Food & Agricultural
Policy Research Institute
University of Missouri

# Selected Impacts of the COVID-19 Pandemic and Responses on U.S. Agriculture and Agricultural Product Markets

*September 2021*

FAPRI-MU Report #06-21

www.fapri.missouri.edu

Published by the Food and Agricultural Policy Research Institute (FAPRI) at the University of Missouri (MU), 200 Mumford Hall, Columbia, MO 65211. FAPRI–MU is part of the Division of Applied Social Sciences (DASS) in the College of Agriculture, Food and Natural Resources (CAFNR).

http://www.fapri.missouri.edu

This material is based upon work supported by the U.S. Department of Homeland Security No. 18STCBT00001 under Texas A&M University subaward M2002234.

Any opinion, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Homeland Security, Texas A&M University, nor the University of Missouri.

Contact authors: Wyatt Thompson (thompsonw@missouri.edu), Patrick Westhoff (westhoffp@missouri.edu), Julian Binfield (binfieldj@missouri.edu), Sera Chiuchiarelli (chiuchiarellis@missouri.edu), Abigail Meffert (abigail.meffert@missouri.edu), Jarrett Whistance (whistancejl@missouri.edu), and Scott Brown (browndo@missouri.edu).

The following text examines some impacts of the COVID-19 pandemic on U.S. agricultural and agricultural product markets, producers, consumers, and related indicators. We outline reasons why reviewing events in isolation in 2020 might not give reliable estimates of the impacts of the COVID-19 pandemic and might result in misleading expectations about a future pandemic.

Next, we explore the effects of three key aspects of the shock in the United States: (1) lockdown impacts that reduced liquid fuel use dramatically, (2) disruptions in the livestock-meat sector supply chain, and (3) changes in overall economic activity, household income, and total expenditures. For these experiments, we use the FAPRI-MU stochastic model to simulate the impacts of a hypothetical future pandemic.

This is not a study of the entire COVID-19 pandemic. The full impacts of the COVID-19 pandemic are large and complex. Factors include effects on health and mortality, a broader economic shock with its employment and income effects, lockdowns and reduced socializing, supply chain disruptions, policy responses, and similar shocks to other countries. The negative effects were experienced differently by each country. We focus only on the U.S. experience.

We draw some conclusions from this and related work.

- Market outcomes in 2020 were driven by factors other than the pandemic, such as a surge in crop exports and weather disruptions, so year-over-year changes alone are probably not good indicators of how the pandemic affected the sector.
- Three of the largest direct impacts of COVID-19 on the agriculture sector were on fuel markets, meat supply chains, and consumer demand patterns. Demands for fuels fell by 5-10% after taking into account price and income effects. Margins between meat retail prices and livestock prices widened after considering other factors.
- The loss of economic activity as measured by the falling U.S. GDP could have been expected to cause weaker demand for agricultural goods, lower prices, and sharply lower farm income than what was observed in 2020.
- U.S. policy responses included payments that increased disposable income, boosted consumer demand, and mitigated the impacts on farm income from the drop in the size of the national economy. Greater payments directly to farmers also help explain why farm income rose in 2020 relative to 2019.
- The impact of COVID-19 is partly a story of policy responses, including sector-specific actions targeting agriculture, fiscal policy, monetary policy, and lockdowns. A future pandemic might be set in a context that limits or disallows some of these options, or a setting that has – perhaps by design – new options.
- A future pandemic's impacts would differ from recent experiences because of disease characteristics and also new individual, firm, and policy responses. If one assumes that a future pandemic is an exact repeat of the 2020 pandemic, then that implicitly requires that the disease is equally contagious and harmful, individuals and firms respond to a new pandemic the same as they did in 2020, and policy responses repeat the responses to COVID-19.

## BACKGROUND

How has the COVID-19 pandemic affected agricultural and food sector in the United States? This question is important for people who are considering the near-term future as this pandemic continues. It is also an important question for people who think ahead and consider what steps might be taken to help limit the damages of a possible future pandemic.

It is too soon for us to see permanent impacts, and even claims that some of the observed shocks were transitory or briefly endured should be taken with caution while the COVID-19 pandemic continues and evidence is gathered. Nevertheless, indications to date allow us to draw four tentative conclusions about how we might frame the question about how the COVID-19 pandemic affected the U.S. agricultural and food sector for calendar year 2020 or, for crops, through the end of marketing year 2019/2020 and the first part of marketing year 2020/2021.

*First, sector-specific shocks are limited* if assessed on an annual basis. There have been large macroeconomic shocks and human health concerns, many of which have implications for agriculture and food. With regards to agricultural supplies and demands, large scale disruptions that were experienced often were typically only sustained for a few months. The lockdowns caused substantial shocks in few relationships on an annual basis.

We attempt to assess the shocks to certain demands, supplies, or relationships after taking into account the impacts of price changes and macroeconomic factors. Liquid fuel markets seem particularly affected, with less domestic and trade demand and greater supplies on offer from foreign sources due to their own demand dropping (Table 1). Changes are expressed relative to 2019 values of the relevant quantity or price to give an indication of scale. Results indicate how much a demand was affected or is estimated to be affected after taking into account the effects of prices, income, exchange rates, or other factors not associated with the pandemic shock to the sector.

