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Financial Implications from Contracting Avian Influenza in a U.S. Broiler Operation

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ABSTRACT

This essay evaluates the on-farm financial impacts of an avian influenza outbreak on a U.S. commercial broiler operation. It investigates how the timing and length of the outbreak impacts farm financial performance for two different farmers, beginning and experienced. Results indicate that a beginning farmer is more susceptible to significant financial losses. Both farmers are financially impacted more when avian influenza is contracted early in the investment and when the contamination and eradication of the virus was prolonged. Furthermore, this essay highlights the problems of using standard financial measures for analyzing disease outbreaks under production contract arrangements and presents alternative measures for financial performance. This study provides the foundation for future research to determine actuarially fair premiums for avian influenza insurance mechanisms.

KEYWORDS

high pathogenic avian influenza, low pathogenic avian influenza, contract production, livestock finance, livestock mortality insurance, poultry

INTRODUCTION

Avian influenza (AI) is a virus that infects poultry and wild birds. AI consists of two general strains, highly pathogenic avian influenza (HPAI) and low pathogenic avian influenza (LPAI). HPAI, the deadlier of the two strains, is infectious and can spread between birds rapidly. Due to the severity of the virus, a rapid emergency response is required to quarantine and eradicate the infected flocks (U.S. Department of Agriculture, Animal and Plant Health Inspection Service [USDA-APHIS], 2016a). An outbreak of AI can be catastrophic financially if infection occurs in 1 of the over 25,000 family farms in the United States that produce broiler chickens. The economic consequences of an infected flock not only impact the producer whose birds initially contract the virus but also has the potential to infect other flocks, which potentially has implications at the state and global levels.

In 2016, the United States produced 9 million broilers weighing 54 billion pounds with a value of $26 billion (U.S. Department of Agriculture, National Agricultural Statistics Service [USDA-NASS], 2017). However, the total economic impact from the broiler industry was $313 billion in 2016 (Chicken Feeds America, 2016b). The top-producing states include Georgia, Arkansas, North Carolina, Alabama, and Mississippi, which accounted for 59% of the total value of U.S. production. For most of the top-producing states, broiler production is number one in cash receipts for all commodities in the state. Kentucky ranks seventh in the United States in broiler production, but like those states in the top five, cash receipts from broiler production are number one in the state at $1.02 billion for 2016 and are forecasted to increase to $1.13 billion in 2018 (USDA-NASS, 2017). The boiler industry has a significant impact on local economies. For example, McLean County, Kentucky, has one of the highest concentrations of broiler houses in the state (350 houses) with a total economic impact on the county valued at $86.5 million in 2016 (Chicken Feeds America, 2016a). Also, McLean County, Kentucky is one of the smallest counties in the state, which means that an HPAI outbreak in such a county would be devastating. Figure 1 illustrates that the majority of the county, due to its size, would be under quarantine from the required control zone of 10 km (USDA-APHIS, 2017c).

AI outbreaks in the U.S. poultry sector have been widespread since the first detection of the virus, in December 2014, in Washington state.

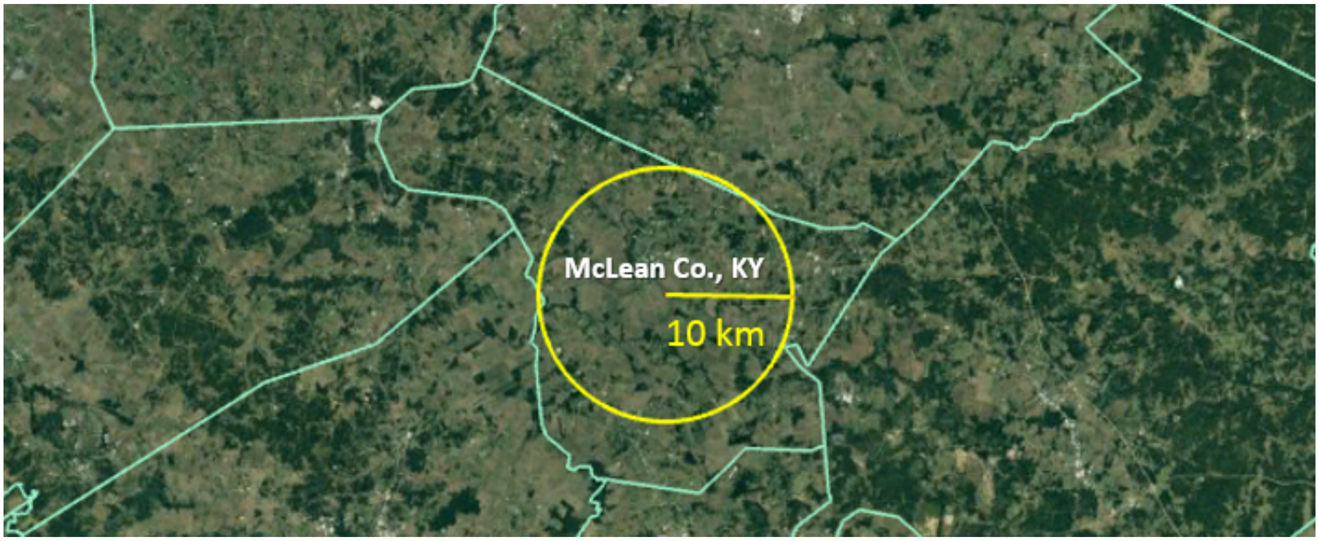

Figure 1. Quarantine Zone from a Hypothetical HPAI Outbreak in McLean County, Kentucky

Following that, the virus spread across 21 states and impacted 211 commercial and 21 backyard poultry flocks by June 2015 (Johansson, Preston, & Seitzinger, 2016). This outbreak was considered the largest poultry health disaster in U.S. history. In total, 50 million chickens and turkeys died from HPAI during this time. The most substantial impact was in Minnesota and Iowa where 87% of the bird losses occurred, most of which were turkey and layer flocks (Ramos, MacLachlan, & Melton, 2017). The federal government expenditure to control this outbreak was $879 million. A majority of the cost was for depopulation, cleaning, and disinfection (Johnasson et al., 2016; USDA-APHIS, 2016c). Since the 2014–2015 outbreak, 667,000 more birds have died from both HPAI and LPAI, costing the federal government $33 million for control measures. These outbreaks occurred in Indiana, Alabama, Georgia, Tennessee, and Kentucky, with the most recent occurring in March 2017 in a commercial broiler operation (USDA-APHIS, 2016d; USDA-APHIS, 2017b). While the federal government provides financial aid to a producer for depopulation, cleaning, and disinfecting, indemnity payments are only for the birds infected with HPAI. It is important to note that the contract grower is not guaranteed 100% of the indemnity payment, as a portion can be distributed to the owner/integrator. There is also no financial assistance provided for future loss of production while the contaminated area is cleared of the virus. This time frame could last more than 120 days and has lasting financial implications (USDA-APHIS, 2017d). A 120-day loss of operation could mean that the producer loses income associated with two to three broiler flocks but still has the expenses of maintaining the facilities. The Crop Insurance Act impedes federal assistance from covering both the disease impacts and loss of business at the same time (U.S. Department of Agriculture, Risk Management Agency, 2015).

Private insurers are available but limited in capacity. One reason for the slow development of AI insurance is the possibility of moral hazard and adverse selection resulting in high premiums. Also, it is difficult to know the frequency and intensity of an AI outbreak. However, for livestock insurance that covers AI to be successful, economically feasible premiums must exist (Boyd, Pai, & Porth, 2013). The magnitude of potential loss and the financial impact at the producer level needs to be understood to establish economically feasible premiums. Additionally, without viable insurance options, producers need to fully understand the risks they are internalizing when producing poultry in an integrated system.

Given the value broilers in the United States, the clustering of broiler houses that often occur, the epidemic nature of AI, and the massive loss in production from AI infection in a broiler flock, investigating farm-level financial impacts from contracting AI is necessary. Prior literature is lacking regarding the farm-level financial implications of contracting HPAI in a U.S. broiler operation.

