

Economic Impacts of an FMD Outbreak

The shocks described above from the NAADSM component of the model are inserted into the quarterly model of U.S. agriculture as percent changes, and the model is solved for 16 quarters to determine the economic impacts of the FMD outbreak. The quarterly agricultural sector solves for the percent changes in the endogenous variables. The percent changes are applied to a baseline formed by the observed data for the first quarter of 2001 through the fourth quarter of 2004. Thus, actual market price and quantity movements during that 16-quarter period are reflected in the baseline.

Several key assumptions influence economic results. One assumption in this analysis is that all U.S. exports of beef, pork, lamb meat, cattle, swine, and lambs and sheep are halted during the full quarters of the outbreak and for one quarter after the last case appears. Interrupting exports for one quarter beyond the end of the outbreak is consistent with Office International des Epizooties (OIE) guidelines and practices during FMD outbreaks. When that additional quarter ends with no FMD reported, we assume that U.S. exports of the embargoed products fully recover to base levels. Thus, the duration of the outbreak becomes a critical element in determining the economic effects from trade disruptions.

Another critical set of assumptions involves livestock grower expectations regarding prices and future returns. In the model, animal production decisions are based on expected future returns relative to current prices for animals. For example, if a cattle rancher expects that prices for cattle nine quarters in the future will be unaffected by the current disease outbreak, breeding animal inventories and calf production will change little. In the model, expectations are set by the modeler, and price expectations in the scenarios are assumed constant.

Finally, U.S. consumers are assumed to be aware that transmission of FMD to humans is so rare that it is virtually nonexistent. Thus, the scenarios assume there is no disease-induced reduction in demand for beef, pork, and lamb meat.

The results can be grouped into two sets to facilitate presentation:

- **Standard-outbreak scenario:** So called because of the nine outcomes, seven are very similar: There is little difference among the three solutions for 1 km ring destruction, or between low and mean outcomes under the direct-contact slaughter and the direct and- indirect-contact slaughter control strategies and the ring outcomes. Thus, all seven outcomes can be summarized as the results of the mean direct- and indirect-destruction strategies.
- **High-outbreak scenario,** consisting of two outcomes that differ from the standard-outbreak scenario, but that are themselves similar: the high results for direct-contact and indirect-contact destruction.

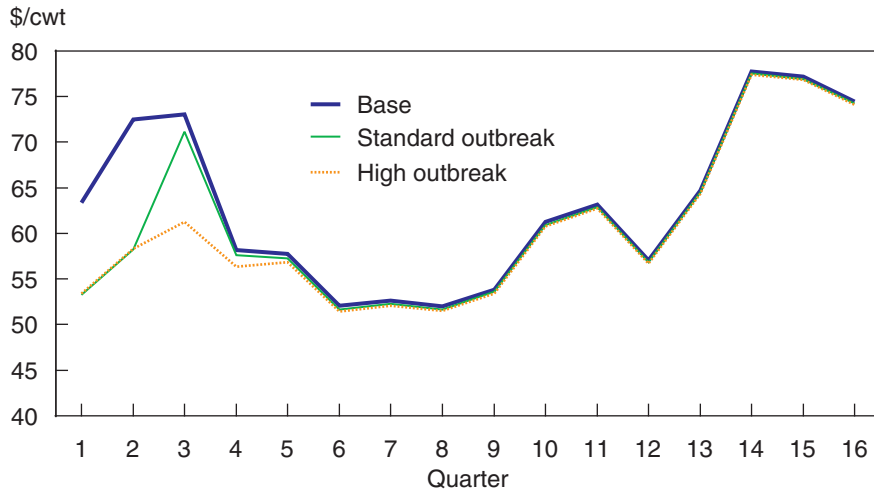
The primary result that separates the nine outcomes into the two groups is the duration of the outbreak. The seven outcomes that form the standard-outbreak scenario all have durations shorter than one quarter. The two differing high-outbreak scenario outcomes have outbreaks lasting 186 to 188

days, or slightly into quarter 3. Export disruptions end one full quarter after slaughter of the last animal associated with the outbreak. Thus, the export disruption for the standard outbreak ends two quarters after the outbreak begins, whereas in the more extreme case, U.S. exports show impacts into quarter 4. Because relatively small numbers of animals are destroyed in these scenarios, trade impacts overwhelm the supply shocks that occur from the destruction of animals.