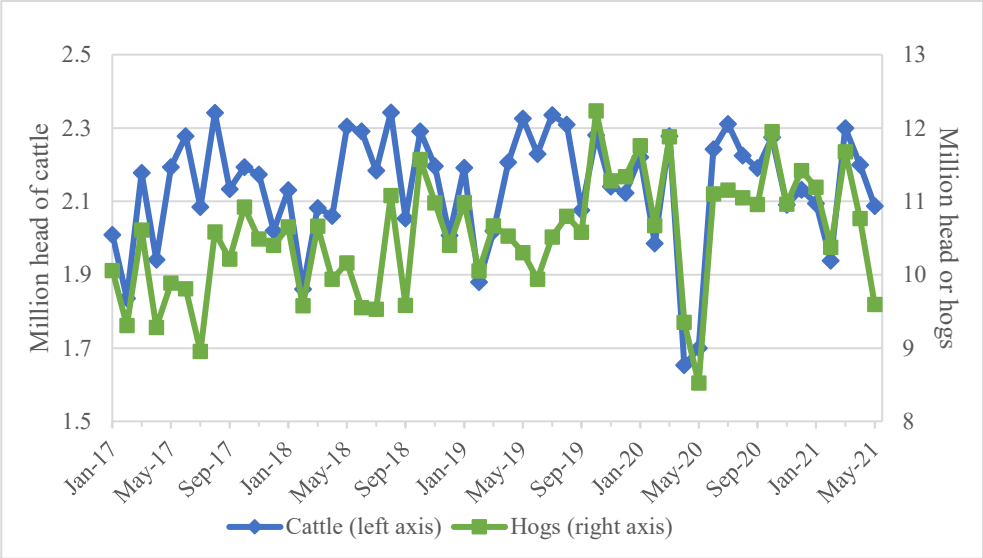
Table 1. Shocks associated with the pandemic, expressed relative to 2019 quantities.

| | 2020 | 2021 |
|---|---|---|
| Motor gasoline demand | -10% | -2% |
| Diesel demand | -5% | -1% |

*Source: calculations based on FAPRI-MU Baseline Outlook (https://www.fapri.missouri.edu/publications/outlook/).*
*Note: the table gives shifts in demand or supply relationships or curves, not quantity changes.*

The supply chain disruptions might have been of serious importance for many in the early months of the pandemic, although the effects appear less pronounced if assessed on the basis of annual data. Meat represents an exception as packing plant disruptions increased consumer prices and pushed down producer prices in 2020. Commercial slaughter of cattle and hogs was sharply lower in April and May 2020, during the lockdown (Figure 1). Variation in these numbers can be wide and it would be a mistake to attribute the entire change relative to some benchmark level as solely caused by the pandemic. Still, news reports of disruptions are associated with at least some part of this downturn.

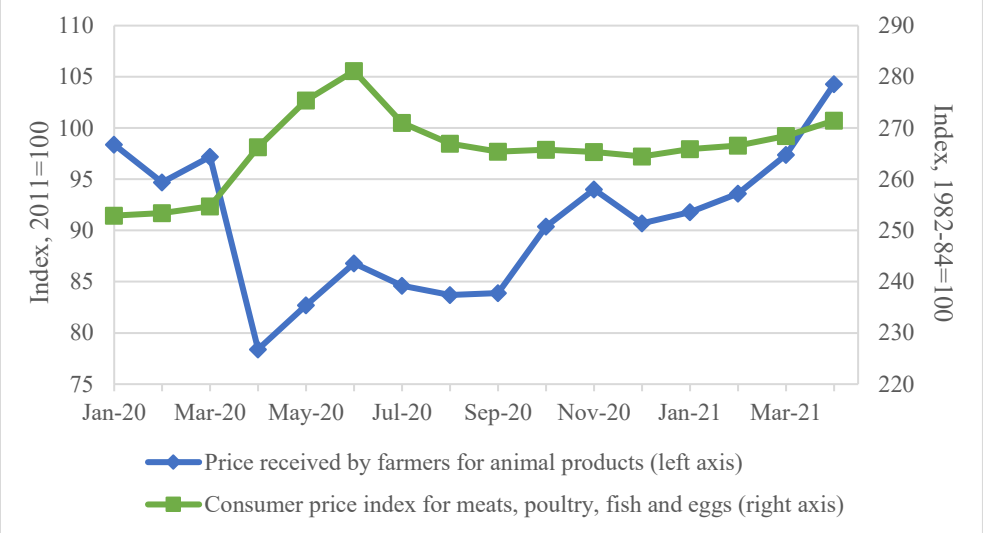
Figure 1. Commercial slaughter fell during the lockdown.




After taking into account some of the other factors, we calculate that the annual fed steer price was about 15% lower due to the pandemic and the retail beef price 4% higher. Moreover, slaughter numbers were reduced, with steer and heifer slaughter reduced by 2% in 2020 after taking other factors into account and barrow and gilt slaughter 1% lower. These changes are not identical to those observed in 2020 because they are on an annual basis and because certain other factors are taken into account, as well.

Contrary to at least some expectations, the pandemic generally has not caused large shifts in the total amount of food consumed. The pandemic has appeared to have a larger effect on what types of food people buy, how they buy the food, and where they eat it. This shift challenged the supply chain, and it appears that the annual impacts on the sector overall included a wider marketing margin, with rising consumer food prices and falling agricultural producer prices (Figure 2). The lack of overall reduction in demand for food might be the result of both the unresponsiveness of total food consumption to economic factors – in the U.S., food is not a large share of most household budgets and consumption can be sustained in most cases even in bad times – and fiscal policies discussed below.

