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The Potential Effects on United States Agriculture of an Avian Influenza Outbreak

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The U.S. poultry industry has spent considerable resources to date preparing for an outbreak of avian influenza in this country. This research quantifies the potential effects of two alternative avian influenza scenarios on the poultry industry. In addition, this research looks at effects on other agriculture sectors including the loss of feed demand from an outbreak and the impacts on aggregate measures like farm income and consumer food expenditures. The economic sector model maintained by the Food and Agricultural Policy Research Institute (FAPRI) is employed for these scenarios.

Key Words: avian influenza, disease outbreak, econometric model, poultry production, poultry trade

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The outbreak of highly pathogenic avian influenza (AI) in over a dozen countries around the world has placed the United States poultry industry on alert. Many industry stakeholders have speculated about the effects on poultry markets under an AI outbreak in the United States. Although it is quickly recognized that an AI outbreak in the U.S. poultry industry could have large effects for the poultry sector, the impacts on other U.S. agricultural industries are often overlooked. This research will provide an analysis of the effects of two alternative AI scenarios on the poultry industry, other livestock markets, the feed sector, and aggregate measures including farm income and consumer food expenditures.

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This research will use the economic model maintained by the Food and Agricultural Policy Research Institute at the University of Missouri–Columbia. This modeling system has been used extensively by Congress to quantify likely effects of changes in farm policies. The system maintained at FAPRI explicitly incorporates cross-commodity interactions to gain a better understanding of the effects that changes in one sector have on the entire U.S. agricultural system.

The FAPRI Modeling System

The FAPRI modeling system is an annual multimarket, nonspatial, partial equilibrium model that covers markets for major grains (wheat, corn, rice, sorghum, barley, and oats), oilseeds, (soybeans, rapeseed, sunflowerseed, peanuts, and palm oil), cotton, sugar, beef, pork, poultry, (chicken, turkey, and eggs), and dairy products. Included with this structural model system are satellite models that provide estimates of U.S. farm income, U.S. government outlays for agriculture, and U.S. consumer food costs. This model is used to

generate annual 10-year baseline projections (e.g., FAPRI 2007) and analyze a wide range of domestic and trade policy questions (e.g., Fabosia et al.).

Of particular interest to this research is the livestock component of the FAPRI system. The supply side of the livestock model incorporates both behavioral supply equations that determine primary supplies such as numbers of cows, sows, and layers and technical relationships that ensure that biological restrictions faced in each livestock sector are not violated. The behavioral supply equations are driven by the expected output and input prices in a naive price expectations specification.

The demand for livestock products includes both domestic and international components. The equations for trade in livestock products are reduced-form specifications derived from the international livestock models maintained by FAPRI. They adjust trade as U.S. meat prices change. Domestic demand specifications are traditional in that they determine consumption of each meat dependent on its own and then substitute prices and the level of consumer income. For complete livestock model documentation see FAPRI (2004).

The connections between the crop and livestock components of the FAPRI model are critical. Feed demand for grains and protein meals depends on the quantity of livestock produced and the relative prices of different feedstuffs. Inherent to the system is an accounting of total feed demand that looks at both feed rations and quantity of animals being fed. To complete the simultaneous interaction between livestock and crop components, feed prices are included in livestock equations that will adjust inventories and slaughter weights.

The FAPRI Baseline

Effects of alternative scenarios can either be measured relative to some observed historical period or to a future baseline. The FAPRI process nearly always takes a forward-looking approach in determining the effects of alternative scenarios. The FAPRI baseline, a 10-year look forward, is developed annually and based on expectations of the macro-economic environment as it is measured by indicators such as exchange rates, inflation, income and population, average weather conditions, continuation of current government policy related to agriculture, and productivity growth rates that continue at currently observed values. The baseline also incorporates expert opinions for areas where the model may not provide well-suited information. An example would be the political decisions forthcoming on the opening of countries to trade similar to what is currently unfolding for U.S. beef exports destined to Japan and Korea. This 10-year baseline is distinguishable from a forecast because of these assumptions.