This research is required to advance the possibilities of a government or privately supported HPAI insurance program. Therefore, the objectives of this research are to

1. Develop farm financial statements for a standard commercial U.S. broiler operation to estimate financial performance measures and the profitability of a broiler operation,
2. Determine the on-farm financial impact from an HPAI outbreak and the resulting loss of production,
3. Determine how the timing and length of the outbreak impacts farm financial performance measures and profitability,
4. Determine the on-farm equity required to self-insure against an HPAI outbreak, and
5. Demonstrate the problems of using standard financial measures for analyzing disease outbreaks under production contract arrangements and present alternative measures for financial performance.

BACKGROUND

AI has received more attention than any other animal disease such as swine flu, foot-and-mouth disease, and Newcastle disease. This is because (1) it can be transmitted to humans and cause death; (2) local effects are severe and cause massive loss in production and income; (3) the disease is endemic in nature, and there are prolonged financial impacts of control measures; and (4) it can be transmitted through migratory birds, which means it has widespread global implications (McLeod, Morgan, Prakash, & Hinrichs, 2005). Due to the potential magnitude of the disease, countries often ban imports of poultry from the infected area. During the 2014–2015 HPAI outbreak in the United States, 12 countries suspended imports from the United States, and 39 countries placed regional bans on specific counties in specific states (Davis, 2015). The regionalization approach, rather than a ban on the entire United States, reduced the trade impacts from the outbreak. Paarlberg, Seitzinger, and Lee (2007) indicated that without regionalization, poultry exports would fall 89% in the first quarter of an outbreak compared to only 19% when using a regional approach. Furthermore, research shows that regionalization lowers economic welfare losses to producers and reduces the overall economic recovery time of an outbreak (Johnson, Hagerman, Thompson, & Kopral, 2015). However, it was more challenging to regionalize net exporting regions compared to net importing regions (Seitzinger & Paarlberg, 2016).

Trade restrictions due to an AI outbreak impact poultry prices globally. If an HPAI outbreak occurred in all four global regions (the United States, the European Union, Asia, and Latin America), global export prices would increase by 10% (Djunaidi and Djunaidi, 2007). During the 2014–2015 HPAI outbreak in the United States, the price of eggs nearly doubled compared to the three-year average for large eggs (USDA-APHIS, 2016c). An AI outbreak would impact the price of not only poultry but also other agricultural commodities. Since the price of poultry would increase, it was estimated that fed steer price and barrow and gilt prices would increase by $4 cwt and $3 cwt, respectively. Also, corn and soybean prices would decrease during the first year of an outbreak by $0.12/bushel and $0.13/bushel, respectively (Brown, Madison, Goodwin, & Clark, 2007).

While the macroeconomic impacts of the U.S. poultry industry and the implications of an AI outbreak have been vastly researched, the farm-level poultry economic research is lacking. Beach, Poulos, and Pattanayak (2007a, 2007b) developed a theoretical model that combined both an epidemiological model and an agricultural household model to maximize profits. While theoretical, the results suggest that policy instruments are required to compensate for destroyed poultry. Furthermore, results suggested that if compensation was low, there would be a barrier to surveillance and rapid disease response. However, if too high, there would be disincentives to adopting biosecurity measures on the farm. There was no data presented by Beach et al. (2007a, 2007b) that would determine the appropriate compensation level. This study occurred before the first outbreak in the United States for which USDA-APHIS compensated for the fair market value of the flock lost due to HPAI. Other studies have examined the farm impact of an AI outbreak (Rahman & Sabur, 2003; Oyekole, 1984). These farm-level studies were on small-scale production scenarios in Nigeria and Bangladesh. While the production and marketing of broilers differ substantially from the United States, the financial implications of an HPAI outbreak were significant. Rahman and Sabur (2003) indicated a reduction in gross revenue at the farm level by 45% per 1,000 birds and a net margin reduction by 430% per 1,000 birds, which caused a temporary shutdown in farming operations. The financial implications of an AI outbreak in a commercial U.S. broiler operation would be significant, which requires a farm-level impact analysis.

METHODS

This essay develops a financial model of a typical vertically integrated broiler operation in the United States to assess the impact of HPAI. The model operation includes four poultry houses, each 43 feet wide and 600 feet long. Each house is assumed to place 32,300 birds per flock per house and sell birds at seven pounds each. Death loss is assumed to be 4% from placement to pickup by the integrator. The modeled broiler operation is also assumed to move five flocks per year with a 56-day grow-out period per flock and a 17-day empty (cleanout) period between flocks.

Additionally, this study examines the financial impacts for a beginning farmer and an experienced farmer, as impacts are likely to differ based on the financial position of the operator. The definition for a beginning poultry farmer is based on requirements to qualify for the Beginning Farmer Loan Program through the Kentucky Agricultural Finance Corporation (KAFC). The KAFC lends money to farmers for agricultural investments by partnering with traditional lenders. Those qualifying for the Beginning Farmer Loan Program can access a greater amount of capital through KAFC, which is willing to take on riskier loans with potentially below-market interest rates.

To be considered a beginning farmer, the individual must have been farming less than 10 years, must have a net worth (or combined net worth with a spouse) of less than $500,000, and must have an off-farm income of less than $100,000. Individuals who receive poultry loans but do not qualify as beginning farmers are considered to be experienced farmers. Initial financial positions for both beginning and experienced farmers are based on a review of recent loan applications to the KAFC. When considering financial positions, only current assets are considered to isolate the financial implications for the poultry operation alone. Current assets for beginning and experienced farmers are $4,133 and $64,466, respectively. These amounts effectively become the initial working capital for each operation.

The economic model is adapted from Oklahoma state's enterprise budgets using the 2016 Poultry Summary from the Kentucky Farm Business Management program. The initial contract price received per pound of production is $0.058. The contract price is the payment per pound of gain from the integrator to the operator. Initial operating costs are $22,380 annually per house, with 48% of this cost being utilities and 12% allocated to ongoing repair and maintenance. The latter is included to avoid a lump-sum payment to upgrade requirements at the termination of the initial contract.

Both prices received and operating costs are adjusted over time. After the first year the price per pound produced is increased by 1.125% annually, based on the USDA-NASS prices received per pound of chicken from 2000 to 2017. Costs are assumed to increase by 2.5% per year based on the USDA-NASS cost of farm supplies from 2000 to 2017. Both trend adjustments are consistent with Goodwin, Ahrendesen, Barton, and Denton (2005).

Financing assumptions are also based on a review of KAFC loan packets over the previous 2 years. Construction cost per house is assumed to be $346,263, for a total investment of $1,385,050. This approach is attractive as this is effectively a turn-key cost, meaning that the operation is fully operational for this amount. Houses are assumed to be financed over 15 years at a 5% interest rate. Fixed costs for the operation are based on a 15-year useful life and a 10% salvage value at the end of the 15 years. Interest on owned capital is charged at 5% to cover opportunity costs. Payment for birds, minus operating, financing, and fixed costs, are considered to be net farm income. It is assumed that the poultry operator will withdraw 50% of net farm income annually for family living and reinvest the remaining 50% back into the operation to be held as working capital.

Based on the enterprise budgets and assumptions previously outlined, financial models consisting of a 20-year income statement and cost-based balance sheet are developed for both a beginning and an experienced farmer that are consistent with Kay, Edwards, and Duffy (2004). A completed income statement and balance sheet allows for the calculation of key performance measures, on an annual basis, for each operation using the standards set forth by the Farm Financial Standards Council (2019). Financial statements and performance measures results are considered the base case from which to examine an HPIA outbreak.

Three outbreak timings are modeled to reflect the impact that HPAI had during the economic life of the broiler operation. HPAI effects are evaluated as if the infection occurred in years 2, 10, and 18. It is assumed that the infection would infect all four houses and that all houses would be immediately depopulated. A considerable delay in the placement of the next flock is also likely, so the impact is evaluated assuming the loss of the infected flock and the next flock as well as the infected flock plus the next two flocks. In the case of losing the infected flock and one new flock, operating expenses are reduced by 20% to reflect lower utility costs. In the case of losing the infected flock and the next two flocks, operating costs are reduced by 30%.

