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The Impact of the 2018 Trade Disruptions on the Iowa Economy

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Executive Summary

In this analysis, we use historical trade patterns, revenue linkages, and recent futures market price changes to discern the 2018 tariffs' near-term impacts on the state of Iowa. We use two distinct modeling techniques, and in each technique we make two distinct assumptions. First, we use partial-equilibrium modeling approaches that do not directly consider linkages among the markets and industries across the state of Iowa. In these approaches, two assumptions about price changes are invoked—either the price changes are based upon supply and demand elasticities or the price changes are based upon observations in the futures market. The partial equilibrium techniques look specifically at the corn, soybean, ethanol, and hog markets along with labor and government revenue impacts from changes in these markets. The second technique is a general equilibrium model that examines the trade disruptions across 20 distinct industries in Iowa while taking into account that some industries benefit from tariffs and others do not. In the general equilibrium analysis, we use two scenarios—using price changes estimated from a global model and using observed futures prices—that reflect assumptions about how tariff revenue might return to Iowa. Both modeling techniques and their two sets of assumptions result in four estimates of the trade impacts. The overall impacts across the methodologies are similar. While there is a great deal of uncertainty about the duration of the trade disruptions and the impact these disruptions might have to long-held trade equilibria, the main results of the study are as follows.

- Overall losses in **Iowa's Gross State Product** are calculated to be $1 to $2 billion (off of a Gross State Product of $190 billion).
- Overall losses to Iowa's **Soybean** industry of $159 to $891 million, with an average revenue loss across all models of $545 million (Iowa soybeans are a $5.2 billion industry).
- Overall losses to Iowa's **Corn** industry of $90 to $579 million, with an average revenue loss across all models of $333 million (Iowa corn is an $8.5 billion industry).
- Overall losses to Iowa's **Pork/Hog** industry of $558 to $955 million, with an average revenue loss across all models of $776 million (the Iowa pork/hog industry is a $7.1 billion industry).
- A 2% drop in **Ethanol** prices resulting in approximately $105 million in lost revenues to Iowa ethanol producers.
- Revenue losses in these industries translate into **additional lost labor income** across the state. Labor income declines from the impacts to the corn, soybean, and hog industries range from $366 to $484 million without federal offsets and $245 to $364 million with federal offsets.
- Iowa **tax revenue losses** (personal income and sales taxes) range from $111 to $146 million. Federal offsets would reduce tax losses to $75 to $110 million.

Introduction

Over the past two years, U.S. trade policy has shifted dramatically and several trade disputes have erupted. From the uncertainty of the ongoing NAFTA renegotiations to the multiple rounds of tariff increases between the United States and China (including a new round on September 18, 2018, as this report was being written), U.S. producers and consumers are adjusting to shifting export/import patterns and higher costs of international trade. Given the importance of international trade to the Iowa economy, we undertook an examination of impacts to Iowa's economy from the current set of trade disputes.

In 2017, Iowa's gross state product (GSP) was $190 billion. The manufacturing and financial services industries were the top contributors, combining for roughly one-third of Iowa's GSP. Several other service sectors, including health, real estate, and government, exceed agriculture's direct contribution of 5% (see Figure 1). However, these numbers mask the indirect impact of agriculture across the Iowa economy. Production of agricultural machinery and equipment is one of the largest segments in Iowa manufacturing, the Iowa Department of Agriculture is among the largest state government departments, farm leasing is a major component of Iowa's real estate sector, and crop insurance is one of the leading segments in Iowa's financial industry.

The Census Bureau estimates Iowa's export value for 2017 at $13.4 billion, roughly 7% of Iowa's GSP. Corn is the top export product at $1.18 billion, tractors are second at $747 million, fresh and chilled pork is third at $442 million, and herbicides and frozen pork round out the top five. The Census Bureau also tracks the destination of exports. Based on their data, Canada is the top export destination for Iowa, receiving $4.08 billion in Iowa products, Mexico is second with

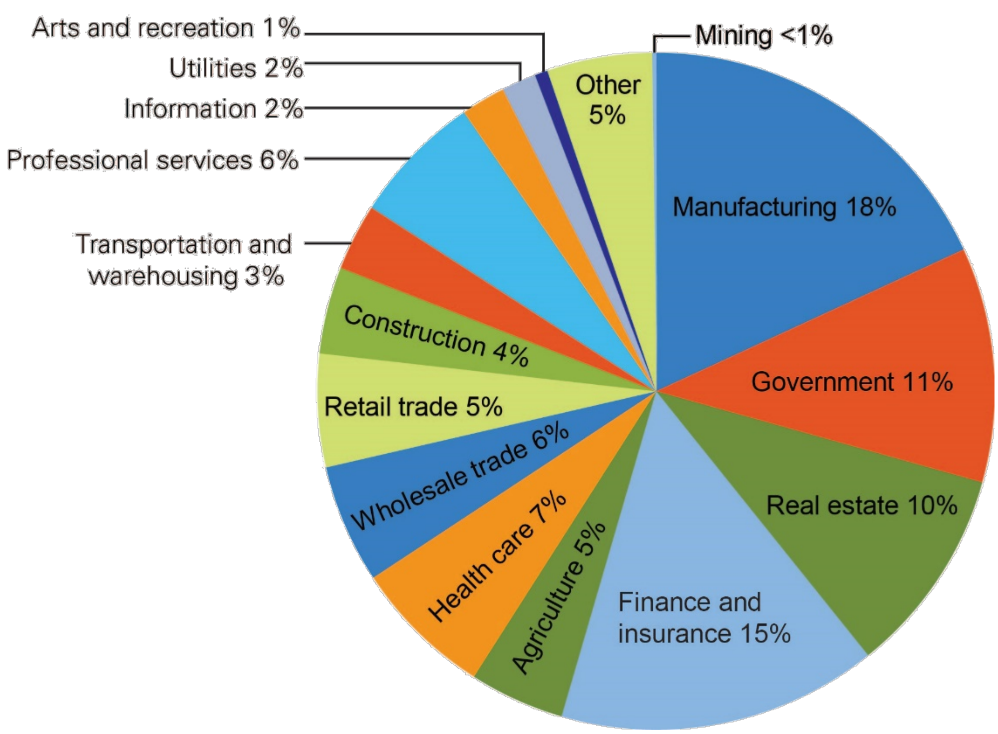

Figure 1. Sectors of Iowa's Gross State Product, 2017
Source: BEA

$2.26 billion, Japan is third at $1 billion, and China and Germany complete the top five. Only two of Iowa's top ten export products can be classified as non-agricultural—civilian aircraft parts at $282 million and aluminum alloy plates at $207 million. Agriculture dominates Iowa's trade scene; however, these numbers actually understate Iowa's trade picture. Census Bureau data is based on origin of movement, which means that products produced in Iowa, but warehoused or stored in another state before export, are counted as exports for the warehousing state.

To better estimate agricultural export values, USDA's Economic Research Service examined farm cash receipt data to reallocate agricultural exports at the state level. Their estimates reveal over $10 billion of agricultural production is exported from Iowa, second only to California in value. The latest estimates for the 2016 calendar year show Iowa is the leader in pork ($2 billion), hides ($237 million), corn ($1.8 billion), feeds ($1.36 billion), and soybeans ($3.24 billion), as shown in Table 1.

Given Iowa's strong rankings for many agricultural products, national patterns mimic state export patterns. Across all agricultural products, Canada and China rotate as the two largest trade partners, with roughly $20 billion of agricultural trade each year, Mexico is third-largest at $18 billion, and the European Union and Japan round out the top five, with trade values in the $11 billion range each.