The baseline that is used for this analysis was developed in early 2007 and covers the period 2007–2016. In examining these U.S. AI outbreak scenarios, it is important to use the baseline as the yardstick against which these alternatives are measured. In most cases, the relevant comparison to examine is the change in these scenarios relative to the baseline.

U.S. Avian Influenza Outbreak Assumptions

There is an enormous amount of uncertainty regarding the effects of an AI outbreak in the United States. Uncertainties surrounding an AI outbreak can be categorized into three major areas: (1) how widespread the area of outbreak becomes and the length of time it takes to contain it, (2) the change in U.S. consumer demand for poultry products as a result of the outbreak, and (3) the response by other countries to an AI outbreak in the United States.

Since it is impossible to determine in advance how large a production area would be affected by an outbreak, this analysis examines two possible scenarios. Assuming an AI outbreak occurs in 2008, the first scenario (referred to as 8-county) is a smaller-scale outbreak contained in Benton, Carroll, Madison, and Washington counties in Arkansas; Lawrence and McDonald counties in Missouri; and Adair and Delaware counties

Table 1. Assumed U.S. Poultry Production and Export Reductions of an Avian Influenza Outbreak

	4-State Scenario					8-County Scenario		
	2008	2009	2010	2011	2012–2016	2008	2009	2010–2016
Production								
Chicken	−26.2%	−13.1%	−6.6%	0.0%	0.0%	−2.2%	0.0%	0.0%
Turkey	−19.1	−9.6	−4.8	0.0	0.0	−5.4	0.0	0.0
Egg	−11.9	−6.0	−3.0	0.0	0.0	−5.7	0.0	0.0
Exports								
Chicken	−100	−50	0.0	0.0	0.0	−8.0	0.0	0.0
Turkey	−100	−50	0.0	0.0	0.0	−8.0	0.0	0.0
Egg	−100	−50	0.0	0.0	0.0	−8.0	0.0	0.0

in Oklahoma. It is assumed that all poultry production in these counties would cease with the onset of the AI infection. Furthermore, it is assumed that these counties would be able to eliminate new outbreaks within six months of the initial infection, allowing production of poultry products to return to normal by the second year of the scenario. The 2002 Census of Agriculture is employed to determine the amount of poultry production contained in these eight counties (Table 1).

The second production scenario (referred to as 4-state) assumes an AI outbreak covering Arkansas, Missouri, Oklahoma, and Texas. Under this scenario, new AI cases continue to occur for one full year, with an additional six months expected before these states can return to pre-outbreak production levels. Data from the 2002 Census of Agriculture show these states represent a significant portion of U.S. poultry production (Table 1).

When addressing changes in U.S. consumer demand that could result from an AI outbreak in this country, two sources of information can be useful in determining potential demand effects. First, one can examine the consumer response in other countries where past AI outbreaks have occurred. Second, information on U.S. consumer behavior from other past animal disease outbreaks can be used. However, looking at these two pieces of information provides conflicting information. While many countries have experienced a decline in demand for poultry products as a result of AI, at least in the short term, observations on U.S. consumer response to other disease outbreaks such as bovine spongiform encephalopathy (BSE) would suggest virtually no demand effect (IFAP, p. 6; Coffey et al., p. 50). For this analysis, it is assumed there would be no adverse domestic demand effects from a U.S. AI outbreak. If domestic demand for poultry products were to weaken, the impacts on U.S. agriculture would be significantly different from those shown in this analysis.

The last assumption in this analysis identifies how other countries will respond to a U.S. AI outbreak. Individual country responses to past U.S. poultry disease outbreaks are used as a guide for this analysis (CAST, p. 5). The outbreak of AI in Texas in 2004 was used as a guide in setting assumptions for these two alternative scenarios. Under the 8-county scenario, it is assumed that South Korea would halt imports of U.S. poultry products for one year, Japan for four months, Hong Kong for three months, and other countries not explicitly tracked by USDA for two months. This assumption results in an 8% decrease in U.S. exports of chicken, turkey, and eggs during the first year, with trade returning to normal after year 1.