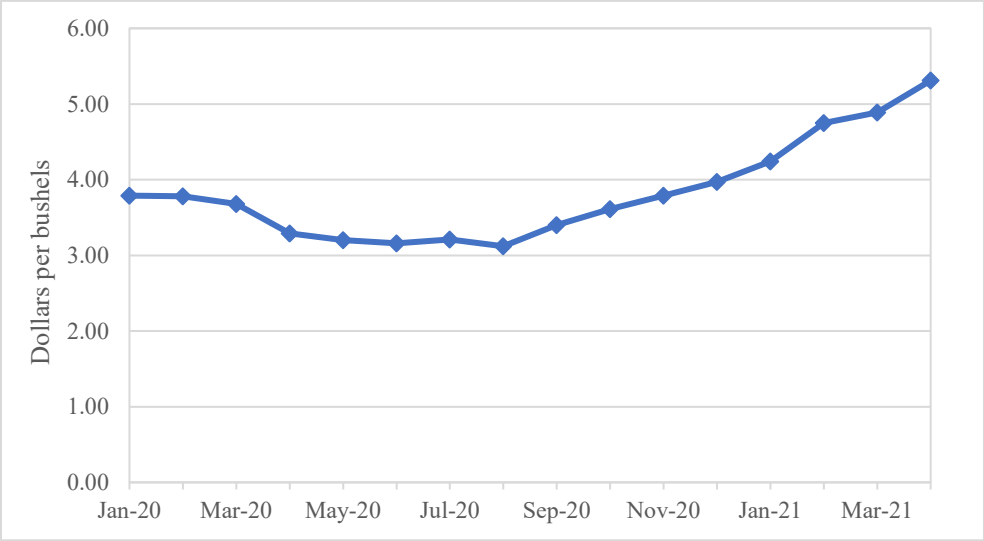
Figure 2. Agricultural producer prices and food consumer prices.




*Source: FAPRI-MU Baseline Outlook (https://www.fapri.missouri.edu/publications/outlook/), page 4.*

*Second, other factors from outside the sector have had important effects* on the agricultural and food sector that need to be disentangled from pandemic impacts. A key example is the surge in Chinese imports of U.S. products, including crops, that has helped pressure prices higher in the last months of 2020 and into the start of 2021 (Figure 3). Yield impacts of weather variations, in the United States or other key growing regions, also have price impacts. The consequences of these shocks should not be conflated with the pandemic.

Figure 3. U.S. corn price.



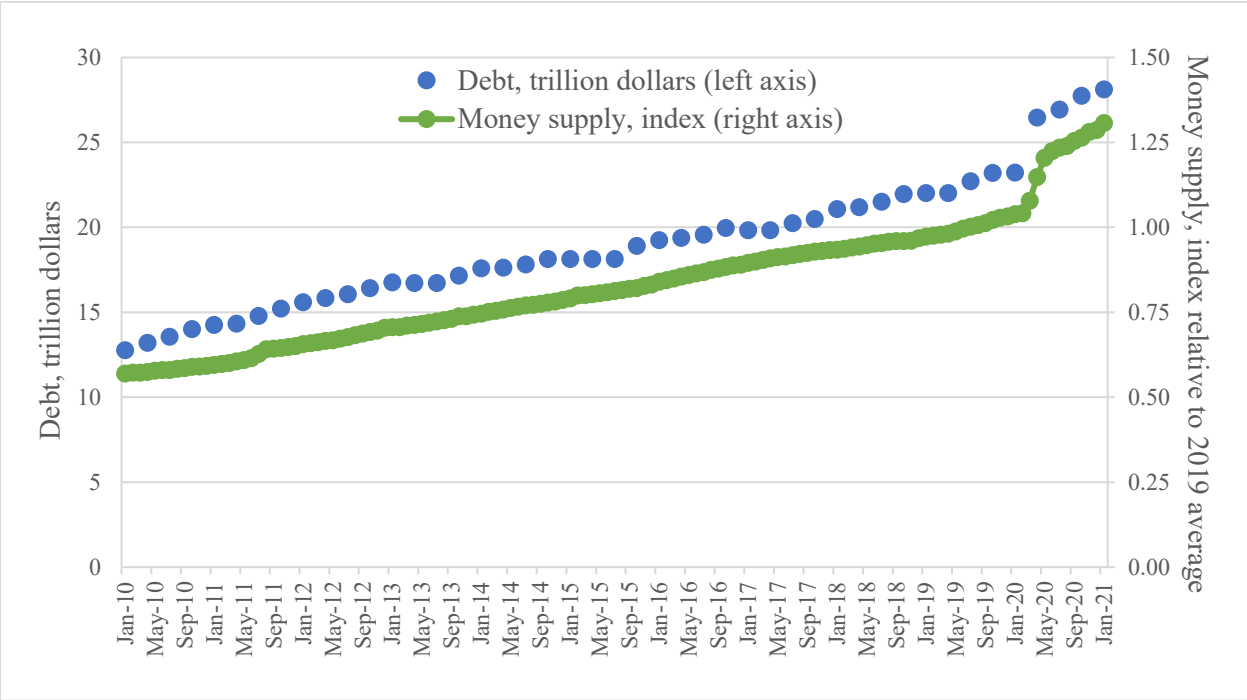

*Source: USDA National Agricultural Statistics Service.*

An important lesson is that before-and-after analysis is probably an inappropriate method of understanding the pandemic impacts. Comparing year-ago prices or other pre-pandemic market data to the latest information is not a way to estimate how COVID-19 affected markets. One should not assume that the differences between projections made before the pandemic to the most recent projections reflect the impacts of the pandemic. Such before-and-after analysis reflects the impacts of the pandemic, surging Chinese imports, weather shocks, and other factors.