Finally, potential indemnity payments made by USDA-APHIS are considered. These payments are generally made to the integrator, since they own the birds, but were often shared with the grower. Each scenario previously described is evaluated with receipt of an indemnity payment equal to 100% of the payment value of the infected flock and without any indemnity payment for the infected flock. This results in three financial scenarios for which the farmer is not compensated for one, two, or three flocks.

Based on these assumptions, financial statements and financial measures are calculated for each of the HPAI infection scenarios. By comparing these to the base case (no HPAI infection), the financial impacts of HPAI on the growers are evaluated. Results include estimates of HPAI infection impacts for beginning and experienced farmers given multiple infection timings, number of lost flocks, and the potential impacts of APHIS indemnity payments.

While standard financial measures are commonly used to evaluate farm businesses, they can be problematic when used to evaluate contract production arrangements. For example, return on assets and asset turnover are two standard measures. Under a profitable contract production system, these two measures will make a beginning farmer look financially better than an experienced farmer because the beginning farmer will have lower asset values than the beginning farmer. This can provide a misleading depiction of the financial health of the two operations. Similarly, if flock loss occurs and working capital is eroded, return on assets will be higher once operations resume because total assets have decreased due to working capital erosion. While this will be the case for both beginning and experienced farmers, it will be especially true for beginning farmers.

For this reason, two alternative measures are also utilized. The first measure, burn rate, is commonly used but is not considered among the 21 financial measures recognized by the Farm Financial Standards Council (2019). Burn rate is calculated using the equation

$$\text{(1)} \qquad \text{Burn Rate} = \frac{\text{Working Capital}}{\text{Operating Expenses}}$$

Burn rate is defined as the length of time a business can continue to operate on existing working capital. If the burn rate is negative, this indicates how many periods of an outside financial source is required to continue operations.

In addition to the burn rate, a novel measure reflecting the long-term financial implications of contracting HPAI is developed. The long-term vulnerability ratio (LTVR) measures the number of periods the business could sustain operation through liquidation of equity from either selling off assets or borrowing against them. The LTVR is calculated using the equation

$$\text{(2)} \qquad \text{LTVR} = \frac{\text{Total Equity}}{\text{Operating Expenses}}$$

If LTVR is negative, the business cannot cover variable costs from within and has no equity to borrow against and therefore would likely shut down or declare bankruptcy. However, off-farm income can supplement the business in the short term, but long-term business sustainability will be challenging with a prolonged negative LTVR. By using these two alternative measures in addition to traditional financial measures, a more thorough understanding of the contracting operation is possible.

RESULTS

Financial performance measures are determined for both an experienced and a beginning farmer operating four U.S. broiler houses over a 20-year time frame. Seven financial performance measures are calculated annually to determine liquidity, solvency, profitability, and financial efficiency. More specifically, working capital, current ratio, debt-to-asset ratio, return on assets, operating profit margin, net farm income, and asset turnover are calculated annually for an experienced and a beginning farmer. The results for each farmer are presented in Table 1 and Table 2 and reflect a typical production environment in which no HPAI is present. Both farmer scenarios are under the same contractual arrangement, with the only difference being the initial current assets when applying for a loan to build the broiler houses ($4,133 and $64,466 for the beginning and experienced farmer, respectively).

The experienced farmer's broiler operation is in better overall financial position than the beginning farmer's broiler operation. Working capital is negative for the first two years of the beginning farmer's broiler operation, as can be seen in Table 2. Negative working capital indicates that the beginning farmer needs to acquire outside funding to support

Table 1. Financial Performance Measures across 20 Years for an Experienced Farmer Operating Four U.S. Broiler Houses with No HPAI

	1	2	3	4	5	6	7	8	9	10
Working capital ($)	24,667	51,727	77,192	100,956	122,907	142,929	160,900	176,691	190,168	201,190
Current ratio	1.345	1.690	1.984	2.228	2.428	2.585	2.703	2.785	2.833	2.851
Debt to asset	0.996	0.987	0.977	0.963	0.947	0.928	0.904	0.875	0.839	0.795
Return on assets	0.061	0.062	0.064	0.065	0.067	0.069	0.071	0.074	0.077	0.080
Operating profit margin	0.047	0.053	0.060	0.066	0.073	0.080	0.087	0.094	0.101	0.108
Net farm income ($)	25,694	29,445	33,331	37,359	41,536	45,870	50,369	55,041	59,896	64,943
Asset turnover	0.195	0.205	0.216	0.228	0.241	0.257	0.274	0.295	0.319	0.347

	11	12	13	14	15	16	17	18	19	20
Working capital ($)	209,608	215,269	218,008	217,655	347,471	480,500	613,544	746,579	879,583	1,012,531
Current ratio	2.840	2.802	2.741	2.658	84.403	116.333	148.268	180.200	212.124	244.036
Debt to asset	0.739	0.668	0.576	0.453	0.008	0.007	0.006	0.005	0.004	0.004
Return on assets	0.084	0.089	0.095	0.103	0.114	0.084	0.070	0.059	0.051	0.045
Operating profit Margin	0.116	0.124	0.132	0.140	0.148	0.156	0.155	0.153	0.152	0.150
Net farm income ($)	70,192	75,653	81,338	87,258	93,425	99,853	99,882	99,865	99,802	99,690
Asset turnover	0.381	0.424	0.477	0.548	0.644	0.512	0.426	0.366	0.322	0.288

Table 2. Financial Performance Measures across 20 Years for a Beginning Farmer Operating Four U.S. Broiler Houses with No HPAI

	1	2	3	4	5	6	7	8	9	10
Working capital ($)	–35,665	–8,605	16,860	40,623	62,574	82,597	100,567	116,359	129,836	140,858
Current ratio	0.502	0.885	1.215	1.494	1.727	1.916	2.064	2.175	2.252	2.296
Debt to asset	1.041	1.034	1.024	1.013	0.998	0.981	0.958	0.931	0.897	0.854
Return on assets	0.063	0.065	0.067	0.069	0.071	0.073	0.075	0.078	0.082	0.086
Operating profit margin	0.047	0.053	0.060	0.066	0.073	0.080	0.087	0.094	0.101	0.108
Net farm income ($)	25,694	29,445	33,331	37,359	41,536	45,870	50,369	55,041	59,896	64,943
Asset turnover	0.204	0.215	0.226	0.239	0.254	0.271	0.291	0.314	0.341	0.373

	11	12	13	14	15	16	17	18	19	20
Working capital ($)	149,276	154,936	157,675	157,323	287,138	420,167	553,211	686,247	819,251	952,199
Current ratio	2.310	2.297	2.259	2.199	69.921	101.852	133.786	165.718	197.643	229.554
Debt to asset	0.800	0.729	0.635	0.506	0.010	0.007	0.006	0.005	0.004	0.004
Return on assets	0.091	0.097	0.105	0.115	0.130	0.094	0.076	0.064	0.055	0.048
Operating profit margin	0.116	0.124	0.132	0.140	0.148	0.156	0.155	0.153	0.152	0.150
Net farm income ($)	70,192	75,653	81,338	87,258	93,425	99,853	99,882	99,865	99,802	99,690
Asset turnover	0.412	0.462	0.526	0.612	0.735	0.567	0.463	0.393	0.342	0.304

the broiler operation in the first two years or have off-farm income to support the operation. At a minimum, any farmer applying for a loan to build and operate four broiler houses needs $39,798 in current assets to have positive working capital in the first year. The current ratio indicated that an experienced farmer has good liquidity according to the Farm Finance Scorecard of greater than two in year 4 of the operation compared to year 4 for the beginning farmer (Becker, Kauppila, Rogers, Parsons, Nordquist, & Craven, 2014). Also, according to the Farm Finance Scorecard, the debt to asset ratio indicates that both farmers do not achieve strong solvency (<30%) until the four broiler houses are paid for in year 15.

Both farmers also have the same profitability, according to net farm income, since both are assumed to have the same contractual arrangement and management strategies. Likewise, operating profit margin is the same for both farmers and achieve strong profitability after the four broiler houses are paid for in year 15. However, the return on assets indicates that the beginning farmer is more profitable than the experienced farmer. This result is one of the problems of using return on assets to evaluate the profitability of production contract arrangements. Since the beginning farmer has lower current assets compared to the experienced farmer, return on assets will be greater for the beginning farmer under contract production. This problem is also present when determining financial efficiency with asset turnover. More details will be discussed on this issue when addressing objective 5 of this investigation.