Under the 4-state scenario, it is assumed that imports would halt for all countries for a period of one year because it would be difficult to assure other countries that U.S. poultry products would be safe under such a significant outbreak. In the second year, exports would remain 50% below normal

levels as some countries would continue to block poultry from the United States. Poultry exports would face no restrictions by the third year, as a year would have passed since the last new AI case, providing an adequate opportunity for trade relations to normalize.

U.S. Avian Influenza Results

Tables 2–5 provide results of both the 8-county and 4-state scenarios. The baseline shown in these tables is sourced from the FAPRI 2007 Agricultural Outlook. Both scenarios are assumed to begin in 2008. For the 8-county scenario, the first two years of the scenario are presented individually on the tables. The remaining years (2010–2016) are averaged together since the impacts of the scenario become extremely small after the first two years. Year-by-year results for the 4-state scenario are shown for the first four years, as significant impacts of the scenario last for a longer period of time. The remaining years (2012–2016) are, again, averaged together.

Impacts on the Poultry Sector

Similar results occur for the chicken, turkey and egg industries under both scenarios. Under the 4-state scenario there are large poultry production cuts in the first two years accompanied by cuts in U.S. exports that are smaller, in absolute terms, than the production declines. Since no domestic demand cuts are assumed, prices rise as domestic supplies of poultry products tighten. A similar outcome is shown under the 8-county scenario, though the magnitude and length of effects are much smaller.

Table 2 summarizes scenario effects for the poultry sector. Chicken production falls by nearly nine billion pounds relative to the baseline in 2008, the first year of the 4-state scenario. With the assumption of no chicken exports in 2008, exports are reduced by 5.6 billion pounds, resulting in a 3.2 billion pound decline for domestic chicken supplies. That cut in domestic supplies allows the 12-city broiler price to rise from the baseline level by 11 cents per pound, reaching 80 cents per pound. It is important to note that although 12-city broiler prices rise, chicken leg prices move lower, with the loss of exports placing more dark meat supply into domestic markets.

Effects for years 2 and 3 moderate from year 1 impacts as the sector begins to bring the AI outbreak under control. With the chicken sector fully recovered by 2011, chicken production actually increases slightly relative to the baseline as higher prices have encouraged a slight production expansion.

Turkey production falls by 0.9 billion pounds the first year of the scenario, with no exports implying a 0.6 billion pounds reduction from the baseline under the 4-state scenario. The cut in domestic supplies of turkey meat results in the wholesale price rising by 19 cents per pound. Outbreak effects moderate in years 2 and 3, but turkey production and exports remain below the baseline, with prices above baseline levels.

Under the 8-county scenario, turkey production and exports are below baseline levels in the first year only. The higher turkey price of eight cents per pound experienced in year 1 results in a slight expansion of production during the second year.

Egg production declines by 0.8 billion dozen in 2008 under the 4-state scenario, while exports are 0.2 billion dozen less than the baseline. As a result, egg prices increase 19 cents per dozen. Egg production declines by 0.1 billion dozen the first year of the 8-county scenario, leading to a price rise of 3 cents per dozen.

In summary, under either scenario, all poultry sectors show first-year production declines that are larger in absolute terms than the loss of exports. This allows output prices to increase. As the sectors are able to recover from the outbreaks, results shown in subsequent years begin to moderate and are virtually eliminated by the second year under the 8-county scenario.

Impacts on the Meat Sectors

It is important to recognize the impact on other meat sectors from an AI outbreak. The assumption of no negative U.S. consumer demand response on poultry consumption has