Pork and Hogs

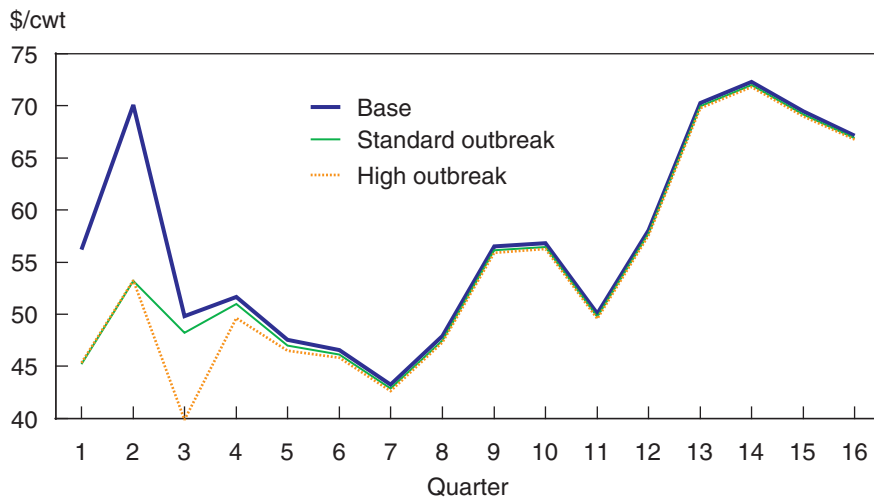
Because most of the animals destroyed are hogs, and exports of pork and hogs are restricted, those sectors are where much of the impact of an FMD outbreak is felt (figs. 2 and 3). An FMD outbreak sharply lowers the prices of pork and hogs under both the standard-outbreak and the high-outbreak

Figure 2
Price of pork (carcass cutout value)



Source: Model simulation results.

Figure 3
Price of hogs



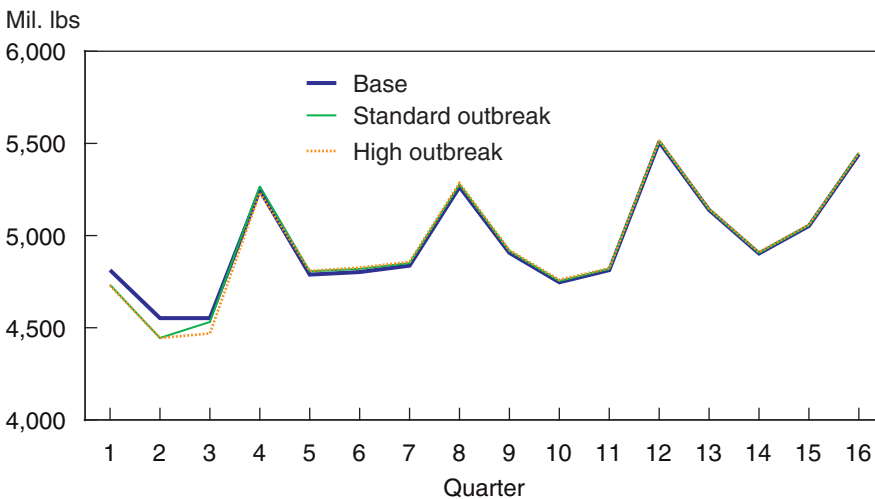
Source: Model simulation results.

scenarios (figs. 2 and 3). Again, this is because trade impacts are larger than depopulation shocks. During the first quarter after the outbreak begins, pork prices (cutout value) fall from \$63.33 to \$53.26 per cwt, while prices of live hogs in the first quarter fall from \$56.52 to \$45.20 per cwt. Pork and hog prices decline because of increased domestic supplies that result from import bans imposed by trading partners. Second-quarter pork and hog prices remain well below base-scenario prices.

One difference in the patterns of hog and pork price changes is that actual hog prices used in the baseline rise rapidly from the first-quarter price level to \$70 per cwt. In the third quarter, differences in the solutions begin to appear for two reasons: (1) the observed base pork and hog prices behave differently—whereas the observed base pork prices are stable, the base hog price falls by \$20 per cwt due to the expansion of the hog industry in 2001, and (2) in the high-outbreak scenario, the outbreak continues into the third quarter, meaning that the export restrictions continue. As a result, prices in the standard-outbreak scenario rise toward the baseline because the outbreak has ended and export restrictions are lifted. Prices in the high-outbreak scenario remain depressed because the export restrictions remain. Pork prices rise slightly in the third quarter, relative to the stable base price, because of the compounding effects of hogs lost to disease on the cost of supplies in quarters 1 through 3. The hog price falls in the third quarter because the observed base price falls as hog numbers rise during that period. Note that the base hog price falls \$20 per cwt, while the high-outbreak hog price falls \$6 per cwt, so the gap between the standard- and high-scenario prices narrows, just as it did for pork prices.