Looking further into the commodity-specific numbers for the 2016 calendar year, Canada and Mexico each purchased over $700 million of beef from the United States. In the pork market, Canada, China, and Mexico are major trade partners, combined they represent over half of all U.S. pork exports. Mexico is the largest international market for corn and soybean meal, capturing roughly 25% of U.S. corn exports and 20% of U.S. soybean meal exports. Meanwhile, China has dominated U.S. soybean exports, taking roughly 60% of all exports—$14 billion of China's $20 billion agricultural trade with the United States is in soybeans alone.

Table 1. Iowa's Ag Export Rankings and Values for 2016

Category	State Ranking	Value ($ million)
Total Ag Exports	2	10,890
Total Animal Exports	1	2,910
Beef	4	384
Pork	1	2,000
Hides	1	237
Dairy	12	113
Other Poultry	4	132
Total Plant Exports	2	7,990
Corn	1	1,800
Feeds	1	1,360
Processed Grain	1	485
Soybean	1	3,240
Soybean Meal	1	581
Vegetable Oils	1	410

Source: USDA-ERS

Agriculture is an area where the United States has maintained a trade surplus for a very long time. Figure 2 shows the value of U.S. exports and imports from 1970 to 2018. In that period, the United States enjoyed an agricultural surplus and saw tremendous growth in agricultural trade. Since 1970, agricultural exports and imports have risen significantly. While U.S. agricultural imports have steadily risen—the only major downturn is related to the Great Recession—U.S. agricultural exports have been much more variable, shifting sizably with trade policies and commodity prices. The downturn in the 1980s is linked to the Russian Grain Embargo, the repositioning of U.S. farm export leadership following that embargo, and the subsequent farm financial crisis. The boost in the late 2000s is tied to the dramatic expansion of soybean trade with China and the general rise in commodity prices from 2006 to 2013.

The expansion of agricultural trade has been global, but the largest effects are concentrated. Figure 3 separates U.S. agricultural export values among three groups—countries with which we have free trade agreements, China, and the rest of the world (labeled Other Non-FTA). During the past few decades, U.S. agricultural exports increased for each of the three groups. However, the growth has been more significant with our free trade partners. Over the course of the last four decades, the United States has entered 14 free trade agreements with 20 countries. Most of these agreements are bilateral, but there are two multilateral agreements, NAFTA with Canada and Mexico and CAFTA-DR with a number of countries throughout the Caribbean and Central America. As our trading relationships with these countries matured, our agricultural exports soared, rising from 19% of total agricultural exports in 1985 to 43% in 2017. The bulk of that growth came with NAFTA, as Canada and Mexico represent nearly two-thirds of the FTA partners' total export values. China had been a relatively small agricultural trade partner until the early 2000s; however, the need for soybeans as feed for the Chinese hog industry created the

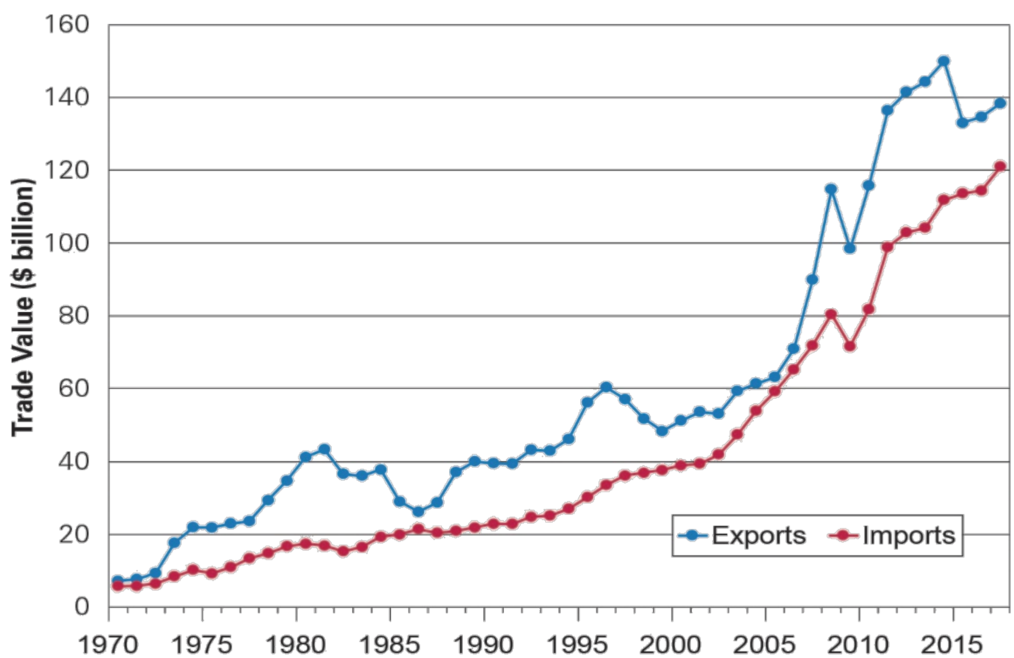

Figure 2. U.S. agricultural trade value ($billions), 1970–2018
Source: USDA

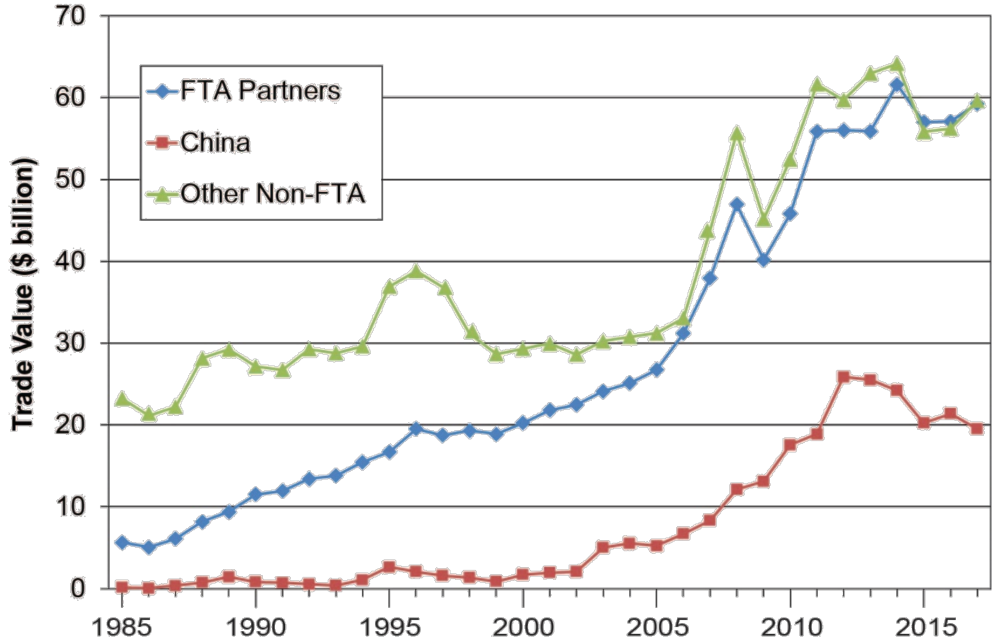

Figure 3. U.S. agricultural export values ($billions), 1985–2017.
Source: USDA

impetus for a dramatic shift. The growth in export values to China from 2003 to 2012 reflects the combination of greater numbers of bushels of U.S. soybeans headed to China and higher soybean prices throughout the period. While soybean export quantities have continued to grow since then, with the exception of 2017, soybean prices have fallen significantly, lowering export values.