*Third, sectoral and macroeconomic policy responses had important implications* for the agricultural sector. The point has already been made that policy response helps explain why real disposable income rose in 2020 while real gross domestic product (GDP) fell.[1] Data suggest important fiscal policy and monetary policy responses if judged by the deficit and money supply increases (Figure 4). These policies can affect income people have to spend on food and other forces that are external, yet important to the agricultural and food sector.

[1] Meyer, S. "2021 Agricultural Economic & Foreign Trade Outlook," presented at the U.S. Department of Agriculture Agricultural Outlook Forum on February 18, 2021. Available at https://www.usda.gov/oce/ag-outlook-forum/aof-program. Westhoff, P, "Expected and Unexpected Impacts of COVID-19 on U.S. Markets for Animal Products," posted online on January 18, 2021. Available at https://cbts.tamu.edu/files/2021/02/Expected-and-Unexpected-Impacts-of-COVID-FAPRI-CBTS-1-18-2021-A-2p.docx.

Figure 4. U.S. debt and money supply.




*Sources: St. Louis Federal Reserve (FRED, https://fred.stlouisfed.org/) with debt from U.S. Department of the Treasury. Fiscal Service, Total Public Debt; and money supply from the Organization for Economic Co-operation and Development, M3.*

We have already highlighted some roles policy played during the pandemic. The lockdowns are a key reason for the shifting nature of food demand and also for the negative impacts on demands for biofuels and cotton. However, we do not assert that the formal lockdowns were the sole cause for these demand shifts because there is no way to know the extent to which people reduced their activities by choice. Even more challenging, we cannot know what people would have chosen without lockdown policies. At least at present, it is not possible for us to know how much of these observed market shocks were due to policy and how much to preference. One might assume in a counter-factual scenario that there is no lockdown and the demand shifts are removed, but it is not clear how to characterize the results of that scenario. Two extreme examples demonstrate the risk: the market impacts of this scenario might incorrectly consider the impacts of policy responses to the pandemic or the consequences of changes in preferences as people choose to protect their health during a pandemic. Yet neither of these characterizations seems accurate.

Agricultural and food sector support also rose during the pandemic (Table 2). Payments to producers during the pandemic had a role in farm income. The impacts on producers and consequently on agricultural commodity supplies going forward might have been different without this support. Federal nutrition assistance expenditures also expanded, helping alleviate food insecurity by sustaining food access.

Table 2. Government outlays, billions of dollars.

| Fiscal year | 2019 | 2020 | 2021 |
|---|---|---|---|
| Total mandatory outlays on agriculture | 36.5 | 47.7 | 51.2 |
| Coronavirus Food Assistance | 0.0 | 10.0 | 24.5 |
| Paycheck Protection | 0.0 | 5.9 | 2.8 |
| Other | 36.5 | 31.8 | 23.9 |
| Nutrition | 92.6 | 114.2 | n.a. |

*Sources: Agricultural outlays from FAPRI-MU Baseline Outlook (https://www.fapri.missouri.edu/publications/outlook/), page 66; nutrition outlays from net outlays by the Food and Nutrition Service, as reported in the Monthly Treasury Statement, Sept. 2020 (https://www.fiscal.treasury.gov/files/reports-statements/mts/mts0920.pdf).*

*Fourth, this pandemic is not over and a future pandemic would be different*. The dramatic reorganization of life observed in 2020 could have permanent impacts. What part of the liquid fuel market changes could be permanent if, for example, remote working becomes more commonplace? What food consumption patterns will remain? One possibility is the persistence of at-home consumption of cooked or delivered food. How are pandemic-induced changes in labor markets affecting the cost of food consumed away from home in 2021, as well as the costs of other labor-dependent goods and services? As time goes on, it might become harder to disentangle some pandemic effects from other trends, such as trade, the share of electric cars in vehicle fleet, advances in information technology use in the food supply chain, or evolving preferences for meats and meat substitutes.

Policy responses could also play a role in the long-term consequences. Steps taken to mitigate risks could have permanent impacts on the sector. For example, requirements that seek to reduce supply chain risks to a hypothetical future pandemic might have side effects. Extra costs could create higher producer-to-consumer price margins or higher taxpayer expenditures, depending on how such requirements are implemented.

A future pandemic will almost certainly have different characteristics. The disease itself will likely differ in degrees of contagion and harm. The international and domestic economic context will be different. In the U.S., a future pandemic might be met more readily given the lessons from 2020 and the increase in pandemic response capability. If similar policy responses are more or less limited, including encouraging or requiring lockdowns, monetary expansion, deficits to support stimulus packages, and agriculture-specific support, then the U.S. response might also be different.