After determining the financial measures under a typical production environment in which HPAI is not contracted, various scenarios are investigated for which the broiler operation does contract HPAI. Two critical questions are addressed regarding the outbreak: (1) how does the timing (across the 20-year financial model) of the outbreak impact farm financial performance measures, and (2) how does the length of the outbreak impact farm financial performance measures?

Three timings of the outbreak occurring in years 2, 10, and 18 are investigated. Also, for each timing, three lengths of time out of production are investigated. One, two, and three flocks represent the number of flocks lost in the year HPAI occurred. For example, assume that HPAI infects a flock resulting in both the current flock (infected) and an additional flock lost due to the time required to contain and eradicate the virus. If USDA-APHIS provides an indemnity payment that is received by the farmer (not guaranteed), then the financial impact will be for only one flock lost. Given that the time frame required to contain and clear the area of the virus can be over 120 days, up to two additional flocks can be lost (not including the flock contracted by HPAI). Furthermore, if the farmer does not receive the indemnity payment from USDA-APHIS and is out an additional two flocks for containment and eradication of the virus, the financial loss can total three flocks.

The financial impact of the timing of an HPAI outbreak and the number of flocks not compensated for are presented in Tables 3–5. Summary statistics are presented for each farmer and financial measure for the HPAI outbreak scenarios investigated. From all three timings of the HPAI outbreaks, it is clear that the beginning farmer is more susceptible to significant financial losses compared to the experienced farmer due to the former's more vulnerable financial position. Furthermore, both farmers are financially impacted more when HPAI is contracted in year 2 than in year 18. Likewise, both farmers are impacted more when the containment and eradication of the virus last long enough (or the farmers do not receive the USDA-APHIS indemnity payment) so that three flocks are lost and a farmer is not compensated. It is also important to note that the later in the grow-out period (56 days) when the flock is infected with HPAI, the higher the potential to be out new flocks due to the length of time to clear the virus. For example, if it takes 100 days to clear the virus and HPAI is contracted in day 2 of the 56 days required to grow a broiler, only one new flock will be lost. If HPAI is contracted in day 55 of the 56 days to grow a broiler, two new flocks will be lost.

The importance of implementing biosecurity measures to prevent HPAI early in a broiler operation is highlighted in Table 3. The loss of three flocks in year 2 results in a net farm income of –$128,903, the largest of all HPAI financial shocks investigated. This results in a reduction in average working capital of $136,444 for both farmers as compared to not contracting HPAI. More important is the working capital impact in the year HPAI is contracted. This is represented by the minimum working capital estimated for three flocks lost. The experienced farmer has a loss in working capital in year 2 of –$91,898 compared to –$152,230 for the beginning farmer.

The financial impact on annual working capital due to an HPAI outbreak is also presented in Figures 2 and 3. Figure 2 illustrates that an experienced farmer will incur negative working capital for 5 years, at a cumulative value below zero of $222,415, after the broiler flock is infected with HPAI in year 2. Furthermore, Figure 3 illustrates that a beginning farmer will incur negative working capital for 10 years, at a cumulative loss of $646,623, after the broiler flock is infected with HPAI in year 2. For each farmer, after the initial infection of HPAI causing a decrease in working capital, working capital begins to accumulate at a steady pace once production resumes. Once the broiler houses are paid for in year 15, net returns and therefore working capital generated are greater, causing the steep increase illustrated in Figures 2 and 3. If biosecurity measures fail and the financial implications above are incurred,

Table 3. Summary Statistics of Financial Measures for Both an Experienced and a Beginning Farmer Based on the Number of Flocks Lost by Contracting HPAI in Year 2

	Experienced Farmer				Beginning Farmer			
	No HPAI	One Flock	Two Flocks	Three Flocks	No HPAI	One Flock	Two Flocks	Three Flocks
Working Cap. ($)								
Average	309,504	262,728	214,139	173,060	249,171	202,395	153,807	112,727
Minimum	24,667	2,489	–48,656	–91,898	–35,665	–57,843	–108,988	–152,230
Maximum	1,012,531	963,293	912,148	868,906	952,199	902,961	851,815	808,574
C.V.	0.90	1.05	1.28	1.57	1.11	1.36	1.78	2.41
Current Ratio								
Average	50.99	47.12	43.09	39.69	46.20	42.33	38.31	34.90
Minimum	1.34	1.03	0.35	–0.23	0.50	0.23	–0.45	–1.03
Maximum	244.04	232.22	219.94	209.56	229.55	217.74	205.46	195.08
C.V.	1.57	1.59	1.63	1.67	1.60	1.64	1.68	1.73
Debt to Asset								
Average	0.58	0.61	0.65	0.68	0.62	0.66	0.69	0.73
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	1.00	1.02	1.07	1.11	1.04	1.07	1.12	1.16
C.V.	0.69	0.68	0.68	0.67	0.68	0.68	0.67	0.66
Return on Assets								
Average	0.074	0.078	0.081	0.084	0.080	0.084	0.089	0.093
Minimum	0.045	0.040	0.000	–0.050	0.048	0.042	0.000	–0.053
Maximum	0.114	0.127	0.143	0.161	0.130	0.147	0.169	0.195
C.V.	0.223	0.229	0.360	0.483	0.248	0.298	0.389	0.510
Operating Profit Margin								
Average	0.110	0.103	0.085	0.044	0.110	0.103	0.085	0.044
Minimum	0.047	–0.083	–0.445	–1.260	0.047	–0.083	–0.445	–1.260
Maximum	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.156
C.V.	0.336	0.534	1.489	6.843	0.336	0.534	1.489	6.843
Net Farm Income ($)								
Average	67,522	65,197	62,639	59,605	67,522	65,197	62,639	59,605
Minimum	25,694	–17,067	–68,213	–128,903	25,694	–17,067	–68,213	–128,903
Maximum	99,882	99,882	99,882	99,882	99,882	99,882	99,882	99,882
C.V.	0.38	0.47	0.62	0.83	0.38	0.47	0.62	0.83
Asset Turnover								
Average	0.348	0.368	0.394	0.419	0.377	0.402	0.434	0.466
Minimum	0.195	0.158	0.123	0.085	0.204	0.166	0.130	0.090
Maximum	0.644	0.716	0.810	0.911	0.735	0.830	0.959	1.103
C.V.	0.348	0.384	0.423	0.461	0.375	0.416	0.461	0.507

Table 4. Summary Statistics of Financial Measures for Both an Experienced and a Beginning Farmer Based on the Number of Flocks Lost by Contracting HPAI in Year 10