Digging a bit deeper in the export data, we can see trade patterns have changed notably. In 1995, Japan and the European Union were the United States' largest agricultural trade partners, as shown in Figure 4. Over time, China replaced Japan as U.S. agriculture's foremost destination in East Asia. The European Union and East Asia shrank in market share, while NAFTA provided the fuel for growth with our North American partners. Agricultural trade has expanded in South and Southeast Asia, with significant gains in India and Vietnam.

These figures show that more open and free trade has benefitted U.S. and Iowa agriculture. While it is not the only driver in export growth, as the growth in U.S.-China trade exhibits, it is a very significant factor. Economic theory in trade outlines the idea of comparative advantage—the ability for an entity to produce a good or service at a lower (relative) cost than other entities competing with it—and each country has different products where they have a comparative advantage. Given the dispersion of comparative advantage across countries and products, trade can be mutually beneficial to all countries involved. Tariffs, border taxes, and other trade-restricting policies distort cost structures; and thus, they distort comparative advantages and trade flows.

In the case of agriculture, the United States has a comparative advantage. We are the world's largest producer of many agricultural products and have developed significant resources to transport our agricultural products throughout the country and around the world. Compared to other countries, the United States is a high production, low cost source of agricultural products.

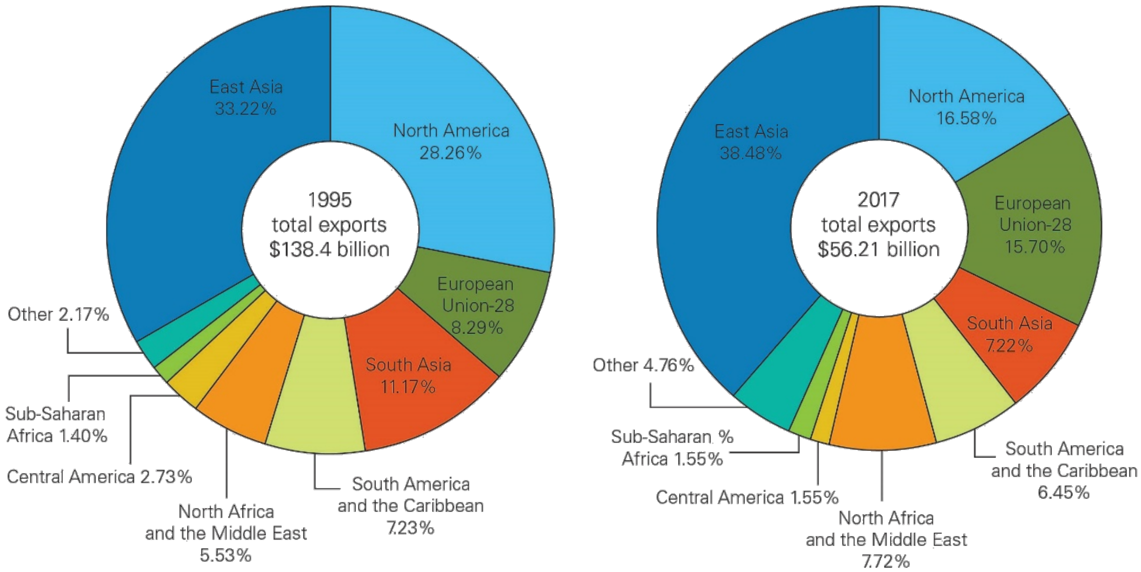

Figure 4. Shifts in regional agricultural trade flows, 1995 and 2017.
Source: USDA
Note: Numbers underneath regions are the percentage shares of U.S. export values.

As Figure 4 shows, the removal of trade barriers, such as tariffs, via free trade agreements provides an economic boost to U.S. agriculture.

Many U.S. agricultural products now rely on international demand as a major component of total demand and U.S. agricultural production has expanded to match global demand. For Iowa's major crops, 2016/17 exports consumed 15% of U.S. corn and 48% of U.S. soybeans. However, other crops are just as, if not more, reliant on exports. Forty-five percent of the U.S. wheat crop is exported, along with 47% of U.S. sorghum, 51% of U.S. rice, and 84% of U.S. cotton. International trade is also important to the livestock and dairy industries. Twenty-one percent of all U.S. pork is exported, along with 10% of U.S. beef, 17% of U.S. broilers, 9% of U.S. turkeys, and 22% of U.S. dairy.

In hindsight, the 2018 trade disruptions should not have been a surprise, as trade rebalancing has been a major issue for the Trump administration. Since Trump took office, the KORUS agreement was modified, NAFTA is currently being renegotiated, trade issues between the United States and China erupted on a variety of fronts, and the battle over tariffs escalated quickly. At the beginning of 2018, the United States imposed tariffs on imported solar panels and washing machines, and China responded by initiating an anti-dumping investigation into U.S. sorghum. In early March, 2018, President Trump announced steel and aluminum tariffs, with China being one of the primary targets. Within two weeks, China responded by announcing 128 U.S. products (including pork products and ethanol) as targets of retaliatory tariffs. Other countries and regions impacted by the steel and aluminum tariffs, such as Canada, Mexico, and the European Union, also responded with tariffs, often hitting agricultural targets. As those tariffs went into effect, the U.S. Trade Representative announced 25% tariffs on $50 billion worth of Chinese imports, along with investment restrictions and the submission of a case to the World Trade Organization over China's trade practices. The Chinese government responded immediately with its own tariff package, targeting roughly $50 billion of U.S. imports, including the largest agricultural import, soybeans. The volleying continues as President Trump announced another round of tariffs for Chinese imports in September, 2018, and China retaliated (the specifics of these recent tariffs were not available when the models in this report were created). While agriculture has not been the root cause for any of these disputes, it has played a prominent role in the international responses to U.S. tariffs.

Previous trade battles, such as the Russian Grain Embargo and the 2009 dispute with China (tires vs. chickens), demonstrate that once trade market share is lost, it is difficult for markets to return to the previous relationships—exporting nations dominating markets in terms of price-setting behavior face more competition as new exporters show they're able to meet supplies once the purview of the dominant nation. Trade flows adjust to avoid tariffs, embargoes, and other trade-distorting policies. Countries outside the disputes gain market share, as their products displace others that face trade barriers. The European Union gained much of the trade the United States lost from the Russian Grain Embargo, and Brazil and the European Union replaced the United States for much of China's chicken trade.

The loss of market share and the resulting loss of farm income is a major concern for U.S. agriculture given the current trade disruptions. What the future looks like after either the disruptions end or the tariffs are made permanent is something no economist can accurately predict because analyses are based on the world as it has existed in the recent past. Markets are like living organisms—they move, they restructure, and they adapt after disruptions. Spain was once the world leader in almond exports; however, today it exports to a negligible share of the world market, selling to the few markets California has passed over. This happened in part because, unlike California growers, Spanish producers never adapted to changing varietal demands from confectioners. Trade distortions also cause market structure to change. The Russian Grain Embargo resulted in the United States' long-run loss to European growers who were ready to fill that void. For decades, U.S. soybeans set the price to which other soybean markets were marked. Today, as a result of the trade disruptions, U.S. soybeans are selling at a discount to Brazilian soybeans. This sends a strong signal to Brazilian and other farmers throughout the world that the market may be very different in a few years. There is no economic model that can accurately predict what a new world where the United States is not the dominant trader will look like. What economists can do is apply what we know about current market relationships and use this to deduce what impacts will be in the near term before more fundamental structural parameters change.