For pork output, the first-quarter difference with the baseline is a decline of 1.6 percent, where output falls from 4,812 to 4,733 million pounds (fig. 4). While there is a small decline in the number of finished hogs due to the disease, the most readily available means of adjusting to the domestic decline is through importing slaughter hogs from Canada. With lower pork prices and return to capital, the incentive to import and kill hogs is reduced. Total

Figure 4
Pork output



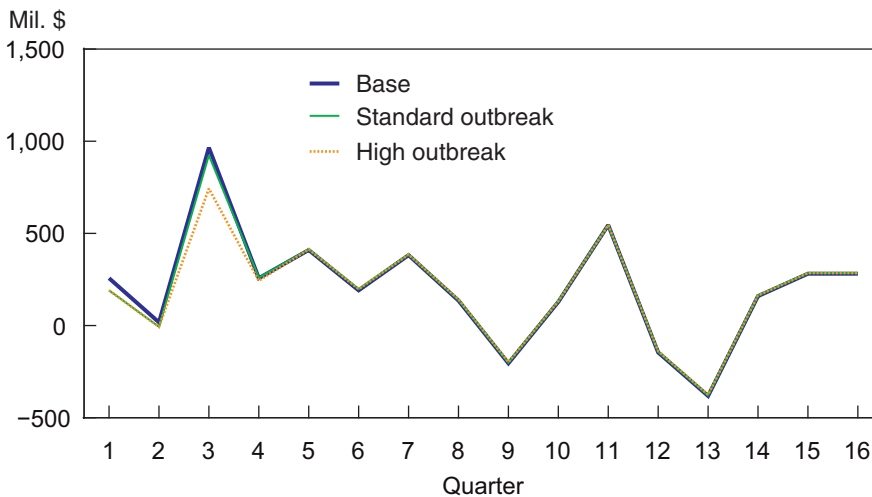
Source: Model simulation results.

first-quarter hog slaughter falls from 23,692,000 to 23,588,000 head. The largest drop in output occurs in the second quarter, because the effects of animal destruction are compounded and price declines relative to the baseline are the largest. Pork output declines 2.3 percent, from 4,550 to 4,444 million pounds. In the standard-outbreak scenario, third-quarter pork output approaches the baseline value to within a difference of -0.5 percent. The high-outbreak scenario continues to show a difference in output, -1.8 percent. The process of returning to the baseline is effectively completed by quarter 6 for both scenarios.

For pork consumption, changes in these scenarios are driven by changes in prices. With lower prices, pork consumption rises in quarters 1 and 2 for the standard-outbreak scenario. In the high-outbreak scenario, the domestic supply effects from the loss of exports into quarter 4 cause prices in quarter 3 to be lower, so pork consumption is higher.

As a result of an FMD outbreak, lower pork prices and output translate into reduced return to capital and management in the pork processing and packing sector (fig. 5). Large reductions in returns to processing hogs occur in quarters 1 and 2. The base returns in quarter 1 are \$256 million. With the FMD outbreak, returns fall to \$191 million. For quarter 2, baseline returns of \$17 million are reduced to losses of \$9 million. As with the other variables, the scenarios begin to diverge in quarter 3. The returns in the standard-outbreak scenario are \$923 million, compared with the baseline value of \$965 million, whereas the high-outbreak returns are only \$742 million. By quarter 4, the gap in returns under the standard-outbreak scenario has been closed, but the difference in the high-outbreak scenario remains \$12 million. By quarter 5, both scenarios are converging on the baseline.

Figure 5
Returns to capital and management, pork processors to retailers

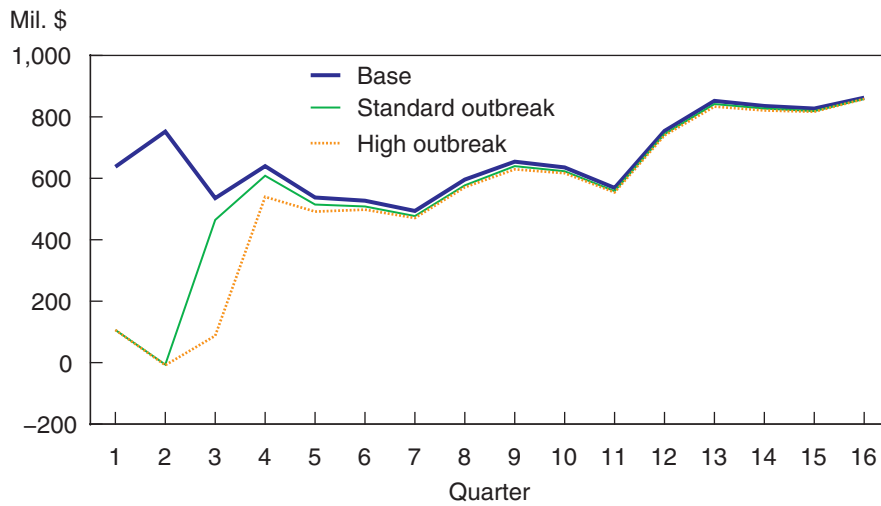


Source: Model simulation results.

