Dynamics of the Economic Impact Associated with the 2015 Avian Flu Virus in the United States

Michelle Paukett*, Senarath Dharmasena, and David A. Bessler
Texas A&M University, Department of Agricultural Economics
*mpaukett@tamu.edu

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Michelle Paukett, Senarath Dharmasena, & David A. Bessler
Department of Agricultural Economics, Texas A&M University

Background

Due to increased consumer perception towards protein sources derived from eggs, per capita consumption of eggs in the United States has been growing over the years and by the end of 2014, it had been highest in seven years at 258 eggs (Watson 2014). However, production and consumption of egg trends were not completely immune to the arrival of avian influenza virus in the spring of 2015 that killed nearly 50 million egg-laying hens in the United States, accounting for about 10% of the U.S. egg-laying flock. This put upward pressure on shell egg prices at grocery stores where it jumped about 85% to $2.20 a dozen at wholesale level in the Midwest (Gee 2015).

Egg producing firms were hard hit during this time due to a decrease in revenue as a result of reduced egg-laying hen population caused by avian flu. The dead or infected birds had to be destroyed and properly disposed of, further draining the egg producing firms financially. Total number of layers during November 2015 averaged 339 million, down 7% from that of 2014 (Chicken 2015). According to the American Egg Board (2015) and USDA-NASS (2015), egg production in the United States totaled 7.66 billion during November 2015, 9% down from the previous year.

Two estimates of economic costs of avian flu found in the extant literature are $957 million to Iowa farmers (Fry 2015) and $1.57 billion (McKenna 2015). However, given the lack of explanation on modeling, data and procedures, it was not clear how these estimates were derived. Therefore, in this study, we will estimate total economic impact of the recent avian flu virus outbreak in the United States using established and cutting-edge econometric tools & methods.

Michelle Paukett
M.S. Agricultural Economics Student
Texas A&M University
College Station, TX 77840

mpaukett@tamu.edu
607-237-7416

Objectives

Specific objectives:

(1) Identify causal relationships between variables that affect production and prices in the U.S. egg industry.

(2) Determine the economic impact, in terms of revenue loss, of the 2015 U.S. avian influenza outbreak on producers at the wholesale, farm, and retail levels.

Data

Data was gathered from various government sources such as USDA-ERS and Federal Reserve Economic Data (FRED). The model was run using monthly data from March 1986 to November 2015 (*Fig. 1*). Variables in the vector autoregression (VAR) model are based on those found in Chavez & Johnson's wholesale egg price structural model (1981):

- Wholesale Grade A Large NYC Egg Prices: PPI Adjusted
- Quantity of eggs produced
- Number of layers on farm
- Soybean Meal
- Corn Gluten Meal, 60% Protein
- Real Pork Prices
- Real Beef Prices
- Real Disposable Personal Income
- Monthly Dummy Variables

Using RATS software, it was determined that trend and seasonal effects were present and that only one lag was needed in the model, based on Schwartz's Loss Criteria.

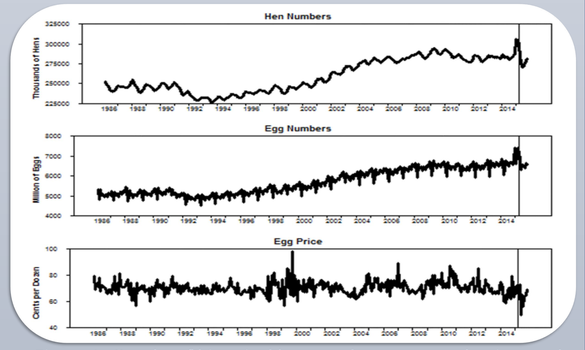

Figure 1: Graphs of historical hen numbers, egg production, and PPI adjusted egg prices from March 1986 to November 2015. The vertical line at April 2015 represents the start of the avian influenza outbreak.