A Partial Equilibrium Examination of the Impacts on Iowa Corn, Soybean, Ethanol, and Hog Markets

Without knowing whether the trade market will restructure, we ask what the impact from the current disruption will be given what we know about the economic relationships as they currently exist. To estimate the loss in farm income due to current trade disputes, we examine the price reactions of various agricultural markets since the announcements of trade barriers and estimate the share of tariff incidence based on U.S. supply and major trading partner demand elasticities and trade market shares. For the major Iowa crop-related commodities (corn, soybeans, and ethanol), the price reaction to the trade barriers began in earnest after Memorial Day. On May 31, 2018, Iowa cash prices were holding at $3.52/bushel for corn, $9.48/bushel for soybeans, and $1.41/gallon for ethanol. By mid-August, corn prices retreated nearly 9%, soybean prices fell 18%, and ethanol prices receded by roughly 4%. Over the same period, corn futures for the 2018 crop declined 9%, soybean futures dropped 15%, and ethanol futures declined 8%. The trade disputes are not the only factor weighing down on prices, as crop production projections for the upcoming crops suggest record soybean production and corn yields (leading to the second-largest corn crop) and record ethanol production.

To proportionally share the price declines between these two factors, we utilize supply and demand elasticities to compute the tariff incidence between the United States and its trade partners. We do this for a range of assumptions to produce a lower and higher range of estimates. Our estimates for corn and soybeans have the greatest range, reflecting less certainty over how these two markets will react. For ethanol, we examine only one scenario based upon the overall demand for inputs in that industry, which are invariant to the scenarios we examine for corn and soybeans. For pork, a lower and higher range of price reduction results in very similar revenue losses.

At the lower level, the tariff incidence indicates roughly 40% of the corn price decline and 60% of the soybean price decline is due to trade disruptions. That works out to a 4% decline in corn prices and a 10% decline in soybean prices.

At the higher level of estimates, the price of soybeans declines by 16.25% and corn by 6%. This second method assigns the 25% tariff incidence in inverse proportion to production, and given that the United States produces 35% of the world's soybeans, the U.S. price falls by 16.25% and the world price rises by 8.75%. The corn price decline is calculated by assuming 2019 futures price for corn fell due to a decline in 2019 soybean prices so as to avoid a huge swing to corn acres in 2019. The 2019 futures price decline impacts 2018 prices via cost-of-carry arbitrage.

Given the May 31, 2018, Iowa cash prices, we compute a $.13–$.21/bushel loss for corn and a $.95–$1.54/bushel loss for soybeans. As elasticities were not available for ethanol, we use half of the corn percentage damage estimate for ethanol, which leads to a 2% drop in ethanol prices ($.03/gallon).

Given the most recent projections for Iowa corn, soybean, and ethanol production, these price losses translate to a $325–$525 million drop in corn revenues, $551–$891 million drop in soybean revenues, and $105 million drop in ethanol revenues.

Combined, that is a $981 million to $1.521 billion decline to Iowa's crop agriculture.

Using a similar approach for hogs, we find that the trade disputes have lowered Iowa's hog receipts by roughly $800 million. Again we calculate this impact in two ways—elasticities and the change in the futures prices after adjusting for changes in expected production. Both methods provide almost identical answers. The elasticity method predicts a 12% decline in the price of hogs (a loss of $8.96/cwt or $18.81/head) with a revenue loss of $817.6 million. The futures markets method predicts a nearly identical 11.5% price loss ($8.47/cwt or $17.80/head) resulting in a revenue loss of $773.4 million.

The aggregate impact across Iowa's major agricultural commodities totals approximately $1.8–$2.3 billion, or roughly 16%–20% of Iowa's agricultural export value.

Economic Impacts Due to Revenue Reductions in the Corn, Soybean, Ethanol, and Hog Sectors of the Iowa Economy

We use the impacts to Iowa agricultural producers in the four major sectors–corn, soybeans, ethanol, and hogs—to determine how these impacts are felt in other sectors of the Iowa economy. In this section, we make restrictive assumptions because Iowa is not a country where trade can be measured precisely at its borders—a dollar earned in Iowa may be spent in Illinois. Where assumptions of this nature must be made we state them, but the reader is cautioned about the flows. We estimate the short-run consequences of revenue reductions associated with trade actions currently affecting Iowa's agricultural sector and its ethanol manufacturing firms. We base the impacts on the previous section's estimates of losses to Iowa producers and manufacturers in these industries and measure them using an input-output model of the Iowa economy.[1] We express losses in the model as reductions in proprietors' incomes for the farm sector, and as reductions in returns to investors for the ethanol firms. In none of the cases do we assume reductions in the quantity of commodity produced, just a reduction in price that is reflected in the compensation realized by farm owners and ethanol stockholders. We then link estimates of farm revenue losses with reductions in labor income in other sectors of the Iowa economy due to reduced economic activity. These reductions in labor income can be translated to job support levels based on typical wage rates within each segment of the economy; however, our calculation assumes no adjustments in wage rates or in employment status (full time vs. part time). We also display estimates of the likely state government tax consequences of these losses. Notably, our initial calculations do not include several factors, such as the economic impacts from Iowa industries that benefit from tariff protection or the potential flow of tariff-related federal offsetting payments to Iowa farmers. We summarize the value of the federal offsets to the economic and fiscal impacts at the end of this section of the report.[2]

Farm Level Impacts: Corn, Soybeans, and Hogs

We estimate that, combined, the corn, soybean, and hog sectors of the agricultural economy will lose between $1.68 billion in revenues, under the lower estimate, and $2.216 billion, under the upper estimate. We enter these losses into the model as a reduction in proprietors' incomes. Table 2 translates the revenue losses to farmers into losses realized in the rest of the Iowa economy.

Using the lower estimate, a reduction of $1.68 billion in receipts in these three sectors would lead to a loss in additional labor income outside of these sectors of roughly $366 million, or enough income to support roughly 9,300 jobs.

Under the upper estimate, shown in Table 3, farm proprietor revenue losses grow to $2.22 billion, which reduces additional labor income spent in the state by $484 million, or enough to support approximately 12,300 jobs.

An impact multiplier from the income losses is evident—using the lower estimate, the total labor income losses in Iowa from the farm sector are $1.68 billion plus $366 million in impact-driven labor income losses in the rest of the Iowa economy for a total of $2.05 billion. We arrive at an income multiplier of $2.05/$1.68 = 1.22, which means that for every dollar of lost proprietors' income to the farm sector, there is $0.22 in lost labor income in the rest of the Iowa economy.

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[1] Specifically, using the low and high estimates of revenue losses to corn ($325–$525 million) and soybeans ($551–$891 million) an $800 million loss to hogs and a $105 million loss to ethanol..

[2] See Appendix A for details on model assumptions.

Table 2. Farm Sector Impacts (Lower Estimate, $ million)

	Sector Revenue Losses	Additional State Lost Labor Income
Corn	-$325	-$71
Soybeans	-$551	-$120
Hogs	-$800	-$175
Total	-$1,676	-$366

Table 3. Farm Sector Impacts (Upper Estimate, $ million)

	Sector Revenue Losses	Additional State Lost Labor Income
Corn	-$525	-$115
Soybeans	-$891	-$194
Hogs	-$800	-$175
Total	-$2,216	-$484

Ethanol Sector Impacts

We measure estimates of the impact on the state's ethanol industry as reductions in returns to investors. Modeling the losses involves treating investment return reductions as losses in ordinary annual household income. There is, however, a critical consideration. Not all of the ethanol investor shares are owned by Iowans; hence, we have no idea of the actual share of Iowa's ethanol industry owned by Iowans. Accordingly, Table 4 presents a simple contingency table.

If Iowa's ethanol industry was entirely Iowa owned, which it is not, then the $105 million loss in revenues by the state's ethanol investors would result in a $27 million reduction in additional labor income, enough to support 693 jobs. The total amounts are reasonable estimates of the impact of the losses somewhere in the United States, but the fraction accruing to Iowa is unknown. Table 4 displays assumptions of losses accruing to Iowa given different levels of Iowa ownership in the ethanol industry.