Returns to capital and management for hog growers reflect the patterns seen in the prices (fig. 6). Both scenarios show large reductions in the first quarter, with returns falling from a base value of \$638 to \$107 million. The second-quarter decline is larger, with returns of -\$12 million vs. \$751 million. Third-quarter returns to capital and management recover to within \$70 million below the baseline under the standard-outbreak scenario, but returns in the high-outbreak scenario are \$448 million below the baseline. By the sixth and seventh quarters following the FMD outbreak, returns to hog growers have recovered almost to the baseline levels.

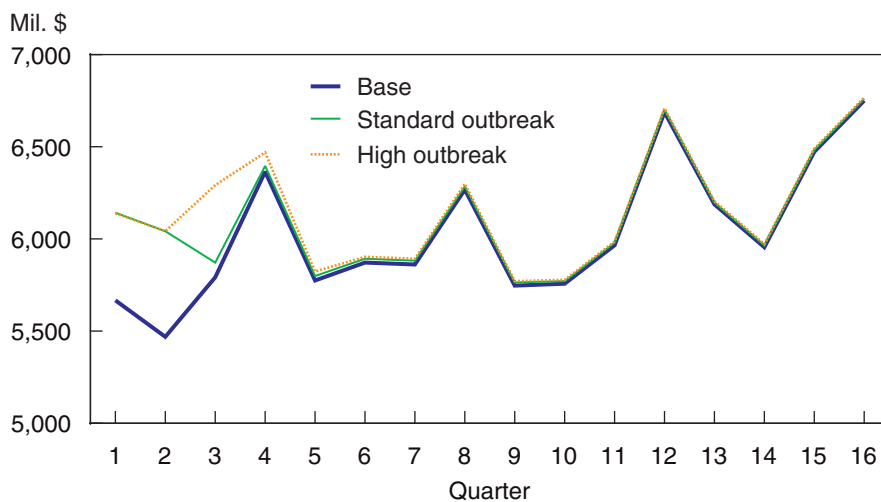
The economic welfare of consumers is measured by the difference between what consumers are willing to pay and what they must pay for each unit consumed. This difference is called consumer surplus. Since the FMD outbreak causes exports of pork to be restricted, the price of pork falls and the lower price causes a gain in consumer surplus (fig. 7). The gap between

Figure 6
Returns to capital and management, hog producers



Source: Model simulation results.

Figure 7
Consumer surplus for pork



Source: Model simulation results.

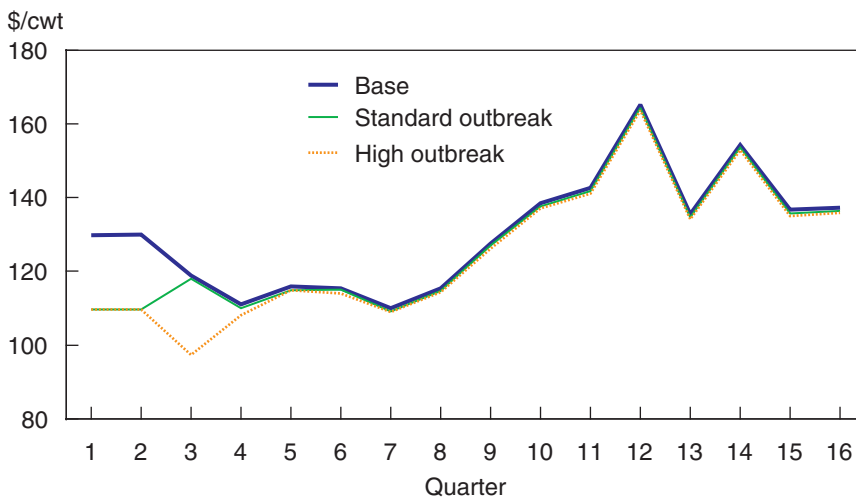
the willingness to pay for each unit consumed and what they must pay expands. In the first quarter, gains to consumers are around \$478 million. The second-quarter gain is \$573 million, because the gap between the baseline price and the model solution price is larger. In the third quarter, the restoration of exports in the standard-outbreak scenario returns consumer surplus to within \$80 million. The high-outbreak scenario has a consumer gain of \$499 million because exports remained embargoed. During the fourth and fifth quarters, benefits to consumers from lower prices continue to shrink and are small.

Beef and Beef Cattle

The beef and beef cattle sectors are also strongly affected by the FMD outbreaks (figs. 8 and 9). The initial patterns appear similar to those for pork and swine. The FMD outbreak causes large initial declines in the prices for beef and for cattle, again because trade restrictions dump extra supplies on the domestic market (i.e., a domestic supply shock). The first-quarter cutout value for beef drops from \$129.69 to \$109.57 per cwt, a fall of 16 percent. The live-steer price falls from \$79.17 to \$64.69 per cwt, a drop of 18 percent. The end of U.S. export restrictions after the second quarter in the standard-outbreak scenario causes a price recovery for both beef and cattle, starting during the third quarter. The high-outbreak scenario, where the export restrictions remain into the third quarter and beyond, shows a further weakening of prices. Both scenarios show recovery of prices beginning after the end of export restrictions.