Table 2. Effects of an Avian Influenza Outbreak on the Poultry Industry

	4-State Scenario					8-County Scenario		
	2008	2009	2010	2011	2012–2016	2008	2009	2010–2016
Chicken production				Billion Pounds				
Baseline	36.2	36.7	37.2	37.8	39.9	36.2	36.7	39.2
Scenario	27.4	31.9	35.4	38.1	39.9	34.5	36.7	39.2
Change	−8.8	−4.8	−1.8	0.4	0.0	−1.7	0.0	0.0
Turkey production								
Baseline	5.8	5.8	5.9	6.0	6.2	5.8	5.8	6.1
Scenario	4.9	5.5	5.7	6.0	6.2	5.5	5.9	6.0
Change	−0.9	−0.3	−0.2	0.1	0.0	−0.3	0.1	0.0
Egg production				Billion Dozen				
Baseline	7.7	7.7	7.8	7.9	8.1	7.7	7.7	8.0
Scenario	6.9	7.5	7.6	7.9	8.1	7.5	7.8	8.0
Change	−0.8	−0.3	−0.2	0.0	0.0	−0.1	0.0	0.0
Chicken exports				Billion Pounds				
Baseline	5.6	5.7	5.8	6.0	6.6	5.6	5.7	6.4
Scenario	0.0	3.1	5.3	6.0	6.6	4.9	5.7	6.4
Change	−5.6	−2.6	−0.5	0.0	0.0	−0.6	0.0	0.0
Turkey exports								
Baseline	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.7
Scenario	0.0	0.3	0.6	0.7	0.7	0.5	0.6	0.7
Change	−0.6	−0.4	−0.1	0.0	0.0	−0.1	0.0	0.0
Egg exports				Billion Dozen				
Baseline	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Scenario	0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.2
Change	−0.2	−0.1	0.0	0.0	0.0	−0.0	0.0	0.0
12-city broiler price				Cents per Pound				
Baseline	69	70	70	71	71	69	70	71
Scenario	80	80	77	69	71	73	70	71
Change	11	9	6	−1	0	4	0	0
Turkey wholesale price								
Baseline	75	76	77	77	78	75	76	78
Scenario	94	82	85	76	78	83	75	78
Change	19	6	8	−2	0	8	−1	0
Egg wholesale price				Cents per Dozen				
Baseline	82	84	85	86	86	82	84	86
Scenario	101	87	90	85	86	85	83	86
Change	19	3	5	−1	0	3	−1	0

important consequences for competing meat sectors. If a negative demand effect was included in the poultry sectors, a positive demand shift would need to be assumed in competing meat sectors in order to account for a shift by consumers away from poultry. However, this research allows only the positive demand effects of higher poultry prices to influence the demand for beef and pork.

Table 3 shows that in the first year of the two scenarios beef and pork prices rise. The fed steer price rises by $4 per hundredweight, while the barrow and gilt price is $3 per hundredweight higher relative to the baseline

Table 3. Effects of an Avian Influenza Outbreak on the Beef and Pork Industries

	4-State Scenario					8-County Scenario		
	2008	2009	2010	2011	2012–2016	2008	2009	2010–2016
Beef production				Billion Pounds				
Baseline	27.0	27.8	28.4	28.6	28.3	27.0	27.8	28.4
Scenario	26.9	27.8	28.5	28.8	28.4	27.0	27.8	28.4
Change	−0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.0
Pork production								
Baseline	21.8	21.7	21.6	21.8	22.7	21.8	21.7	22.4
Scenario	21.8	21.8	21.9	22.0	22.7	21.8	21.7	22.4
Change	0.0	0.2	0.3	0.3	0.0	0.0	0.0	0.0
Beef exports								
Baseline	1.7	2.0	2.2	2.2	2.2	1.7	2.0	2.2
Scenario	1.6	1.9	2.1	2.2	2.2	1.7	2.0	2.2
Change	−0.1	−0.1	−0.0	0.0	0.0	0.0	0.0	0.0
Pork exports								
Baseline	3.3	3.4	3.5	3.5	3.9	3.3	3.4	3.8
Scenario	3.3	3.4	3.5	3.7	4.0	3.3	3.4	3.8
Change	−0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Fed steer price				Dollars per Hundredweight				
Baseline	86	84	82	82	85	86	84	84
Scenario	90	87	83	80	85	87	84	84
Change	4	3	1	−2	0	1	−0	0
Barrow and gilt price								
Baseline	44	48	51	54	49	44	48	50
Scenario	48	49	50	51	49	46	48	50
Change	3	1	−2	−3	0	1	−0	0

under the 4-state scenario. Both cattle and hog prices rise by $1 per hundredweight in 2008 under the 8-county scenario.