As was the case with the analysis of the farm sector, there is also an implied multiplier—using any of the ownership percentages, that multiplier is roughly 1.3. For example, with the 50% ownership, we have ($53 + $14)/$53 = 1.3. This means that for every dollar of reduced ethanol industry returns to an Iowa household, there is a $0.30 reduction in labor income in the remainder of the Iowa economy.

State Fiscal Effects

Tables 5 and 6 show estimates of the state government fiscal consequences owing to these revenue and labor income losses. We base these values on statewide average tax incidences for personal income taxes, general sales taxes, and selected sales taxes.

In all, the reduced statewide incomes due to farm sector losses would potentially result in state tax collections reductions of $111 million under the lower estimate, and $146 million under the upper income loss estimate.

Table 4. Ethanol Sector Impacts ($ million)

Iowa Ownership Percentage	Revenue Losses to Iowa Investors	Additional State Lost Labor Income
100	-$105	-$27
50	-$53	-$14
10	-$11	-$3

Table 5. Potential State Government Tax Collection Impacts (Lower Estimate, $ million)

	Personal Income Taxes	General Sales Taxes	Selective Sales Taxes	Total Taxes
Corn	-$9	-$9	-$4	-$21
Soybeans	-$15	-$15	-$7	-$36
Hogs	-$22	-$21	-$10	-$53
Total	-$46	-$45	-$21	-$111

Table 6. Potential State Government Tax Collection Impacts (Upper Estimate, $ million)

	Personal Income Taxes	General Sales Taxes	Selective Sales Taxes	Total Taxes
Corn	-$14	-$14	-$6	-$34
Soybeans	-$24	-$24	-$11	-$59
Hogs	-$22	-$21	-$10	-$53
Total	-$60	-$59	-$27	-$146

As with the ethanol sector total income loss estimates, we use a contingency table for state government fiscal effects (see Table 7). If Iowa households owned 100% of the state's ethanol sector, which they do not, the income losses would lower state tax receipts by about $4 million, whereas 10% ownership would only lower receipts by less than half-a-million dollars. The appropriate fraction of ownership is not known, so Table 7 shows the range of potential state receipt losses.

Offsets to the Economic and Fiscal Impacts from Trade-Related Federal Payments

Current estimates predict the USDA will make payments totaling $550 million to Iowa farmers to offset the tariff-related impacts on agriculture. Those payments will, in turn, affect the economic impacts of the trade actions we present above as well as the state-level fiscal impacts. Tables 8 and 9 summarize the total economic impacts and the fiscal impacts with the federal payment offsets.

With the tariff-related federal payments to farmers, sector revenue losses in corn, soybeans, and hogs reduce to $1.1 and $1.7 billion (from $1.7–$2.2 billion as shown in Tables 2 and 3) for the lower and upper estimates, respectively. Additional state lost labor income falls from $415 and $533 million (see Tables 2 and 3) to $279 and $401 million under the lower and upper

Table 7. Expected State Government Tax Collection Impacts from Investment Income Reductions in the Ethanol Sector ($ million)

Iowa Ownership Percentage	Personal Income Taxes	General Sales Taxes	Selective Sales Taxes	Total Taxes
100	-$1.7	-$1.7	-$0.8	-$4.2
50	-$0.9	-$0.9	-$0.4	-$2.1
10	-$0.2	-$0.2	-$0.1	-$0.4

Table 8. Total Farm Sector Impacts After Federal Offsetting Payments ($ million)

	Sector Revenue Losses	Additional State Lost Labor Income
Lower Estimate	-$1,126	-$245
Upper Estimate	-$1,666	-$364

Table 9. Total Expected State Government Tax Collection Impacts After Federal Offsetting Payments ($ million)

	Personal Income Taxes	General Sales Taxes	Selective Sales Taxes	Total Taxes
Lower Estimate	-$31	-$30	-$14	-$75
Upper Estimate	-$45	-$45	-$20	-$110

estimates, respectively. These new numbers reflect lost labor income to support approximately 7,000–10,000 jobs.

Table 9 shows the total state-level fiscal effects with consideration of federal offsets. Under the lower estimate, state tax receipts would fall by $75 million after the federal offset payments, versus a $111 million drop without the offsets. Under the upper estimate, state tax receipts decline by $110 million with the federal offset payments, versus $146 million without the payments.[3]

A General Equilibrium Approach to the Tariff Impacts

In the previous sections, we focus our analysis on the impacts on the four main agricultural sectors of the Iowa economy—corn, soybeans, hogs and ethanol—and examine how reductions in revenues from those sectors might impact labor and tax receipts in the rest of the Iowa economy using an input-output analysis. Economists refer to this type of analysis as partial equilibrium analysis because general connections among markets are not (entirely) taken into account. Partial equilibrium analysis is often used as a first-pass analysis but is always useful as a comparative study. The tariffs will impact more than these four industrial sectors of the Iowa economy; and, in some cases, tariffs may benefit other sectors. Likewise, the impacts for the four sectors do not take into account feedbacks from any revenue losses and revenue gains in other

[3] Federal offsetting payments do not affect any of the ethanol-related economic impact or fiscal impact estimates.

sectors, nor do the tariff impacts take into account that the federal government collects revenue from the tariffs that may also offset some of the revenue reductions in the four main sectors.

In this section, we consider the economy-wide impacts of the current set of bilateral tariffs on Iowa using an open-economy general-equilibrium simulation model. In our model, the Iowa economy is represented as a system of non-linear equations that are calibrated to 2017 data, including supply and demand, production technologies, and external trade in a comprehensive set of goods and services. The general equilibrium model captures the whole Iowa economy and identifies consistent interactions across sectors, which are interrelated through the markets for intermediate inputs and factors of production. A general equilibrium approach also allows us to perform a theoretically consistent welfare analysis. General-equilibrium simulation analysis is the preferred method for analyzing trade policy because of the inherent distributional consequences of trade distortions, where tariffs benefit import-competing industries and harm exporting industries. This is the technique adopted by agencies like the United States International Trade Commission (USITC) and the World Bank to assess the welfare and income impacts of trade distortions.[4]

We use a set of consistent social accounts as the starting point for the Iowa general equilibrium model. The social accounts include value data on intermediate and primary-factor inputs for each sector, where the accounts satisfy the condition that supply equals demand across all commodities. We extract the Iowa social accounts from the open-source blueNOTE system recently developed at the University of Wisconsin's Department of Agricultural and Applied Economics (Rutherford and Schreiber 2018). We adjust the accounts to represent an equilibrium for Iowa in 2017, where we match income (gross state product) as well as the gross output of key sectors (soybeans, pork, corn, beef, primary metals, and fabricated metal products). We use USDA sources for output of the agricultural sectors, which are consistent with the partial equilibrium calculations in other parts of this report, and IMPLAN for metal sectors output.[5] With the equations calibrated to the 2017 benchmark equilibrium, we compute alternative equilibria under specific tariff scenarios.

The key drivers for the tariff scenarios are the tariff inclusive import and export prices that Iowa faces. We derive these price impacts from a global trade model based on the GTAPinGAMS system (Lanz and Rutherford 2016). We calibrate the global model to the Global Trade Analysis Project (GTAP) version 9 data, which includes a comprehensive set of countries and global regions but does not represent sub-national regions (like Iowa). To look at Iowa in detail, we port the price impacts established in the global model over to the Iowa model, which takes these as given.[6] Li (2018) compiles all imposed tariffs in the global model in a database that represents all implemented tariffs as of August, 2018.