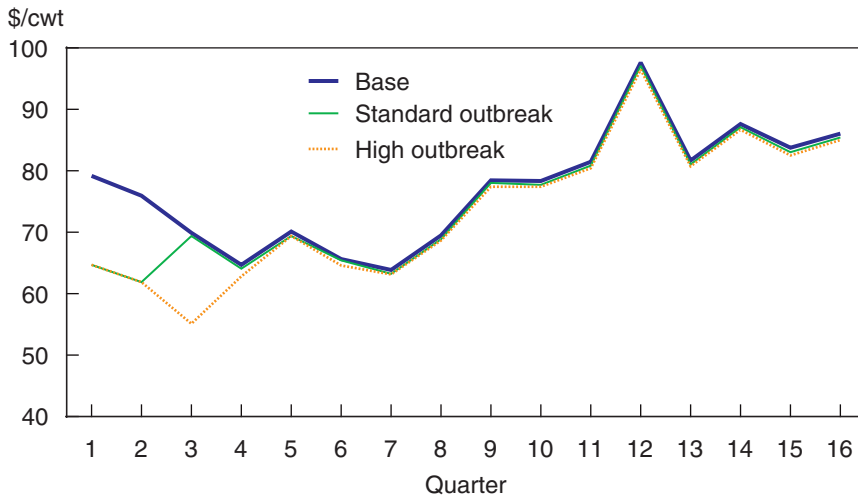
Beef output shows little difference in the effects of the two outbreak scenarios over the 16-quarter period (fig. 10). In the first few quarters, beef production is slightly higher, despite slightly lower slaughter. For example, in quarter 1, beef production rises from 6,272 to 6,379 million pounds, while the number of cattle slaughtered falls from 7,581,000 to 7,579,000 head.

Figure 8
Price of beef (carcass cutout value)



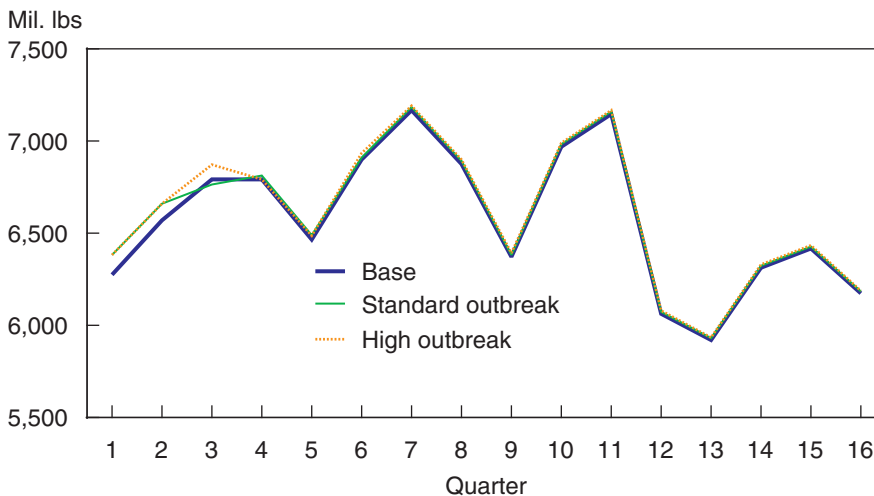
Source: Model simulation results.

Figure 9
Price of cattle



Source: Model simulation results.

Figure 10
Beef output



Source: Model simulation results.

Changes in meat yields per animal depend on the difference in the change in the cattle price relative to the rent on capital in the beef industry and the elasticity of substitution. Slaughter weights are 1.6 percent larger, since the price decline for cattle is greater than that for beef. Weights rise from 753.3 pounds per animal to 765.2 pounds. Packers substitute cattle for capital as the price of cattle falls more than the rent on capital by running the plants slightly more slowly, with closer trim. Given the time lags in raising an animal for slaughter, adjustments are muted.

Imports of slaughter cattle are reduced under both outbreak scenarios, but imports account for a small share of total cattle slaughter. Once U.S. export restrictions are removed, changes occur in the relationship between slaughter numbers and slaughter weights. Slaughter weights drop slightly below baseline weights; fourth-quarter weights are 783.8 vs. 784.5 pounds in the