Methodology

1) Determine variable correlation using Simetar (*Fig. 2*)
2) Estimate Vector Autoregressive (VAR) model with RATS
3) Run VAR model to find variable significance, impulse response functions, and forecast error decomposition (*Fig. 3 & 4*)
4) Estimate the revenue impact of the 2015 avian influenza outbreak on wholesale producers using the observed and counterfactual egg production and price change due to the hen depopulation
5) Determine farm and consumer level economic impacts using price transmission elasticity

Preliminary Results/Discussion/Conclusions

Once the wholesale egg price model is developed we will be able to determine the revenue loss to these producers, then translate losses using elasticities to the farm and consumer level. This will give us a reasonable estimate of the economic impact of the U.S. 2015 avian influenza outbreak. The model will also be relevant to apply to other hen reducing events or government policies, such as California Proposition 2. Some preliminary analysis follows:

Linear Correlation Matrix

	hens	eggs	PPIAP	SMP	CMP	BeefA	PorkA	RDI
hens	1	**0.95**	0.08	**0.63**	**0.69**	**0.47**	**-0.19**	**0.90**
eggs		1	0.09	**0.67**	**0.74**	**0.46**	**-0.19**	**0.92**
PPIAP			1	-0.10	-0.07	**-0.16**	-0.07	0.03
SMP				1	**0.94**	**0.53**	0.02	**0.62**
CMP					1	**0.53**	-0.03	**0.69**
BeefA						1	**0.47**	**0.32**
PorkA							1	**-0.35**
RDI								1

Figure 2: Correlation matrix for variables, as produced using Simetar. Bold values represent the correlation statistic significance for a two-tailed test at the 95% confidence level.

Forecast Error Decomposition: Hens

Month	Hens	Eggs	Egg Price	Soybean Meal Price	Cornmeal Price	Beef Price	Pork Price	Income
1	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	87.95	0.142	2.349	2.193	0.005	3.609	0.845	2.905
24	70.67	0.225	3.323	5.504	0.044	11.619	3.3001	5.319

Forecast Error Decomposition: Egg Price

Month	Hens	Eggs	Egg Price	Soybean Meal Price	Cornmeal Price	Beef Price	Pork Price	Income
1	0.00006	0.954	99.06	0.00	0.00	0.00	0.00	0.00
12	1.369	1.805	91.42	3.591	0.311	0.367	0.047	1.093
24	1.518	1.780	90.14	4.613	0.394	0.392	0.064	1.095

Figure 3: Forecast error decomposition for hens and egg price due to a one time shock.

Preliminary Results/Discussion/Conclusions

The forecast error decomposition (*Fig. 3*) for hens shows that initially the variability is due entirely to the number of hens, but over time their effect slowly decreases and other factors such as beef price, soybean meal price, and income affect the number of hens. For egg price, the initial variability is primarily due to itself, then egg production and hens. This decreases slowly, and less than the hens, with factors such as soybean meal price also having more of an effect after 24 months.

The impulse response functions (*Fig. 4*) indicate that price returns to normal fairly quickly after the one-time shock, while impacts on hens last considerably longer. This shows that the egg price is fairly inelastic, which is expected.

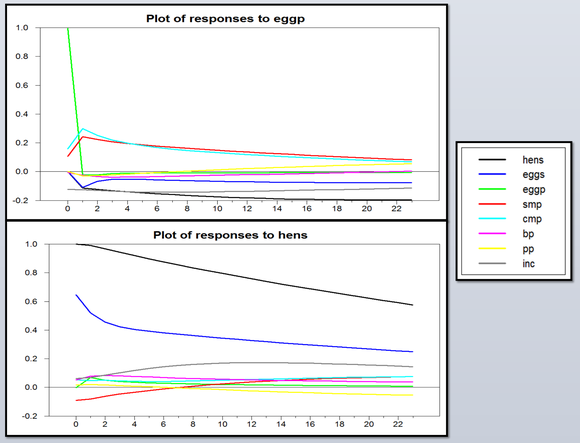

Figure 4: Impulse Responses to hens and egg price, with time in months on the x-axis and the scaled shock impact on the y-axis.

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