	Experienced Farmer				Beginning Farmer			
	No HPAI	One Flock	Two Flocks	Three Flocks	No HPAI	One Flock	Two Flocks	Three Flocks
Working Cap. ($)								
Average	309,504	290,414	259,651	234,183	249,171	230,082	199,318	173,851
Minimum	24,667	24,667	24,667	24,667	–35,665	–35,665	–35,665	–35,665
Maximum	1,012,531	977,823	921,889	875,585	952,199	917,491	861,557	815,253
C.V.	0.90	0.92	0.97	1.03	1.11	1.16	1.26	1.38
Current Ratio								
Average	50.99	48.42	44.27	40.84	46.20	43.63	39.49	36.05
Minimum	1.34	1.34	1.34	1.34	0.50	0.50	0.50	0.50
Maximum	244.04	235.70	222.28	211.16	229.55	221.22	207.80	196.68
C.V.	1.57	1.58	1.60	1.62	1.60	1.62	1.65	1.69
Debt to Asset								
Average	0.58	0.59	0.61	0.62	0.62	0.63	0.65	0.67
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	1.00	1.00	1.00	1.00	1.04	1.04	1.04	1.04
C.V.	0.69	0.68	0.67	0.66	0.68	0.68	0.66	0.66
Return on Assets								
Average	0.074	0.074	0.075	0.076	0.080	0.081	0.082	0.084
Minimum	0.045	0.041	–0.028	–0.093	0.048	0.045	–0.030	–0.102
Maximum	0.114	0.122	0.140	0.158	0.130	0.141	0.164	0.190
C.V.	0.223	0.270	0.440	0.631	0.248	0.299	0.469	0.661
Operating Profit Margin								
Average	0.110	0.104	0.087	0.058	0.110	0.104	0.087	0.058
Minimum	0.047	–0.010	–0.347	–0.934	0.047	–0.010	–0.347	–0.934
Maximum	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.156
C.V.	0.336	0.435	1.220	4.002	0.336	0.435	1.220	4.002
Net Farm Income ($)								
Average	67,522.	64,163	61,366	59,051	67,522	64,163	61,366	59,051
Minimum	25,694	–2,236	–58,170	–104,474	25,694	–2,236	–58,170	–104,474
Maximum	99,881	99,881	99,881	99,881	99,881	99,881	99,881	99,881
C.V.	0.38	0.47	0.62	0.77	0.38	0.47	0.62	0.77
Asset Turnover								
Average	0.348	0.356	0.376	0.395	0.377	0.388	0.413	0.438
Minimum	0.195	0.195	0.195	0.154	0.204	0.204	0.204	0.168
Maximum	0.644	0.693	0.790	0.894	0.735	0.799	0.931	1.078
C.V.	0.348	0.383	0.441	0.500	0.375	0.415	0.481	0.548

Table 5. Summary Statistics of Financial Measures for Both an Experienced and a Beginning Farmer Based on the Number of Flocks Lost by Contracting HPAI in Year 18

	Experienced Farmer				Beginning Farmer			
	No HPAI	One Flock	Two Flocks	Three Flocks	No HPAI	One Flock	Two Flocks	Three Flocks
Working Cap. ($)								
Average	309,504	304,216	299,628	289,827	249,171	243,884	239,296	229,494
Minimum	24,667	24,667	24,667	24,667	–35,665	–35,665	–35,665	–35,665
Maximum	1,012,531	977,279	946,694	881,351	952,199	916,947	886,361	821,019
C.V.	0.90	0.88	0.86	0.82	1.11	1.09	1.08	1.04
Current Ratio								
Average	50.99	49.72	48.62	46.27	46.20	44.93	43.83	41.48
Minimum	1.34	1.34	1.34	1.34	0.50	0.50	0.50	0.50
Maximum	244.04	235.57	228.23	212.55	229.55	221.09	213.75	198.07
C.V.	1.57	1.56	1.55	1.53	1.60	1.59	1.58	1.56
Debt to Asset								
Average	0.58	0.58	0.58	0.58	0.62	0.62	0.62	0.62
Minimum	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	1.00	1.00	1.00	1.00	1.04	1.04	1.04	1.04
C.V.	0.69	0.69	0.69	0.69	0.68	0.68	0.68	0.68
Return on Assets								
Average	0.074	0.072	0.071	0.067	0.080	0.078	0.076	0.072
Minimum	0.045	0.020	–0.016	–0.104	0.048	0.022	–0.017	–0.113
Maximum	0.114	0.114	0.114	0.114	0.130	0.130	0.130	0.130
C.V.	0.223	0.275	0.359	0.629	0.248	0.296	0.375	0.641
Operating Profit Margin								
Average	0.110	0.105	0.098	0.069	0.110	0.105	0.098	0.069
Minimum	0.047	0.047	–0.087	–0.664	0.047	0.047	–0.087	–0.664
Maximum	0.156	0.156	0.156	0.156	0.156	0.156	0.156	0.156
C.V.	0.336	0.351	0.565	2.497	0.336	0.351	0.565	2.497
Net Farm Income ($)								
Average	67,522	63,997	60,938	58,467	67,522	63,997	60,938	58,467
Minimum	25,694	25,694	–31,810	–81,247	25,694	25,694	–31,810	–81,247
Maximum	99,882	99,882	99,882	99,882	99,882	99,882	99,882	99,882
C.V.	0.38	0.41	0.54	0.69	0.38	0.41	0.54	0.69
Asset Turnover								
Average	0.348	0.345	0.343	0.342	0.377	0.374	0.372	0.371
Minimum	0.195	0.195	0.195	0.161	0.204	0.204	0.204	0.175
Maximum	0.644	0.644	0.644	0.644	0.735	0.735	0.735	0.735
C.V.	0.348	0.352	0.360	0.372	0.375	0.380	0.388	0.398

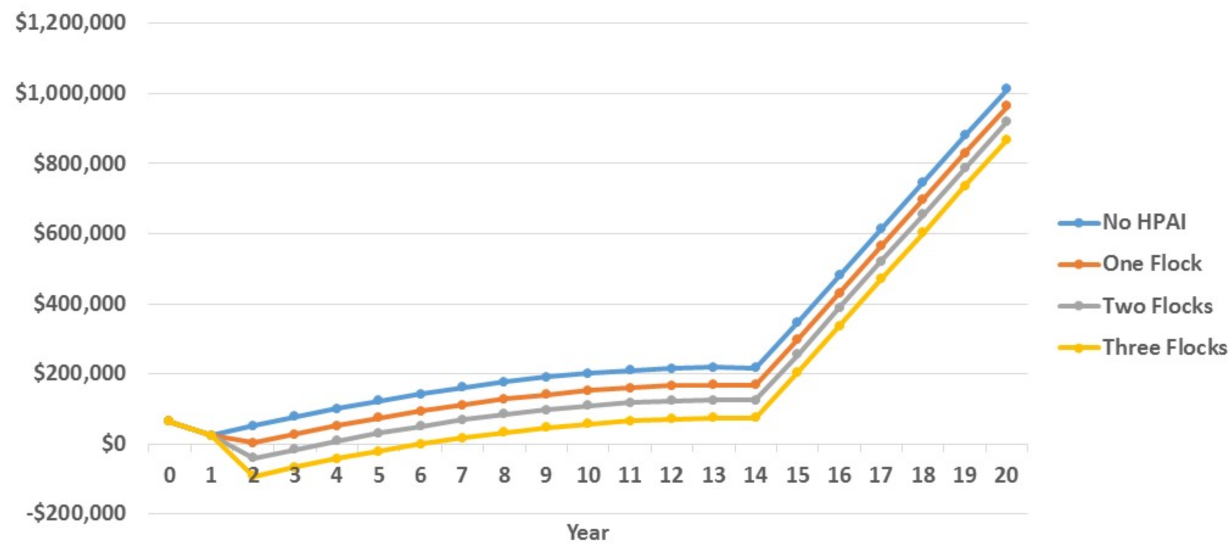

Figure 2. Impact on Annual Working Capital for an Experienced Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2

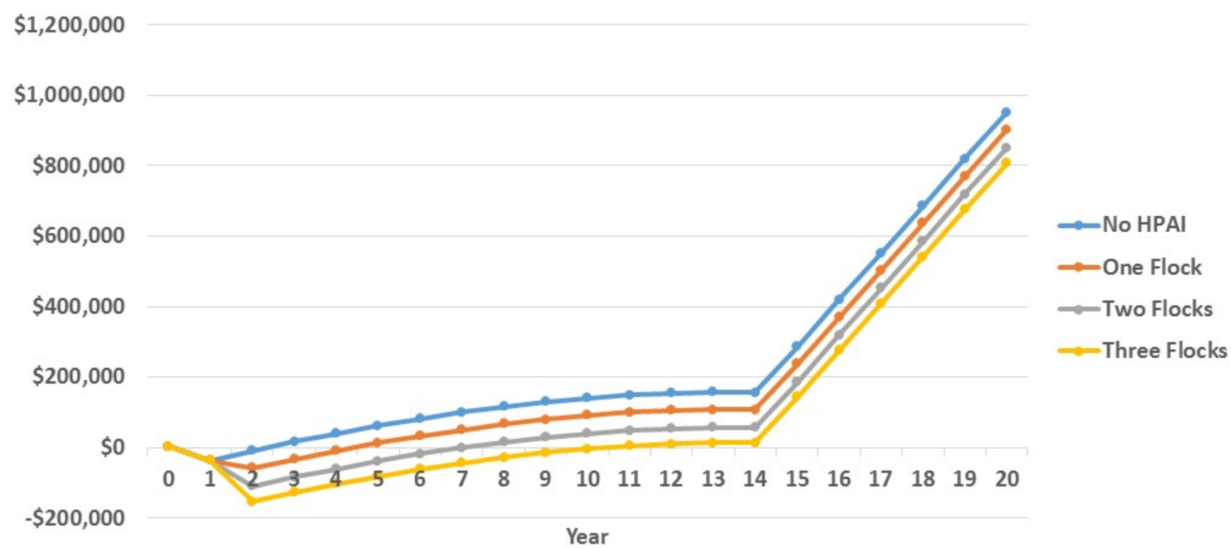

Figure 3. Impact on Annual Working Capital for a Beginning Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2

HPAI insurance or industry (integrator) support is required.