The year 2 results of the 4-state scenario show both cattle and hog prices remain above baseline levels. Higher hog prices result in pork production expanding by 0.2 billion pounds relative to the baseline; beef production remains virtually unchanged. Although the beef cow herd begins expanding because of higher cattle prices in year 1, it takes until year 3 of the 4-state scenario for additional beef production to reach the market. Beef production actually declines in year 1 as a result of more animals being kept by producers for breeding rather than heading to slaughter. The 4-state scenario results in production expansion in the beef and pork sectors that oversupplies the domestic market once poultry production begins to return to baseline levels. This causes declines in cattle and hog prices in the latter years of the scenario.

The effect of the 8-county scenario on the beef and pork sectors is minimal. Both cattle and hog prices rise by $1 per hundredweight in the first year of the scenario, but by year 2 these sectors are nearly unchanged.

Impact on Feedstuffs

Beyond the livestock industries that are obviously affected by an AI outbreak, there are other sectors within agriculture that would experience changes. As areas halt production for a period of time to eliminate AI, feed use will decline as well. This impacts both grain and protein meal markets, resulting in less

Table 4. Effects of an Avian Influenza Outbreak on Feed-Related Sectors

	4-State Scenario					8-County Scenario		
Crop Year	2007	2008	2009	2010	2011–2015	2007	2008	2009–2015
Corn feed use				Billion Bushels				
Baseline	5.7	5.6	5.6	5.7	5.8	5.7	5.6	5.8
Scenario	5.4	5.5	5.6	5.7	5.8	5.6	5.6	5.8
Change	−0.2	−0.2	−0.0	0.0	0.0	−0.0	−0.0	0.0
Soymeal domestic use				Million Tons				
Baseline	33.7	33.7	34.2	34.9	37.0	33.7	33.7	36.3
Scenario	30.5	32.3	33.7	35.1	37.0	33.1	33.8	36.3
Change	−3.2	−1.4	−0.5	0.2	0.0	−0.6	0.1	0.0
Corn farm price				Dollars per Bushel				
Baseline	3.24	3.24	3.25	3.22	3.10	3.24	3.24	3.14
Scenario	3.11	3.24	3.24	3.23	3.11	3.22	3.25	3.14
Change	−0.12	0.00	−0.01	0.01	0.00	−0.02	0.01	0.00
Soybean price								
Baseline	6.68	7.02	7.01	6.90	6.65	6.68	7.02	6.74
Scenario	6.55	6.91	7.00	6.92	6.66	6.66	7.02	6.74
Change	−0.13	−0.12	−0.02	0.01	0.00	−0.02	0.00	0.00
Soymeal price				Dollars per Ton				
Baseline	187	186	182	178	169	187	186	172
Scenario	177	180	181	179	169	185	186	172
Change	−10	−6	−1	1	0	−2	0	0

demand and thus lower prices. Table 4 shows that in the first year under the 4-state scenario, feed corn use declines by 0.2 billion bushels relative to the baseline. Soybean meal domestic use declines by 3.2 million tons. The reduction in feed demand results in corn prices declining by $0.12 per bushel in the first year. Soybean meal prices are $10 per ton lower and soybean prices decline by $0.13 per bushel relative to the baseline for the first year of the 4-state scenario.

In subsequent years of the 4-state scenario, declines in feed component prices are moderated as both corn and soybean acreages adjust to reflect decreased feed use. The acreage changes coupled with the return of feed demand as the poultry sector recovers from the outbreak result in feed prices that return to baseline levels.

The 8-county scenario shows only modest effects on the crop sector, with corn and soybean prices down only $0.02 per bushel relative to the baseline in the first year of the outbreak. After the first year, the crop sector returns to baseline paths.

Impact on Farm Income and Consumer Expenditures

Beyond examining sector-level effects of an AI outbreak, a look at the broader effects of the outbreak can provide more information regarding expected aggregate impacts. Table 5 provides impacts on net farm income and consumer food costs for these two alternative scenarios.