*A conclusion is to suggest caution when looking at the scenarios presented here.* There is a risk that pandemic analysis can be murky, with a difficulty of assessing how much of what was observed was associated with the pandemic and an additional challenge of identifying the contributions of different policies, individual and firm responses, and the disease itself. Moreover, if the goal is to inform policy design or other decisions, then the relevance of the results that matter most with respect to future pandemics may be unknown. In the next section, we focus on three aspects of the pandemic that seemed to be critically important to the U.S. agriculture sector.

## SCENARIOS

### Scenario definitions

Scenarios are defined relative to the FAPRI-MU 2021 baseline.[2] Scenarios are set in the future (in 2025 and 2026), not in the past. This means results presented below estimate the impacts of three elements of a

[2] Westhoff, P., M. Rosenbohm, J. Whistance, J. Binfield, S. Chiuchiarelli, Y. Kim, H. Hoang, A. Meffert, and W. Thompson, "2021 U.S. Agricultural Market Outlook," FAPRI-MU report 1-21. Available at http://www.fapri.missouri.edu/.

hypothetical future pandemic in comparison to a future without a pandemic. The focus here is on annual market conditions. Larger impacts are possible at the start of a pandemic when mobility and economic activity are most restricted, but they do not determine the numbers on an annual basis alone.

*Domestic biofuel demand*

Liquid fuel markets seem particularly affected during the COVID-19 pandemic, with less domestic demand for fuels. After taking into account changes in prices and income, motor gasoline and ethanol demand is estimated to shift back by 10% in 2020 relative to 2019. The diesel and biodiesel demand shift is estimated to be 5%. FAPRI-MU baseline assumptions based on information available at the start of 2021 were that the demand shock was one-fifth as large in the second year of the pandemic.

The domestic focus omits some impacts on fuel markets, including the implications of lockdowns in other countries. The pandemic impacts on demand for US biofuels or biofuel import supplies also appear to be important, but not included here. Demand for fuels fell in many other countries, including important importers and competing exporters. Lockdowns elsewhere reduced the scope to export ethanol or biodiesel. The United States also imports biofuels, such as ethanol made from sugar cane, and reduced demands for those fuels in other countries led to greater availability of those fuels. The analysis does not explore pandemic impacts in other countries could affect U.S. markets.

*Livestock-meat margins*

Disruptions in the livestock sector led to wider margins and lower slaughter in 2020. After controlling for certain other factors, the margin shocks relative to 2019 levels are estimated to cause a 4% increase in beef and pork retail prices, a 15% reduction in fed steer price, and an 8% lower barrow and gilt price. Steer and heifer slaughter is reduced by 2% and barrow and gilt slaughter is 1% lower after accounting for certain other factors, including animal inventories at the start of the year and prices.

The focus on beef and pork sector margins and slaughter is narrow. Once again, potentially important trade impacts are omitted. We do not take meat demand shifts into account (although income effects are considered in the next set of scenarios). The shift from away-from-home food consumption to at-home food consumption during the pandemic had important consequences for food commodity demands that we do not explore here.

This scenario probably attributes too much of an effect to the pandemic. There were other reasons for meat processing sector stress in 2020 that we do not consider here. To some extent, then, this scenario might present an upper bound of the pandemic's impacts.

*GDP, income, and expenditures*

The pandemic, personal choices, and policy responses intertwine. The lockdown was caused by some combination of personal decisions and policy restrictions. The pandemic and lockdown triggered a surge in unemployment and lower GDP in the United States in 2020, yet policy response led to higher household disposable income. Consumer expenditures, including on food, were affected by factors such as the reduced economic activity, greater support to incomes, limited purchasing options during the lockdown, and changing needs due to the pandemic itself. Moreover, the effects varied quite widely, with severe job losses in some sectors and stronger employment in others. It is beyond the scope of this project to decompose all these impacts, or to determine the relative roles of the pandemic itself, personal choices, and policy responses.

We highlight the implications of the lower GDP and the higher disposable income, and consequently the role of certain policy responses. To focus on the effects of total disposable income and GDP, the 2020

changes and historical relationships between these measures of household well-being and expenditures are combined to generate hypothetical consumer expenditure shocks. Relative to a baseline assumption of 3% growth in real consumer expenditure in 2025, the alternatives are to repeat the increase in real disposable income in 2020 and consequently set real consumer expenditures to rise by 6% in 2025, or else to repeat the decrease in real GDP change in 2020 and let this change cause a 4% decrease in real consumer expenditure in 2025.

*Scenario summary*

Scenarios are introduced cumulatively in the following order: fuel demand only, biofuel plus the livestock and meat shocks, and then the two alternative shocks from the broader economy are added along with these agricultural commodity market shocks (Table 3).

Table 3. Summary of scenarios with selected impacts of a hypothetical future pandemic.

| | Scenario | | | |
|---|---|---|---|---|
| | Biofuel only | Biofuel and meat | Disposable income, biofuel, meat | GDP, biofuel, meat |
| Fuel demands | | | | |
| Motor gasoline | -10% | -10% | -10% | -10% |
| Diesel | -5% | -5% | -5% | -5% |
| Livestock and meat | | | | |
| Beef retail price | | +4% | +4% | +4% |
| Pork retail price | | +4% | +4% | +4% |
| Fed steer price | | -15% | -15% | -15% |
| Barrow and gilt price | | -8% | -8% | -8% |
| Steer and heifer slaughter | | -2% | -2% | -2% |
| Barrow and gilt slaughter | | -1% | -1% | -1% |
| Income or GDP | | | | |
| Cons. expenditures, real | | | +6% | -4% |

## SCENARIO RESULTS

Results are the averages of 500 stochastic simulations but focus on the differences in mean values. The discussion relates mostly to the immediate effects in the first year of the hypothetical future pandemic.