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[4] See, for example, USITC (2017) "The Economic Effects of Significant U.S. Import Restraints," (USITC publication 4726).

[5] We use 2015 output values from IMPLAN to calibrate output in the metals sectors. The IMPLAN primary metals output appears to give us an accurate representation of the large Alcoa facility near Riverton, IA and the SSAB Montpelier steel works near Muscatine.

[6] Iowa is modeled as a "small open economy." That is, Iowa is assumed to be sufficiently small that within-state production allocations do not substantially impact world markets. Thus, Iowa takes import and export prices as given. Using a global model to determine external prices, or similar decomposition methods, are key to analyzing global policy shocks at the state level (see Balistreri and Rutherford 2001).

There are two alternative scenarios, and two corresponding sets of price impacts, that we consider for the analysis of Iowa:

- **Scenario A:** Current (Aug. 2018) bilateral tariffs with elastic responses.
- **Scenario B:** Current (Aug. 2018) bilateral tariffs with inelastic responses.

Under Scenario A, we assume technologies are more price responsive; and thus, the added tariffs indicate a relatively large reallocation of resources across sectors, and also represent relatively muted price changes. Under Scenario A, we adopt model parameters as in Lanz and Rutherford (2016). These include a set of trade elasticities derived from the GTAP database, and capital that is mobile across sectors. Under Scenario B, we assume that we have sector-specific capital, which limits supply responses. On average, Scenario B generates larger price impacts, which translates into larger welfare, output, and income impacts for Iowa.

We do make some adjustments in the price impacts as indicated by the global trade model. First, because the global model operates at a more aggregate commodity level, some of the price impacts are diluted. For example, pork is aggregated with poultry and other animal products in the GTAP accounts and corn is aggregated with other coarse grains. In Scenario B, we replace the price impacts from the global model with the observed futures price impacts for key commodities. The price impacts are -10% for soybeans, -4% for corn, and -12% for pork (notice we assume the same price changes in both hogs and pork as the data in the general equilibrium model do not disaggregate the inputs and outputs). In addition, for Scenario A we adjust the price of pork to -7%, which, in our judgement, is more realistic than applying the -0.5% indicated for the aggregate GTAP good that combines pork and poultry.

In order to run the Iowa model, we have to make one additional assumption concerning tariff revenue— the United States 2018 tariffs generate non-trivial amounts of revenue, and it is unclear how this will trickle down to individual state economies. The global model suggests that U.S. tariff revenue will increase by $14.5 billion. We present results for two alternative assumptions about how the revenue may be allocated. First, we consider a central case where Iowa receives a transfer of the tariff revenue in proportion to its income. Iowa's share of U.S. income is 0.98% (based on the ratio of Iowa GSP to U.S. Gross Domestic Product); thus, in the central runs we allocate 0.98% of the tariff revenue to Iowa as a direct transfer. As an alternative (worst case) scenario, we consider that Iowa receives none of the tariff revenue. Consider, for example, that the tariff revenue is used to offset the government deficit. The benefits would not accrue to the current Iowa economy, although it may benefit future generations through a reduced future tax burden.

Table 10 presents the price impacts (in percentage change) across Scenarios A and B for the commodities in the Iowa model. We take export price changes from the prices faced by U.S. producers in the global model. For import prices we use a weighted average of the gross of tariff import price and the U.S. domestic price, where the weights are based on indicated shares of Iowa imports that are sourced from international markets and the share of Iowa imports that are sourced from other states. We see substantial decreases in the prices received for the agricultural goods, whereas goods that have significant U.S. import tariffs become more expensive for Iowa agents to purchase. Note the figures in Table 10 in bold are assumed values (as explained above), whereas all other figures are calculated out of the global equilibrium.

Table 10. Iowa Price Impacts

	Export Price (% change) (US price)		Import Price (% change) (wtd. avg of Import and US price)	
	Scenario A	**Scenario B**	**Scenario A**	**Scenario B**
Soybeans	-2.8	**-10.0**	-0.3	-0.8
Corn	-0.9	**-4.0**	-0.5	-0.4
Other crops	-1.1	-0.3	-0.3	0.1
Beef	-0.8	-0.6	-0.9	-0.7
Dairy	-0.8	-0.7	-0.8	-0.7
Poultry and eggs	-0.6	-0.6	-0.6	-0.6
Pork	**-7.0**	**-12.0**	-0.2	-0.2
Natural resources	-0.1	0.0	0.0	0.1
Construction	0.1	0.1	0.1	0.1
Food	-0.1	-0.3	0.0	-0.1
Petroleum	0.2	0.2	0.2	0.2
Chemicals	0.0	0.1	0.2	0.2
Plastic and rubber	0.0	0.1	0.1	0.2
Primary metals	0.7	2.4	4.3	5.5
Metal products	0.6	0.6	0.7	0.7
Electronics	0.5	0.9	1.5	1.7
Other Manufacturing	0.2	-0.1	0.1	0.0
Trade	0.0	0.0	0.0	0.0
Transport	0.0	0.1	0.1	0.1
Other Services	0.0	0.0	0.0	0.1

Results

The first set of results presents welfare impacts, which, in this context, are precisely defined as "Equivalent Variation" (EV) according to economic theory. EV measures the value of the tariffs imposed in 2018 to Iowa households in aggregate.[7] Welfare evaluations in this type of static model hold the level of investment and government spending as fixed. The assumption is that benefits from these final demand activities are independent of (separable from) private consumption. Table 11 presents the welfare impact of the 2018 tariff increases. The range of burdens imposed by the tariffs range from $952 million under modest price impacts and a transfer of tariff revenues to Iowa (based on Iowa's income share), and over $2 billion with

[7] As used in this section, the term "welfare" is unrelated to the conventional usage of the term meaning government transfers. Technically equivalent variation (EV) is the maximum amount that the representative agent in Iowa would be willing to pay in order to avoid the tariff increases. In this case, because the tariffs adversely impact Iowa households, the maximum that they would be willing to pay is a negative number. That is, it measures how much less income is required to reach the level of utility achieved under the tariff scenarios had prices not changed.

Table 11. Welfare impacts ($ million)

	Scenario A	Scenario B
With Tariff-revenue Transfer	-952.2	-1,909.6
No Tariff-revenue Transfer	-1,094.9	-2,052.2

Table 12. Gross State Product impacts by expenditure ($ million)

		Scenario A		Scenario B	
	Benchmark	change ($M)	change (%)	change ($M)	change (%)
Consumption	111,119	-955	-0.9	-1,900	-1.7
Investment	35,742	44	0.1	36	0.1
Government	24,800	-3	0.0	4	0.0
Net Exports (X-M)	18,529	-140	-0.8	-140	-0.8
Gross State Product	190,191	-1,054	-0.6	-2,000	-1.1

higher price impacts and no transfer of tariff revenue. With 2017 benchmark consumption in Iowa of $111.1 billion the range of percentage losses in welfare range from 0.9% to over 1.8%.