If HPAI is contracted later in the investment of the broiler operation, working capital is accumulated and can minimize the financial impact of the outbreak. While contracting HPAI in year 10 reduces net farm income to –$104,472, both farmers will be able to bear the loss through working capital. So, how much on-farm equity is required to self-insure against an HPAI outbreak? Table 6 addresses this question (objective 4) and presents the on-farm equity required to self-insure against an HPAI outbreak based on timing and the number of flocks lost. Since the boiler operation is more profitable in year 18 versus year 2 due to trend adjustments over time, more cash or equity is required to self-insure. Nonetheless, working capital in year 18 is greater than in year 2 and is able to absorb the loss by self-insuring. However, it is more critical to have equity

Table 6. On-Farm Equity Required to Self-Insure against an HPAI Outbreak Based on the Number of Flocks Lost and When the Outbreak Occurs

Number of Flocks	Year 2	Year 10	Year 18
1	$46,512	$67,179	$70,504
2	$97,658	$123,113	$131,675
3	$158,348	$169,417	$181,112

in year 2, since the financial impact of an HPAI outbreak can permanently shut down the broiler operation.

In addition to financial measures, the impact on total equity from a broiler flock contracting HPAI in year 2 is measured and illustrated in Figures 4 and 5. The difference between no HPAI in year 2 and flocks lost is the same for the experienced and beginning farmers at $49,237, $100,383, and

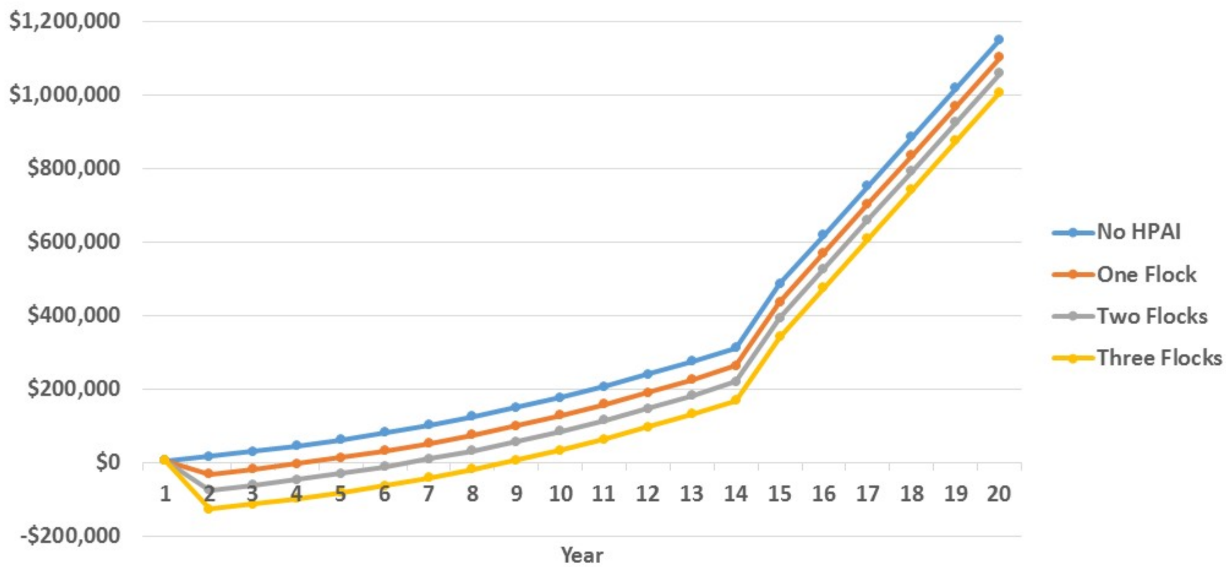

Figure 4. Impact on Total Equity for an Experienced Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2

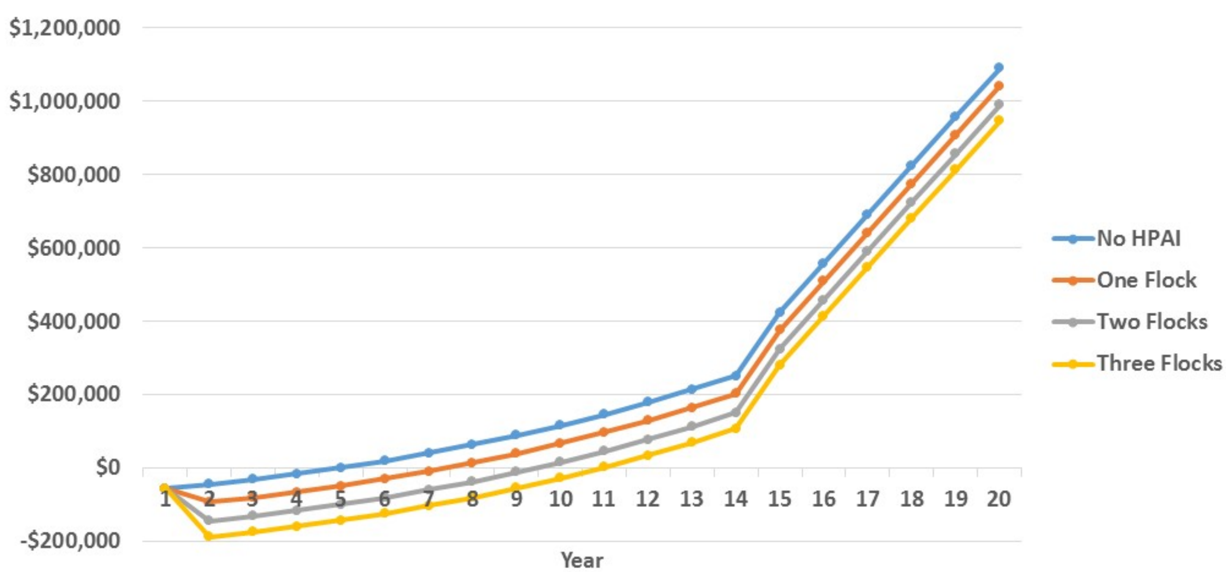

Figure 5. Impact on Total Equity for a Beginning Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2

$143,625 loss in equity for one, two, and three flocks, respectively. However, the magnitude of loss and the time to regain positive equity are significantly different between the farmers. For three flocks lost, the experienced farmer will incur total negative equity for 8 years with a cumulative loss of $543,309. In contrast, the beginning farmer will incur total negative equity for 10 years with a cumulative loss of $1,100,646. The fewer number of flocks lost, the earlier the producer could regain positive equity. Equity increases sharply at year 15 for both farmers once loan payments for the broiler houses are complete. It is important to note that the beginning farmer does not attain positive equity in the broiler operation until year 5 under a typical production scenario without contracting HPAI. This highlights the importance and vulnerability of financing beginning farmers for broiler operations. Even with guaranteed production contracts, HPAI creates a real risk that will likely require insurance or industry (integrator) support during an outbreak.