Under the 4-state scenario, aggregate net farm income increases by $1.9 billion relative to the baseline in the first year. Livestock receipts are $1.9 billion higher; the combination of higher receipts and lower feed costs of $2.2 billion allows income to the livestock sector to increase. This result may seem counterintuitive, but with inelastic meat demand, a cut in supply should result in an increase in livestock receipts. It is important to recall the assumption of no

Table 5. Effects of an Avian Influenza Outbreak on Farm Income and Food Expenditures

	4-State Scenario					8-County Scenario		
Calendar Year	2008	2009	2010	2011	2012–2016	2008	2009	2010–2016
Crop receipts				Billion Dollars				
Baseline	142.7	146.3	148.9	150.7	155.8	142.7	146.3	154.1
Scenario	141.2	145.8	148.9	150.9	155.9	142.5	146.3	154.1
Change	−1.5	−0.5	−0.0	0.2	0.1	−0.2	0.0	0.0
Livestock receipts								
Baseline	124.3	126.1	127.6	130.2	134.5	124.3	126.1	132.9
Scenario	126.3	128.6	129.1	127.3	134.4	126.1	126.0	132.8
Change	1.9	2.4	1.5	−2.9	−0.1	1.8	−0.2	−0.0
Feed expenses								
Baseline	37.9	38.3	38.6	38.7	38.6	37.9	38.3	38.6
Scenario	35.7	37.5	38.5	38.9	38.7	37.6	38.4	38.6
Change	−2.2	−0.8	−0.1	0.2	0.1	−0.3	0.1	0.0
Farm income								
Baseline	63.4	62.8	62.4	62.8	61.5	63.4	62.8	61.8
Scenario	65.3	65.2	64.0	60.7	61.5	65.0	62.6	61.8
Change	1.9	2.4	1.5	−2.1	−0.0	1.6	−0.1	−0.1
Consumer food expenditures								
Baseline	781.0	805.6	830.0	854.9	931.1	781.0	805.6	905.8
Scenario	783.6	808.7	831.9	854.5	930.8	781.8	806.1	905.7
Change	2.6	3.0	1.9	−0.4	−0.3	0.8	0.5	−0.1

declines in poultry demand under these scenarios. If demand for poultry meat was assumed to decline as a result of an AI outbreak, it would have negative consequences for the poultry sector. However, if an offsetting positive demand shift was assumed in other meat sectors, the overall livestock effect could be close to the results shown here. Although total livestock revenue is higher, those individual operations dealing with an AI outbreak will certainly not see any benefits from the outbreak. Not all sectors see improved income as a result of the outbreak. Crop receipts are $1.5 billion lower in year 1, without any significant declines in production expenses.

Under the 4-state scenario, farm income remains above the baseline level for the first three years. By the fourth year, farm income is lower as a result of supply over response in the beef and pork sectors dampening cattle and hog prices and a return to pre-outbreak price levels in the poultry sector. The averages from 2012 to 2016 show only very small changes to all sectors relative to baseline levels. Consumer food expenditures rise under the 4-state scenario by $2.6 billion in the first year, consistent with the increase in farm income. Consumer food expenditures remain above baseline levels for the first three years of the 4-state scenario.

Farm income and consumer food expenditure changes under the smaller 8-county scenario are similar to the 4-state results, just smaller in magnitude and shorter in duration. The different levels of absolute effects between the 4-state and 8-county scenarios highlight the importance of handling outbreaks as quickly as possible to minimize market disruptions to these industries.

Summary

The results of these two possible AI outbreak scenarios highlight the obvious concern of the poultry industry regarding the potential consequences of an AI outbreak situation, as well as the finding that several other sectors within

agriculture would be affected. Spillover effects to other livestock sectors and to those producing feed for livestock could be large.

The results presented in this research should magnify the importance of consumer response to these types of disease outbreaks. This requires not only knowledge about the consumer response to the livestock sector in which the disease outbreak occurs, but also insight into any potential consumer shifts to substitute products. It is essential to differentiate consumer response to different levels of outbreaks. For instance, how would a well-contained AI outbreak that affects only the poultry sector change consumer demand response relative to an outbreak that affects humans directly?

The two AI outbreak scenarios presented here highlight the importance of quick identification and containment of an AI infection in the United States. The difference in the effects of the larger 4-state scenario versus the smaller 8-county scenario reveals that billions of dollars are at stake regarding the severity and length of the outbreak. These figures greatly overshadow amounts of money currently spent on preparing for an outbreak.

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