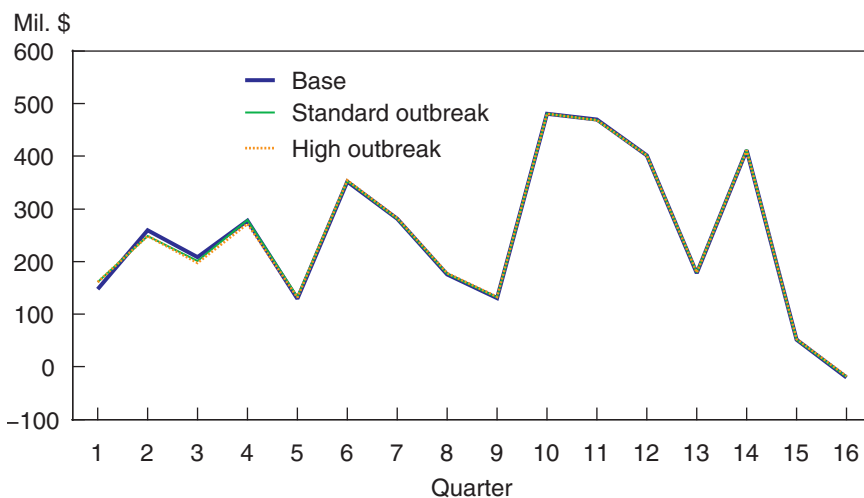
base. The number of animals slaughtered rises, because low cattle prices in quarters 1 through 4 relative to static price expectations cause ranchers to hold more cattle in inventory, and larger cow inventories result in larger calf crops. Larger inventory and calf crops mean more animals for slaughter after quarter 5. Quarter-5 slaughter is 7,615,000 head, compared with 7,575,000 head in the baseline. The resumption of U.S. exports boosts U.S. prices, and U.S. imports of slaughter cattle increase. These adjustments, although small, do result in slightly more beef output in quarters 4 through 16.

Because demand for beef is unchanged in these scenarios, the supply shifts result in beef consumption that is driven by price changes. Higher slaughter volume and higher slaughter weights lead to lower beef prices (below baseline levels), and beef consumption rises. The increase in first-quarter consumption is 7.1 percent. As beef prices rise toward baseline levels, consumption declines toward baseline levels.

Lower prices for beef and cattle following an FMD outbreak affect returns to capital and management (fig. 11). The first-quarter return is \$13 million higher, or a 9.1-percent increase. The FMD outbreak lowers returns to capital and management in the second quarter from \$259 to \$249 million, a decline of 3.9 percent. With the end of U.S. export restrictions, returns begin to climb back to the baseline. For the standard-outbreak scenario, that climb occurs in quarter 3, whereas for the high-outbreak scenario, the recovery to the baseline starts in quarter 4. By quarter 10, little difference remains.

Figure 12 converts FMD-response-motivated price declines (fig. 9) into returns to capital and management for beef cattle producers. Positive baseline returns of \$1,035 million become outbreak-associated returns of \$216 million (fig. 12). In the high-outbreak scenario, U.S. export restrictions result in low returns that continue into quarter 3. As export restrictions are relaxed, net returns to capital and management start to recover.

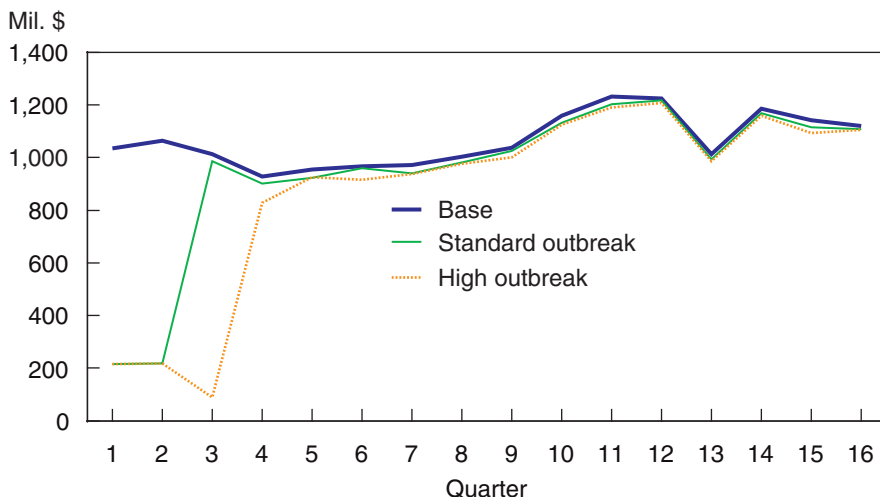
Figure 11
Net returns to capital and management, beef processors to retailers



Source: Model simulation results.

Figure 12

Net returns to capital and management, beef cattle producers



Source: Model simulation results.

With beef prices falling due to the U.S. export restrictions, consumer welfare increases (fig. 13). Consumer surplus in the first quarter rises from \$9,646 to \$11,034 million. In the standard-outbreak scenario, consumer surplus in quarters 2 and 3 is above baseline values by \$1,538 million and \$66 million, respectively. The longer export prohibition in the high-outbreak scenario generates additional gains in quarters 3, 4, and 5.

