significantly lower than the one from the export model (2), which further indicates that although trade restrictions and the price of food products are likely related, there is a high probability that other variables significantly affect the CPI. Due to the additional complexity of considering tariffs depending on the sector, an assumption was made that the weighted average of the proposed tariffs was like that of the food sector products.

Further research should be conducted on other factors related to tariffs, exports, and the CPI. With higher complexity models, the accuracy of the models developed here can be tested to assess whether the assumptions hold true. Other sectors should also be studied and modeled to better understand the implications of trade restrictions within the broader economic sector, each with its own nuances. Additionally, more variables besides the specific sector exports and CPI can be analyzed as different quantifiable metrics that are affected by changes in tariffs.

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