Welfare losses are technical measures that are useful in policy comparison and cost-benefit analysis. These measures are not familiar to policy makers and so it is useful to consider a measure of GSP decomposed into Iowa expenditures and income (value added) across different sectors of the economy. Table 12 shows the GSP impacts on Iowa broken down by the familiar expenditure categories (consumption, investment, government spending, and net exports) under the assumption that Iowa receives its share of the collected tariff revenue. We show that Iowa GSP will fall by between $1 billion and $2 billion due to the 2018 tariff escalation. GSP is inherently a nominal measure, and so a common unit of measurement must be chosen across the categories for consistent aggregation and comparison. In this case, we choose the external price faced by Iowa as a small open economy as the numeraire. Essentially, this can be thought of as measuring Iowa GSP in consistent U.S. dollar units. The real changes in consumption do not line up exactly with the welfare changes presented in Table 11 because there are deviations between the true cost of living in Iowa and the external price index. We hold the real expenditure on investment and government spending as fixed, but relative price changes indicate small adjustments in these measures. Iowa faces a standard balance-of-payments constraint; and thus, the changes in net exports reflect the transfer of tariff revenue measured in the external price index.[8]

Expenditures are supported by income, so through the standard accounting conventions we can represent Iowa GSP as value added by sector. Our model tracks gross-of-tax payments to primary factors of production for each sector. Table 13 presents this decomposition of GSP. We see that income from soybeans, corn, and pork farming in Iowa are down substantially. The pork sector shows the largest impact, with gross income down from between 11.5% under Scenario A to nearly 20% under Scenario B. While overall income is down, there are sectors that benefit

[8] We could have reported the tariff revenue transfer as a separate itemized account, but in the tradition of measuring GSP strictly as C+I+G+X-M we included it in net exports (increased M).

Table 13. Gross State Product impacts by sectoral value added ($ million)

	Benchmark ($M)	Scenario A change ($M)	Scenario A change (%)	Scenario B change ($M)	Scenario B change (%)
Soybeans	2,496	-144	-5.8	-520	-20.8
Corn	2,949	-77	-2.6	-337	-11.4
Other crops	4,164	-79	-1.9	-26	-0.6
Beef	995	-21	-2.1	-12	-1.2
Dairy	1,218	-27	-2.2	-20	-1.7
Poultry and eggs	801	-15	-1.8	-12	-1.6
Pork	4,623	-532	-11.5	-911	-19.7
Natural resources	1,217	-2	-0.1	1	0.1
Construction	7,998	7	0.1	17	0.2
Food	6,888	2	0.0	-38	-0.6
Petroleum	1,511	0	0.0	-4	-0.2
Chemicals	6,116	4	0.1	8	0.1
Plastic and rubber	1,119	-4	-0.4	-3	-0.3
Primary metals	1,453	18	1.2	215	14.8
Metal products	2,369	-42	-1.8	-72	-3.1
Electronics	2,581	31	1.2	72	2.8
Other Manufacturing	13,940	-103	-0.7	-348	-2.5
Trade	19,718	-40	-0.2	-79	-0.4
Transport	5,335	-2	0.0	2	0.0
Other Services	102,702	-29	0.0	68	0.1
Gross State Product	190,191	-1,054	-0.6	-2,000	-1.1

from the tariffs. In particular, notice that income in primary metals (mostly aluminum and steel production) are up by $215 million or 14.8% under Scenario B. This reflects the substantial price

increases related to the steel and aluminum tariffs imposed on U.S. imports. Electronics manufacturing also benefits due to the tariffs primarily targeting electronics imports from China. Notice, however, that price increases in these components and intermediate inputs put other manufacturing sectors at a disadvantage. In equilibrium, we observe income decreases in fabricated metal products and the aggregate "other manufacturing" category. Under Scenario B, the other manufacturing industry has substantial income losses of nearly $350 million or 2.5%.

In addition to income, our model tracks gross output (revenue) by sector. Figure 5 and Table 14 show the changes in gross output across production in Iowa. This makes it transparent for which sectors revenues are expanding and for which sectors revenues are contracting. Again, primary metals and electronics manufacturing are the winners. The agriculture and other manufacturing sectors suffer under the tariffs. The largest revenue reductions are for pork farms with revenue reductions of between $558 million and $955 million.

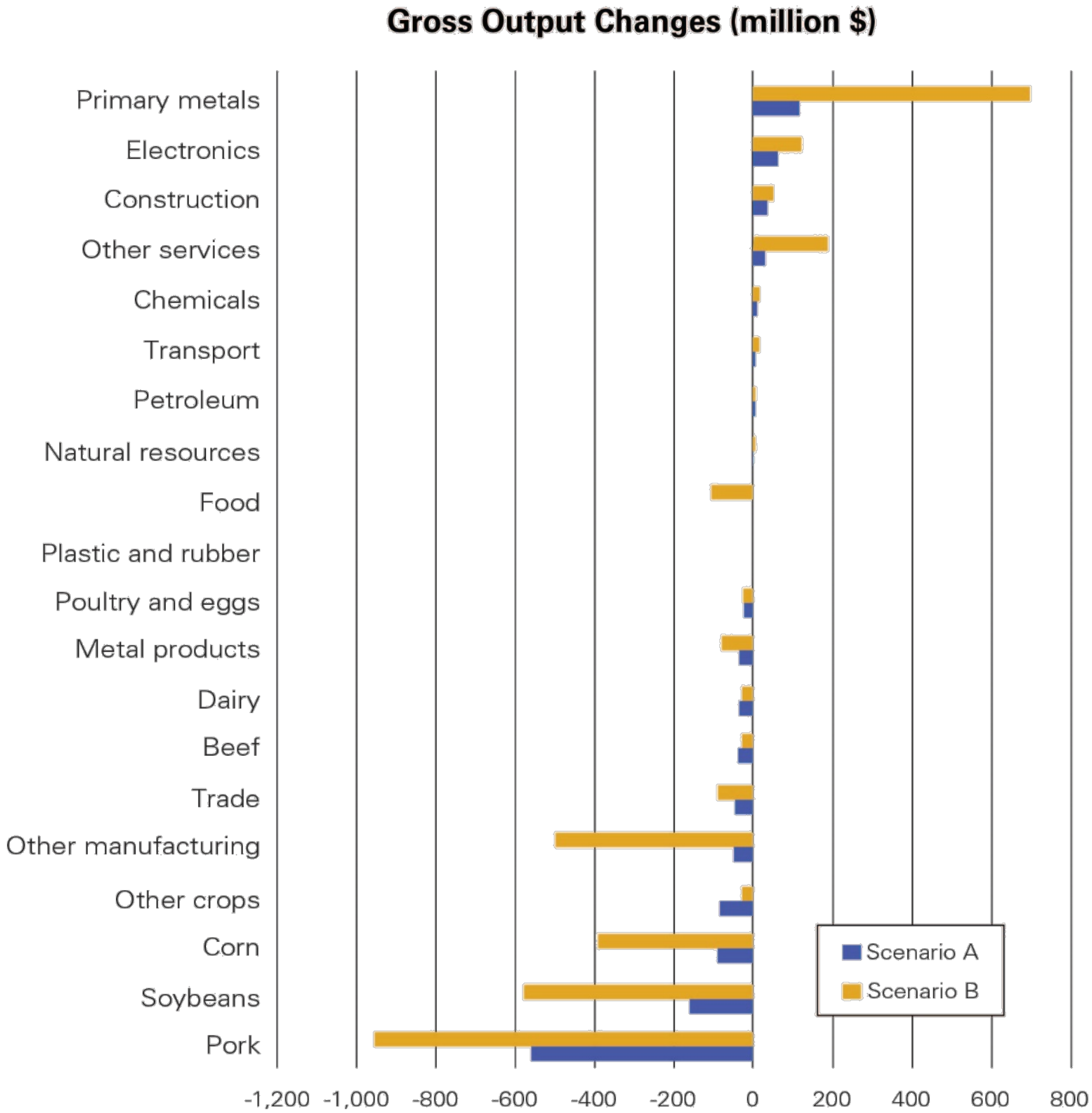

Figure 5. Gross output (revenue) impacts for Iowa industries.