As discussed previously, return on assets and asset turnover are problematic when evaluating contract production arrangements (Figure 6). Therefore, incorporating burn rate and LTVR provides a deeper understanding of these operations. Figures 7 and 8 illustrate the impact that one, two, and three flocks lost has on the burn rate of a four-house broiler operation. An HPAI outbreak in year 2 resulting in three flocks lost will reduce an experienced farmer's burn rate to –1, indicating that the farmer must acquire funding from an outside source for one year of operating expense. Furthermore, it takes until year 6 for an experienced farmer to exceed a burn rate of zero. The burn rate of the beginning farmer reduces to –2 as a result of the outbreak, indicating that the farmer must acquire funding from an outside source for two years of operating expense, and it takes until year 10 to exceed a burn rate of zero.

Figures 9 and 10 illustrate the impact that one, two, and three flocks lost has on the LTVR of a four-house broiler operation. For the experienced farmer, an HPAI outbreak in year 2 will reduce the LTVR below zero but only for a short period if only one flock is lost. If three flocks are lost, it will take until year 9 for the LTVR to be above zero, which will require long-term off-farm income and potentially bankrupt the broiler operation.

The beginning farmer will require four years of off-farm employment under a typical production environment in which HPAI is not contracted. This is an indicator that the average beginning farmer applying for broiler loans should not have been awarded the loan or have proof of sustained off-farm income to supplement the first four years of the broiler operation. Furthermore, any

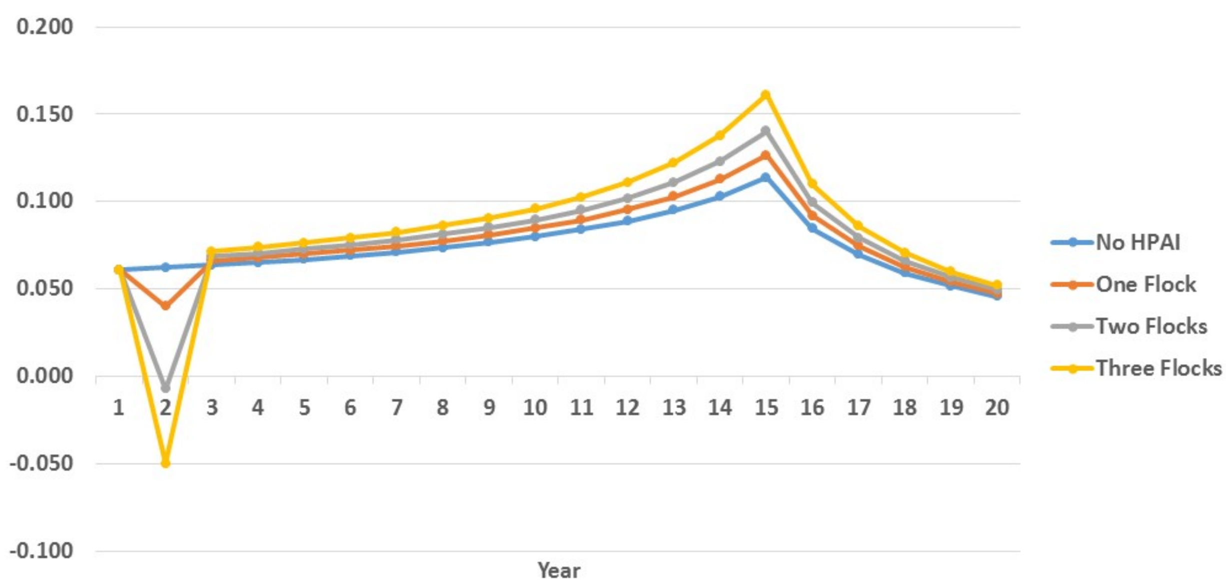

Figure 6. Impact on Return on Investment for an Experienced Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2

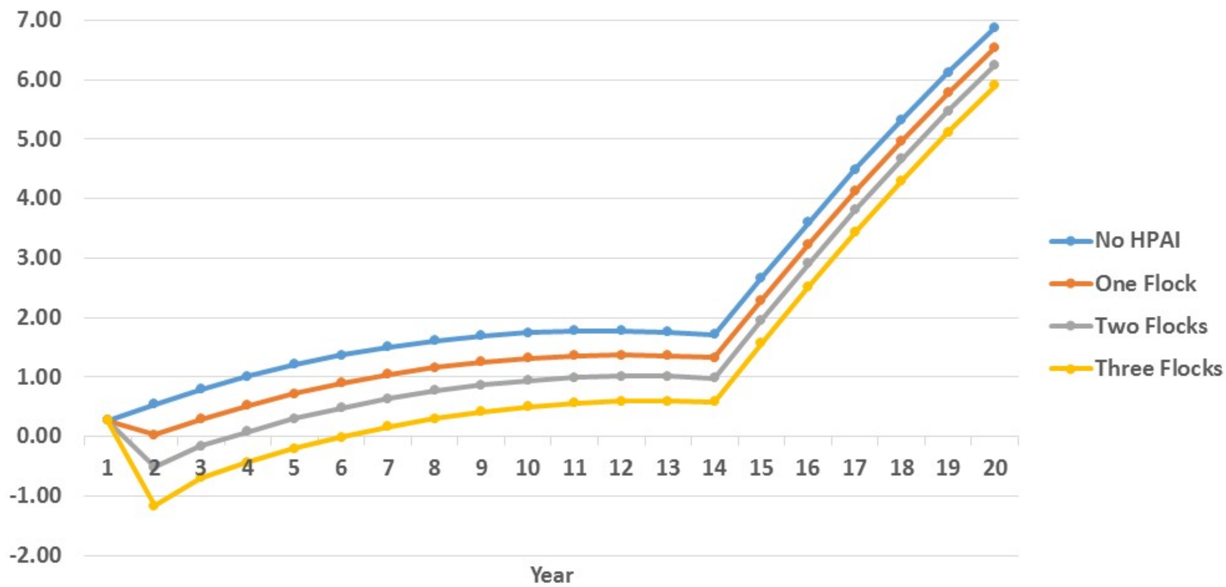

Figure 7. Impact on Burn Rate for an Experienced Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2

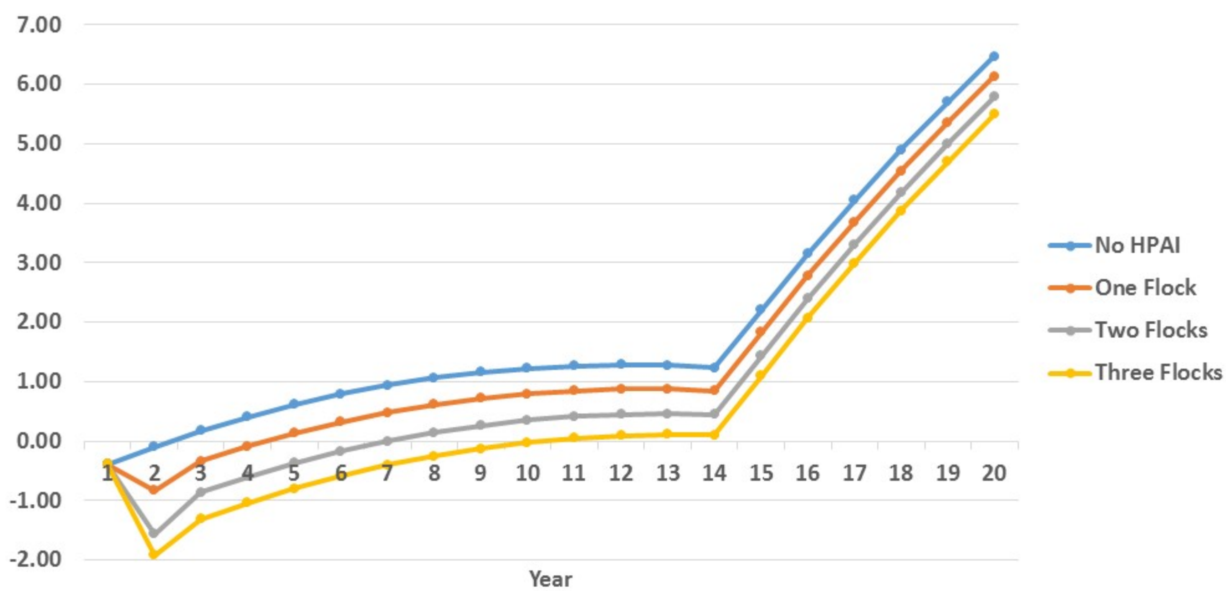

Figure 8. Impact on Burn Rate for a Beginning Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2

HPAI outbreak in year 2 will bankrupt the operation for a beginning farmer, which further supports the need for enhanced biosecurity measures, HPAI insurance, and industry (integrator) support during an outbreak.