*Biofuel market impacts*

The lockdown affects driving and motor fuel use falls by about 10% and diesel use falls by 5% in all scenarios. The biofuel mandate, or Renewable Fuel Standard (RFS), requirements fall by as much as overall fuel use because they are applied as a constant percent mandate within the year. One reason for a smaller impact on biofuel use is the incentive to buy compliance certificates (RINs) to hold for future use. The lower requirements of the RFS do not necessarily mean that the use of biofuel falls by the same amount as overall fuel use because there is an incentive to buy compliance certificates (RINs) to hold for future use. Nevertheless, estimated ethanol use and biodiesel use fall by almost as much as the total change in overall fuel use, or 8% (Table 4).

The reductions in use map to a smaller production change in the case. Ethanol and biodiesel production fall by 7% to 9%, depending on the income shock. The reduced use is partly offset by trade response as exports expand and imports contract due to changes in the domestic market. This mitigating effect might evaporate if we studied a global pandemic and reduced the scope for trade response, so the production and feedstock market effects of a global pandemic could be larger than the results shown here.

The ethanol producer price falls by 12% or more, while the biodiesel producer price falls by 4% to 5%, and conventional RIN prices (those associated with corn starch ethanol) are also lower, suggesting that the reduced mandate requirement is easier to meet.

The income effects play a role as well. If the weakened GDP feeds through to fuel markets, then quantities used and produced are lower, as are producer prices. In contrast, a stronger disposable income can mitigate some of these impacts. The meat and livestock sector shocks have limited direct impact on biofuel markets, particularly in the first year. Although small, the implications for biofuel feedstock prices and the value of biofuel co-products, such as distillers' grains, have some effects in the first and later years.

Table 4. Biofuel market impacts in the first year.

| | Fuel only | adding meat and livestock | also with higher income | or with lower lower GDP |
|---|---|---|---|---|
| Ethanol quantities, billion gallons | | | | |
| Production | -0.82 | -0.81 | -0.78 | -0.86 |
| | -5% | -5% | -5% | -5% |
| Net exports | 0.22 | 0.22 | 0.21 | 0.25 |
| | 12% | 12% | 12% | 14% |
| Domestic use | -1.14 | -1.14 | -1.10 | -1.23 |
| | -8% | -8% | -8% | -9% |
| Biodiesel, billion gallons | | | | |
| Production | -0.24 | -0.24 | -0.23 | -0.28 |
| | -7% | -7% | -7% | -9% |
| Net imports | -0.02 | -0.02 | -0.02 | -0.03 |
| | -21% | -20% | -19% | -23% |
| Domestic use | -0.30 | -0.30 | -0.28 | -0.36 |
| | -8% | -8% | -8% | -10% |
| Prices, dollars per gallon | | | | |
| Ethanol | -0.17 | -0.17 | -0.16 | -0.19 |
| | -12% | -12% | -12% | -14% |
| Biodiesel | -0.15 | -0.15 | -0.14 | -0.18 |
| | -5% | -4% | -4% | -5% |
| Conventional RIN (D6) | -0.04 | -0.04 | -0.03 | -0.05 |
| | -13% | -14% | -11% | -19% |

*Livestock and meat market impacts*

The shock that includes meat, livestock, and fuel market effects causes a divergence between retail beef and pork price relative to animal prices as well as suppresses cattle and pig slaughter. Production of both meats decreases by 1% in the year of the hypothetical pandemic. The retail prices are driven higher by 8% for beef and 5% for pork. In this case, the barrow and gilt price is lower by 3%, the fed steer price is

pushed down by 5%, and the calf price is reduced by 9%. As noted earlier, however, there is a risk that this scenario overstates the impacts of the pandemic on the meat supply chain.

Livestock market impacts change if disposable income is increased, as observed historically. The greater income can drive meat demand higher than it would be otherwise.[3] The demand pressure on top of reduced slaughter pulls retail prices higher in this case and also reduces the negative animal price impacts of the supply chain disruptions. The draw of greater disposable income and more demand to buy foods, particularly meats, pulls prices up, but there is inadequate time within the year for producers to respond by increasing herds, raising slaughter, and delivering more meat, particularly in the context of supply chain disruption.

Table 5. Livestock and meat market impacts in the first year.

| | Fuel only | adding meat and livestock | also with higher income | or with lower lower GDP |
|---|---|---|---|---|
| Beef quantities, billion pounds | | | | |
| Production | 0.0 | -0.3 | -0.4 | -0.3 |
| | 0% | -1% | -1% | -1% |
| Domestic use | 0.0 | -0.9 | -0.7 | -1.5 |
| | 0% | -3% | -3% | -6% |
| Pork quantities, billion pounds | | | | |
| Production | 0.0 | -0.3 | -0.3 | -0.3 |
| | 0% | -1% | -1% | -1% |
| Domestic use | 0.0 | -0.3 | -0.2 | -0.4 |
| | 0% | -1% | -1% | -2% |
| Prices, dollars | | | | |
| Retail beef, per pound | 0.00 | 0.57 | 0.62 | 0.39 |
| | 0% | 8% | 9% | 5% |
| Fed steer, per cwt. | -0.12 | -7.25 | -4.28 | -16.95 |
| | 0% | -5% | -3% | -13% |
| Calf, per cwt. | 0.48 | -16.85 | -11.44 | -34.59 |
| | 0% | -9% | -6% | -19% |
| Retail pork, per pound | 0.00 | 0.24 | 0.27 | 0.14 |
| | 0% | 5% | 6% | 3% |
| Barrow and gilt, per cwt. | -0.07 | -1.67 | -0.35 | -5.90 |
| | 0% | -3% | -1% | -11% |