Dairy and Milk

The milk and dairy sector is modeled on a milk basis. The FMD outbreak has no significant impact on the price of milk because few dairy animals are destroyed relative to the size of the national herd, and no exports of dairy products are banned (fig. 14). For the other commodities discussed, it is primarily the export shock that drives the results, and that shock is missing here.

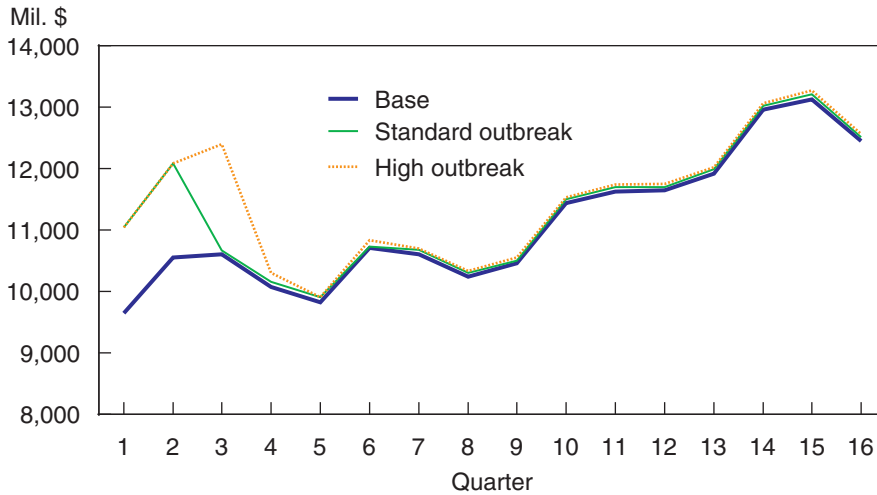
Since milk prices are not affected much by the FMD outbreak and few dairy cattle are destroyed in the scenarios, the impacts on other variables are small. Milk production and consumption correspond to the baseline levels. Net returns to capital and management in the dairy sector are largely unaffected.

Poultry and Eggs

Poultry meat and eggs are not directly affected by an FMD outbreak. The impacts operate through cross-price impacts in demand and through the impacts on feed prices. For poultry meat prices, these impacts are not large (fig. 15). Prices weaken somewhat in sympathy with the prices of beef and pork, but since the cross-price effects are small, the price decline is small. With few animals killed during the outbreak, the effects on feed prices are not large. Poultry meat production is slightly lower. First-quarter poultry meat output falls from 8,896 million to 8,762 million pounds, or 1.5 percent. First-quarter net returns fall from \$538 million to \$506 million, or 5.9 percent (fig. 16). Returns recover to the baseline by quarter 4.

Figure 13

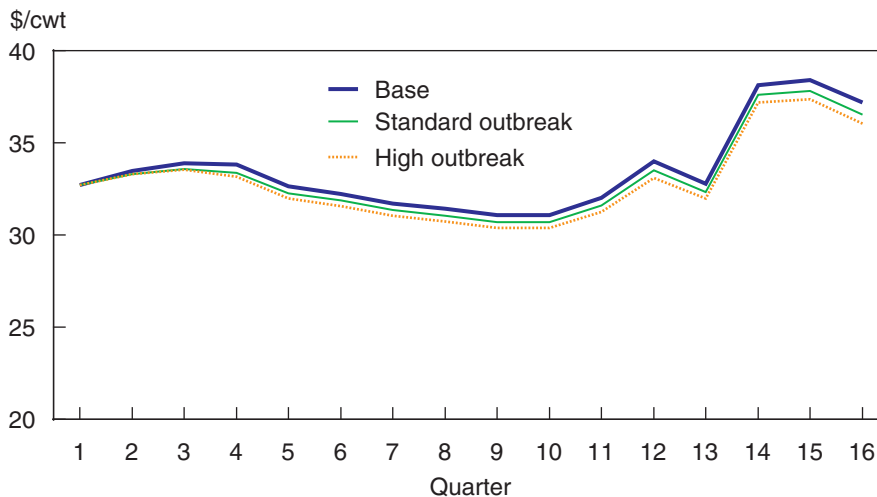
Consumer surplus for beef



Source: Model simulation results.

Figure 14

Retail price for milk



Source: Model simulation results.