CONCLUSION

AI is a catastrophic disease that can cause a significant financial loss in U.S. broiler operations. The magnitude of potential loss and the financial

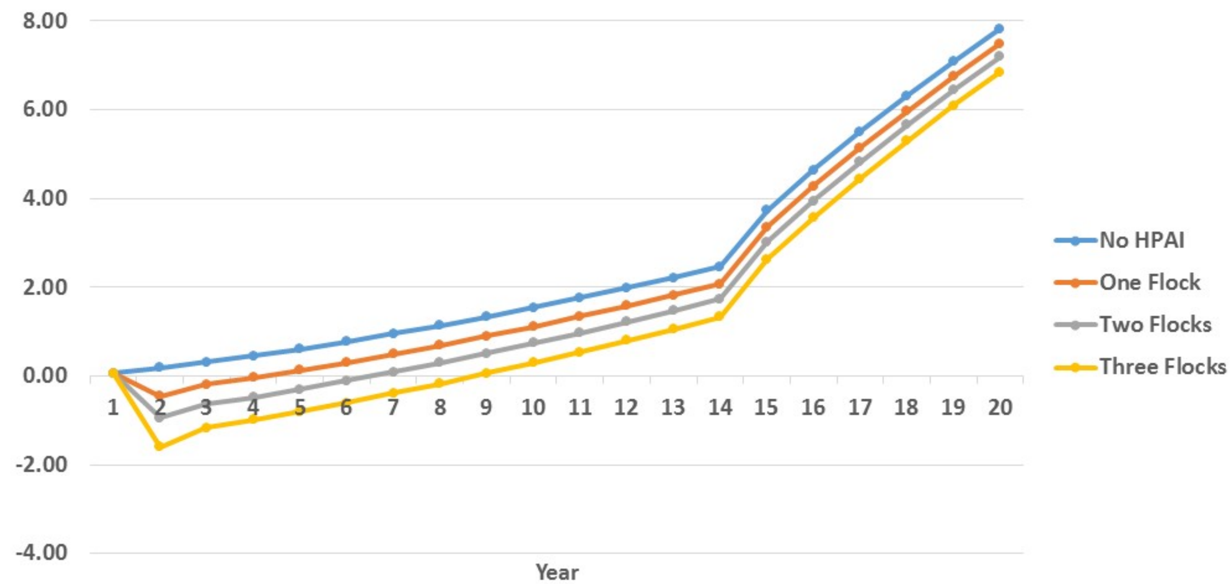

Figure 9. **Impact on the Long-Term Vulnerability Index for an Experienced Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2**

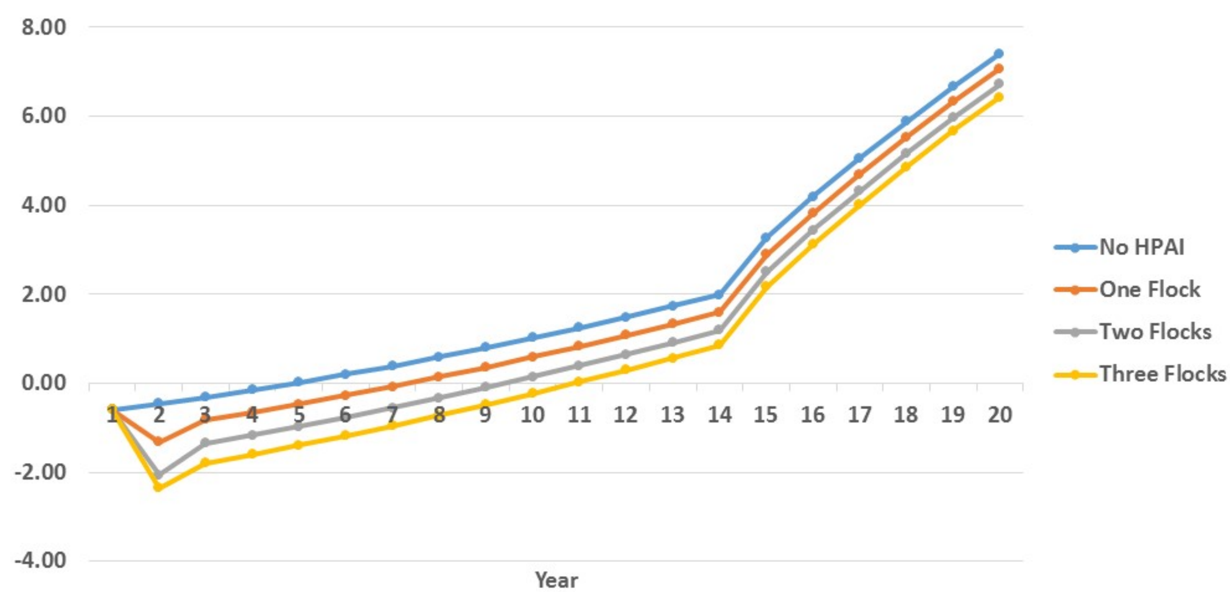

Figure 10. **Impact on the Long-Term Vulnerability Index for a Beginning Farmer Based on the Number of Flocks Lost Due to Contracting HPAI in Year 2**

impact at the producer level needs to be understood by the producer when undertaking an investment of this magnitude. Furthermore, it must be understood to advance the possibilities of a government or privately supported HPAI insurance program to transfer this risk away from producers. This essay established baseline performance measures for a U.S. commercial broiler operation to determine the financial impact of an HPAI outbreak. The overall financial impact differed between the type of farmer (beginning or experienced), the timing of the outbreak, and the length of the outbreak. From all three timings investigated, it was evident that the beginning farmer was more susceptible to significant financial losses compared to the experienced farmer due to the former's more vulnerable financial position. Furthermore, both farmers were financially impacted more when HPAI was contracted early in the investment of the poultry farm rather than later, as significant equity had not yet been built to absorb the loss. Likewise, both farmers were impacted more when contamination and eradication of the virus were prolonged as more flocks were lost.

The importance of implementing biosecurity to prevent HPAI early was highlighted by the reduction of net farm income by –$128,903 due to the loss of three flocks. This resulted in a reduction of working capital of –$136,444 for both beginning and experienced farmers. The financial impact on annual working capital was significant, as an experienced farmer would incur a negative working capital for 5 years after an early infection of HPAI and 10 years for a beginning farmer. If biosecurity measures fail and the financial implications presented herein are incurred, HPAI insurance, industry support, or on-farm equity is required. The on-farm equity required to self-insure against an HPAI outbreak was also presented. Equity was needed early, as the financial implication of an outbreak could permanently shut down the broiler operation.

One of the most significant contributions of this essay was highlighting the fallacies of standard financial performance measures for evaluating contract production, especially when evaluating shocks such as an HPAI outbreak. Two alternative measures were presented for calculating profitability impacts, burn rate, and LTVR. The LTVR is a novel measure reflecting the long-term financial implication of HPAI by calculating the number of periods the business could sustain operations through liquidation of equity from either selling off assets or borrowing against them. If LTVR was negative, the business could not cover variable costs organically and had no equity to borrow against. Therefore, the operation would likely be forced to shut down or declare bankruptcy. Results from the LTVR measure indicated that an HPAI outbreak in year 2 would bankrupt the operation for a beginning farmer, which further supports the need for enhanced biosecurity measures, HPAI insurance, and industry (integrator) support during an outbreak.

Poultry loans are generally seen as low risk given the contractual arrangements between the farmer and the integrator. Furthermore, AI is a risk that is typically not considered, as it is perceived to have a low probability of occurring. However, the potential impact on the operation can be substantial and potentially catastrophic, as illustrated herein. This research quantifies the farm-level financial impact of an HPAI outbreak in a U.S. broiler operation. These results provide the foundation for future research about actuarially fair premiums to transfer the financial risk of HPAI through insurance mechanisms.

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