The lower GDP would imply reduced consumer purchasing power, as might happen in the absence of a policy response that includes direct stimulus payments, extended unemployment benefits, and expanded food assistance. The lower GDP along with the fuel and meat market disruptions would reduce domestic meat use relative to the case with only the disruption to meat and livestock supply chain and fuel markets (the second column of numbers). However, as in the case of greater disposable income, lower GDP would have larger price impacts than quantity impacts in the span of one year. Retail price increases persist (due to the supply chain disruptions) but are lower with weaker demand. The livestock prices fall by more in the case that lower GDP translates into lower demands, with the fed steer, calf, and barrow and gilt prices showing double-digit percent drops in this case.

[3] As noted earlier, we do not attempt to reproduce the shifts in meat demand associated with the lockdown, including the move away from restaurant dining to at-home food consumption.

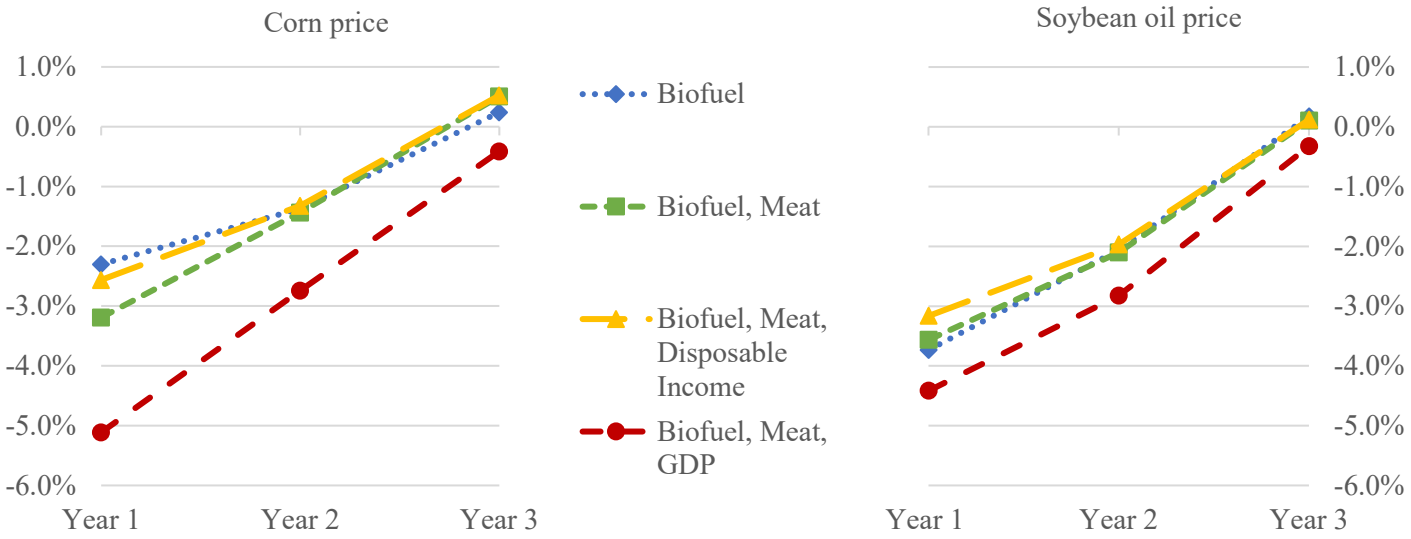
Trade is not shifted by the hypothetical pandemic in this case given the focus on direct U.S. impacts. However, trade responds as domestic market conditions evolve, moderating some of the price and quantity effects shown here relative to what would happen if trade did not adjust as U.S. prices change. Moreover, if a pandemic also caused substantial shifts in meat export demands or import supplies due to events in other countries, then these effects would feed back into the U.S. market.

*Crop and crop product markets*

The shocks to fuel demand, livestock supply chain, and income affect demands for crops and crop products, pushing prices lower (Figure 5).

The fuel-only shock explains an important part of the first year of the drop in biofuel feedstock prices in all scenarios explored here, particularly for soybean oil. Meat and livestock supply chain disruptions reduce feed demands and can draw corn price lower. The soybean oil price effects are reversed. Less demand for soybean meal for feed use causes lower soybean crush and shorts the soybean oil market, so some of the price drop is recovered in this case. The effect of higher disposable income on crop prices also tends to be positive, with the greater demand for agricultural goods pushing up these prices. The lower GDP without offsetting policies would imply less demand and even sharper reductions in crop prices.

Figure 5. Key crop and crop product prices.




*Note: the percent changes in these two prices are presented for the years one to three of the scenarios.*

The shocks are short-lived by assumption. As noted earlier, most of the initial shock wears away after two years and we assume no further shock by the third year. However, agricultural price signals affect supply-side decisions that can result in crop, meat, and biofuel production changes years later. The commodity market effects of a short-lived shock can take longer to evaporate and can cause some degree of over-response and associated price swings in the opposite direction for a brief time.