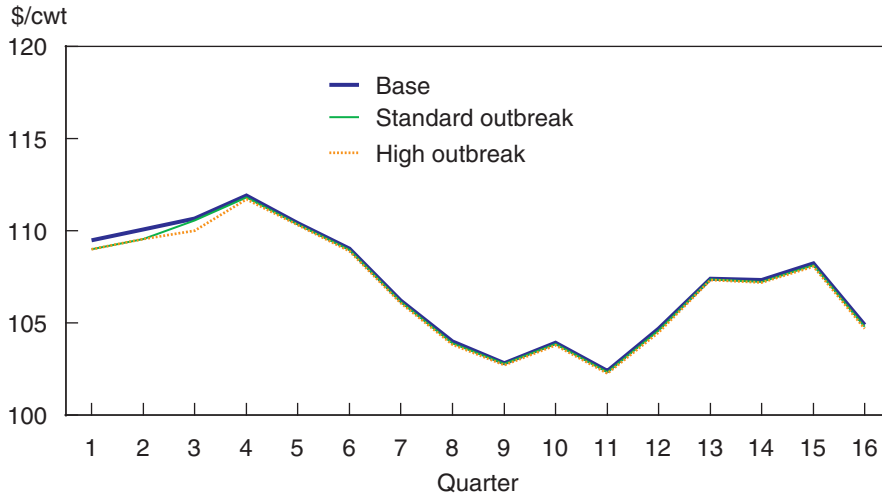
If poultry movements were restricted during an FMD outbreak, there would be additional impacts. However, since well under 10 percent of poultry production is located in the Midwest, the impacts would likely be small in the scenarios presented here.

Lamb and Sheep Stocks and Meat

The number of lambs and sheep destroyed in the outbreak is negligible, and the United States exports little meat or few live animals, except for cull ewes to Mexico. In fact, the United States imports a large share of its lamb meat supplies, reducing any impact of animal destruction on meat supply. Thus, the impact on these sectors is not large compared with the other red meat sectors. The first-quarter price of lamb meat falls by 2.4 percent as consumption declines when consumers switch to lower-priced beef. Since imports

Figure 15

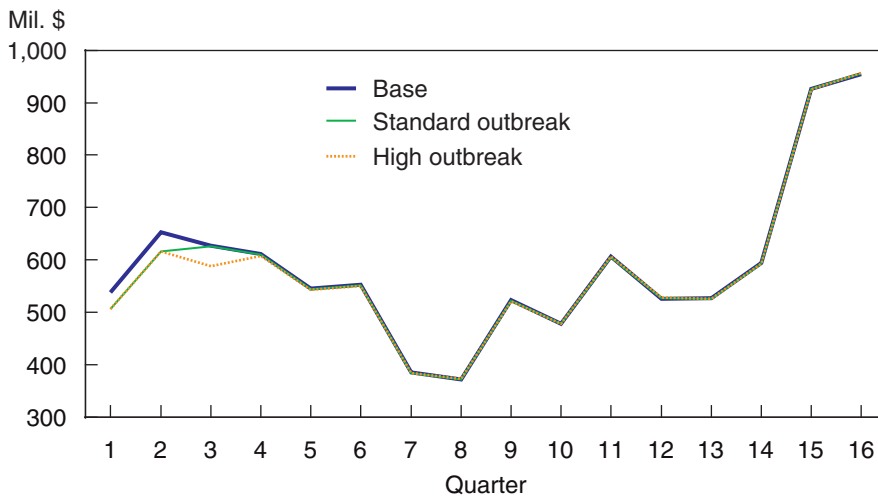
Retail price of poultry meat



Source: Model simulation results.

Figure 16

Net returns to capital and management, poultry meat



Source: Model simulation results.

are more elastic, they show a greater adjustment. U.S. imports decline by 9.6 million pounds, and domestic lamb meat production rises by 5.4 million pounds. The percent increase in production exceeds the percent decline in price, so the value of production increases slightly.

In the lamb and sheep markets, U.S. live animal exports are reduced by 74,700 animals in quarter 1. These animals are added to slaughter, which boosts meat output. The additional animals sold on the U.S. domestic market result in animal price declines from the baseline value of \$79.55 to \$73.33 per cwt. Total revenue is slightly greater, and so are net returns to capital and management.

Crops

With so few animals destroyed and the short duration of the outbreak, there is little effect on feeding. Corn, wheat, and soybean prices decline very slightly. Even if prices had changed greatly, government payments would adjust to preserve net returns.

Changes in Aggregate Net Returns to Capital and Management

The changes in net returns to capital and management, summed over 16 quarters, give the most comprehensive overview of the cost to agriculture and agribusiness of the assumed FMD outbreaks (table 15). Since the impacts dampen over time, most of the effects occur in the first four quarters.

The beef packing/processing and beef cattle sectors show the largest losses from the assumed outbreaks, even though the number of cattle destroyed is small. The combined losses range from \$1,951 million to \$3,075 million. Pork and swine sectors experience losses in returns to capital and management of between \$1,652 million and \$2,358 million. Returns in the dairy sector improve, because few dairy cattle are lost to FMD and dairy exports do not decline, while feed costs—especially the cost of forage—are lower. Other sectors experience either small losses in returns to capital and management or small gains, as in the case of lamb and sheep meat and milk. Total losses to capital and management over 16 quarters amount to between \$2,773 million and \$4,062 million.