Comparison of the Partial and General Equilibrium Results

The partial equilibrium models, which do not take into account the feedbacks among the varied industries in Iowa, find that the impact across the Iowa agricultural industries we studied (corn, soybeans, ethanol and hogs) results in a revenue loss between $1.8 and $2.3 billion. The general equilibrium model, which takes all of the major Iowa industries into account, finds revenue losses to GSP of between $1.05 and $2 billion. Thus, two very different economic modeling techniques result in a quite similar range and show that, even when accounting for industries that may benefit from greater protectionism (e.g., primary metals manufacturers), the overall impact is about 1%–2% of Iowa's GSP.

Conclusion

What are the impacts to the state of Iowa from the 2018 trade disruptions? As we were publishing our report (September, 2018), the Trump administration announced $200 billion

Table 14. Gross Output Impacts

	Benchmark ($M)	Scenario A change ($M)	Scenario A change (%)	Scenario B change ($M)	Scenario B change (%)
Pork	7,119	-558	-7.83	-955	-13.42
Soybeans	5,195	-159	-3.07	-579	-11.15
Corn	8,469	-90	-1.06	-393	-4.64
Other Crops	7,610	-86	-1.13	-27	-0.36
Other Manufacturing	36,447	-48	-0.13	-501	-1.37
Trade	33,321	-42	-0.13	-88	-0.26
Beef	4,059	-40	-0.98	-27	-0.67
Dairy	3,578	-34	-0.95	-29	-0.80
Metal Products	5,603	-31	-0.56	-81	-1.45
Poultry and eggs	3,333	-23	-0.69	-23	-0.70
Plastic and rubber	3,466	-4	-0.10	0	0.00
Food	23,660	-2	-0.01	-103	-0.43
Natural resources	1,873	-2	-0.09	1	0.05
Petroleum	1,286	4	0.29	4	0.29
Transport	11,151	8	0.07	17	0.15
Chemicals	13,704	10	0.08	16	0.12
Other services	163,919	31	0.02	189	0.12
Construction	14,635	35	0.24	52	0.35
Electronics	3,962	61	1.53	124	3.12
Primary metals	5,176	119	2.30	701	13.54

more in tariffs on Chinese imports, and China responded with another $60 billion in tariffs on U.S. imports. Mexico and the United States also look to be entering into a bilateral agreement while the United States continues NAFTA negotiations with Canada. Thus, the results in this report may soon change, potentially dramatically.

The research we present here is based on two distinct modeling techniques, each using two sets of additional assumptions. The first technique is a partial-equilibrium modeling technique that examines the impacts specifically in the agricultural sectors of corn, soybeans, hogs, and ethanol. This partial equilibrium analysis further considers two modeling techniques to determine price changes—an elasticity technique and a futures market technique using observed price changes to date. Partial equilibrium examines each industry without taking into account feedbacks or the impacts from the tariffs across the entire Iowa economy.

The second modeling technique is a general equilibrium technique that examines 20 Iowa agricultural, manufacturing, and other sectors and takes into account how the tariffs may benefit and harm particular sectors. General equilibrium also considers scenarios of how the federal revenue earned from the import tariffs is redistributed back into the Iowa economy.

Combined, the two modeling techniques with their two assumptions results in four outcomes for how the trade disruptions might impact the four main agricultural sectors in Iowa (soybeans, corn, ethanol, and hogs/pork). Table 15 shows the lost revenue for these four sectors for each modeling technique.

Table 15. Gross Output Impacts ($ millions)

Models:	Partial Equilibrium		General Equilibrium		
	Elasticity Method	Futures Method	Scenario A	Scenario B	Average
Corn	$325	$525	$90	$393	333
Soybeans	$551	$891	$159	$579	545
Hogs/Pork	$818	$773	$558	$955	776
Ethanol	$105	$105	a	a	105
Total	$1,799	$ 2,294	$807	$1,927	1,707

Notes: Scenario A includes a partial federal tariff revenue transfer to Iowa; Scenario B does not.
a: Ethanol was not examined specifically in the general equilibrium model but is aggregated in "chemicals" in Table 14.

Overall, the loss to Iowa's GSP (revenues) is an average of $1.6 billion dollars from a roughly $190 billion state product. We determine additional labor income losses across the state to be between $248 million and $511 million, with the lower number considering the impact of compensation to farmers from the federal government for lost revenues. State tax impacts, likewise, might vary from as low as $75 million (taking into account compensation) to $146 million (without compensation) just for the three main agricultural commodities (hogs, corn, and soybeans). The biggest industrial gainer in Iowa will be primary metals manufacturing, which may see an $18–$215 million increase in revenues from increased protection. The largest revenue reductions will come from the hog/pork sector where revenue reductions might reach close to $1 billion.

Economists can model market impacts based on trade disruptions that remain within mostly well-understood parameters, especially in the short run. Even then, predictions are still guess work, albeit educated guesswork. We have attempted to understand the disruptions to the Iowa economy from the current state of the tariffs and have based those predictions on the way we have seen markets respond in the recent past. However, with a few exceptions on particular goods, general trade disruptions have not been a regular feature of the U.S. economy for a long time—our models are based on how the world looked as recently as 2017 before hundreds of millions of dollars in tariffs and retaliatory tariffs existed.

What we cannot do is predict how such disruptions might change markets in the very long run. As the tariffs raise the world price of a variety of goods, not just agricultural goods, firms and nations that previously remained mostly on the sidelines will find their industries competitive. People will still need to eat, and the higher prices will mean that importers will substitute one nation's goods for another's. In the years ahead, as farmers around the globe find that they can now compete at a higher world price, those who once produced mostly for domestic consumption may find certain export markets are now open for business. This longer-run structural disruption and its impact on Iowa agriculture is harder to predict, but not harder to imagine. With more time and resources, as new data arrive (for example, the latest round of tariffs), and as we see how markets around the world react, we can update our models and come to a better understanding of what the global markets facing Iowa producers will look like.

Resources

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Appendix A. Notes to the Impact Analysis

In our analysis of both the farm sector and the ethanol sector, we do not presume quantity changes in production. Instead, we presume reductions in incomes to farmers and to ethanol investors, which ultimately translate into reductions in household spending. In our modeling system, we do not manipulate those respective agricultural and manufacturing sectors.

Our modeling system does not allow us to distinguish among different types of proprietors. Our assumption is that farm proprietors spend their earnings in manners similar to non-farm proprietors. Similarly, we use a higher-income household segment ($100,000 to $150,000) for the ethanol sector investment return reductions, and assume that for these households investment incomes are used like all other types of income accruing to that segment of Iowa households.

Input-Output Terms:

> Total output: the value of goods or services produced in the Iowa economy that were forgone owing to the proprietor income or the investment income reductions.
>
> Value added: in producing total output, payments are made to labor income, to investors, and to governments in the form of indirect tax payments. Value added is analogous to gross domestic product.
>
> Labor income: a subset of value added, it reflects the value of wages and salaries received by workers as well as the value of employer provided (or mandated) benefits.
>
> Job support: modeling systems measure the number of full and part-time jobs in the economy, they do not measure full time equivalencies.

Our model for this analysis is based on a 2015 input-output dataset of the state of Iowa with prices adjusted to reflect 2018 values.

Finally, when we calculate the fiscal effects, we make several basic assumptions. First, we base tax incidences on U.S. Census of Governments revenue data for Iowa for fiscal year 2016. We use the average of total personal income in Iowa for 2015 and 2016 to arrive at the appropriate incidence coefficients for each tax category. Next, in applying those incidences, we reduce returns to state personal income taxes by 10% to reflect state tax law changes that went into effect in 2018 that significantly lowered personal income tax liability in Iowa. Last, when we calculate state tax effects, we assume that both farm proprietors' incomes and investment incomes are subject to the same effective average tax rates as all non-farm income and other forms of taxable income in Iowa.