*Government expenditures on agricultural commodity programs and farm income*

The reductions in agricultural products trigger payments under existing agricultural commodity programs (Table 6). Programs that increase farm payments when prices fall pay more in these scenarios, with increases of 0.25 to 0.60 billion dollars, or 1% to 2%, relative to the base case without the shock to fuel

demands, meat and livestock supply chain, or income. Note that these scenarios do not incorporate all the types of policy responses observed in 2020, when new emergency programs made additional billions of dollars of payments.

Table 6. Government expenditure and farm income indicators averages in the first two years.

| | Fuel only | adding meat and livestock | also with higher income | or with lower lower GDP |
|---|---|---|---|---|
| Mandatory federal outlays | | | | |
| Billion dollars | 0.25 | 0.31 | 0.27 | 0.60 |
| | 1% | 1% | 1% | 2% |
| Net farm income | | | | |
| Billion dollars | -0.74 | -4.81 | -2.38 | -17.66 |
| | -1% | -4% | -2% | -15% |

The immediate farm income effects range widely, from -1% to -15%. These are initial impacts caused by falling prices. Before producers can adjust output, they endure the effects of the price decrease without much ability to adjust production to match the changes in demands.

The fuel market shock has important effects on certain demands for agricultural commodities that serve as biofuel feedstocks, but much of these are spread out throughout the market with other domestic uses, trade, and stocks absorbing much of the shock. Moreover, the reduced demand for biofuel feedstocks leads indirectly to lower livestock producer costs for some feeds. The final impact on farm income in the case of only a fuel market shock is consequently modest.

Meat and livestock supply disruptions reduce livestock and crop producer receipts, causing net farm income to fall by almost 5 billion dollars, or 4%. The short-run price impacts on animal prices directly affect livestock producer receipts. While in time they could respond by reducing animal numbers, causing both live animal prices to rise and feed prices to fall, the initial impacts reported here reflect the impacts before animal numbers can be adjusted very much. However, there is a risk due to scenario design that these results might contain disruptions caused by other factors in the market, not only the impacts of the COVID-19 pandemic.

The case of fuel and livestock shocks along with greater disposable income mitigates the impacts on net farm income by moderating the pandemic's negative effects on producer prices. The farm income reduction of 2% is less pronounced than in the case with meat supply chain and fuel market shocks. For the final case with the GDP reduction driving demand lower in the context of fuel and meat supply chain shocks, the net farm impact sees a reduction of 18 billion dollars, or 15%, as the shocks combine to drive down producer prices the most of all cases explored here.

The scenario results highlight the possible impacts of the various economy-wide assistance packages approved last year. If those packages had not been approved and consumer expenditures had fallen in line with GDP, the impacts on farm income could have been dramatically more severe. Of course, farm income was also affected by agriculture-sector specific emergency payments that offset the reductions in farm income that otherwise might have occurred because of the pandemic.

**Scenario limitations**

We address only three aspects of a hypothetical pandemic and link the size of shocks to the COVID-19 pandemic impacts on agricultural sector supplies and demands in 2020. These choices might be useful to

narrow down the problem and focus on pandemic impacts, thus moving beyond year-over-year changes that might relate to any number of pandemic impacts – or to other factors unrelated to the pandemic. The focus omits important aspects of the COVID-19 pandemic and might limit the applicability to a future pandemic. Policy responses could differ, leading to sharply different income and expenditure implications. Impacts on markets for fruits, vegetables and other specialty crops are ignored. Going farther, events of 2020 could affect the resilience of these markets either by encouraging precautionary steps based or by giving a sense of complacency if certain particularly negative outcomes for people, firms, or society were avoided. More generally, as noted earlier, there is a risk to assuming that a future pandemic would be similar to the current pandemic.

There is also a risk in assuming that the sector will respond to shocks in a way that is similar to how it responded in the past. If COVID-19 creates permanent changes in the sector that increase resilience, then these changes would presumably reduce the quantity and price impacts of a future pandemic. For example, the widening packing plant margins during Spring 2020 might have signaled to operators that there could be economic rewards to designing facilities and worker environments that are less sensitive to a pandemic and can consequently continue operating near capacity if set in a similar context. If firms took such actions, then the impacts of a future pandemic would be reduced at least somewhat so retail price increases, live animal price decreases, and meat quantity reductions would all be mitigated to some extent. A similar outcome could come about if a courtroom or policy decision requires changes in meat packing that create resilience. All that said, such provisions to create resilience could raise costs of business overall and cause wider margins in normal times, when there is no pandemic. The baseline without a future pandemic could include at least somewhat higher retail prices and lower livestock prices if supply chain costs are higher.

The focus here is on the United States alone. As noted earlier, some part of the biofuel market shocks in the U.S. were caused by weaker demand for such fuels in importing countries and competing exporters. A future pandemic could have similar effects on these and other markets. Even if a pandemic were local, not global, and only affected the U.S., trade could be affected by travel and trade restrictions intended to prevent the spread of a disease. In the event of a hypothetical global pandemic, the scope of trade impacts might depend on many of the same factors that determine its direct impacts on the U.S., such as the characteristics of the disease and how people and policies respond to it.