Understanding the economic impacts of a highly pathogenic avian influenza housing order on commercial free range egg layers

Andrew P. Barnes*^, Nick Sparks^, Irmelin S. Helgesen#, Tarek Soliman^

^ Department of Rural Economy, Environment and Society, SRUC, West Mains Road, Edinburgh, EH9 3JG. Contact: Andrew.Barnes@sruc.ac.uk
# Department of Economics, NTNU, Postboks 8900, NO-7491 Trondheim, Torgarden, Norway

Introduction

Avian Influenza (AI) has been present in birds for at least 100 years. Highly pathogenic variants of AI (HPAI) are the result of the evolution of these strains and result in broad transmission pathways across wild and domestic species. AI can be zoonotic and the recent H5N1 variant has caused some concern that infection has led to a number of deaths in humans (WHO, 2021). Its zoonotic potential makes AI a particularly pertinent example of a potential vector for a future pandemic (Av Inf Working Group, 2008).

A range of measures have been proposed for managing HPAI in commercial flocks, including mass vaccination, culling and heightened biosecurity (Sims, 2007; Liu et al., 2020). Western Governments have tended to impose housing orders on free-range flocks, coupled with heightened biosecurity, as the main preventative measure (Kaleta et al., 2007; Verhagen et al., 2021; EFSA, 2021;2022;2023). The aim of a housing order is to separate poultry from wild birds and other potential sources of HPAI by imposing a set period in which poultry remain housed and restricted from ranging.

The UK has the highest proportion of free-range egg production across Europe. It is estimated that the UK produce approximately 10.4 billion eggs annually with a value of £1.3bn. Free range eggs represent around 65% of the market (British Egg Industry Council, 2023). A housing order could therefore have a significant impact on the industry. A number of previous studies have outlined the financial impacts of a housing order on the sector as a whole (Paarlberg et al.,2007; Boni et al., 2013; Ramos et al., 2017).

The purpose of this paper is to explore the range of impacts that may occur to commercial free-range flocks during a housing order. We exploit a rarely available commercial data set of UK poultry sheds which provide weekly cost, revenues and production dynamics which span the two most recent outbreaks.

Methods

We take a mixed linear regression approach and apply a random intercept model to control for variance within the environments that birds operate.

$$y_{it} = (\beta_1 + \zeta_t) + \beta_2 x_{2it} + \beta_3 x_{3it}^2 + \beta_4 x_{4it} + \beta_5 x_{5it} + \beta_5 H_{it} + \beta_6 P_{it} + \beta_7 D_i + \epsilon_{it}$$

Where y_{it} is the outcome of interest, *i* is the shed in which the poultry were housed, and *t* is a *weekly* time step. The intercept (β_1) is augmented with a random intercept error term (ζ_t) as the permanent error component, e.g., of the lasting characteristic of the different sheds including breed used and (ϵ_{it}) the transitory component, e.g., of the individual production effects.

As our purpose is to explore the effect of changes in output revenue and commercial production, we discount the first 20 weeks of development before the hen comes into production. This helps to simplify our curve fitting and we impose both a linear term (x_2) and squared term (x_3) to capture this growth over the bird's weekly lifecycle from 20 weeks onwards. Various components which pertain to explaining the outcome of interest are measured in x_4 and x_5. We add a categorical term for the housing order (H). This compares the period of housing (*H=0*) with pre-housing (*H=1*) and post-Housing (*H=2*) to measure the impact of housing and capture the dynamics of production when the housing order occurred, a dummy to reflect production cycle (P) and a dummy (D) to control for multi-tier to single deck systems.

Results

The housing orders had a range of significant impacts on the financial indicators. Feed cost was lower pre-housing by around £0.01 per bird per week, or around 3% of weekly feed cost per bird. This reflects the observed increased feed consumption when birds were housed. Revenue was also lower pre-housing order of £0.04 per bird per week, which equates to around 6% of weekly revenue per bird per week across all farms

Results

Revenue was higher during the housing order, potentially as a result of the increases in graded egg weights observed as a result of more controlled feeding. Margins over feed cost were lower when pre-housed, at £0.03 per bird per week, or around 9-10% of weekly margins per bird. Post-housing order margins were higher by £0.03 per bird per week, though at a lower level of significance. Overall, the impact of the housing order was positive on revenues, and this exceeded the increased feed cost burden from feed per bird.

	Feed Cost/bird			Revenue/bird			MOFC/bird		
	Est.		(SE)	Est.		(SE)	Est.		(SE)
Fixed part									
Bird age	-0.0002	-	(0.000)	0.021	***	(0.004)	0.053	***	(0.003)
Bird age²	0.0000	-	(0.000)	0.000	***	(0.000)	0.000	***	(0.000)
Feed Intake	0.003	***	(0.000)	0.008	***	(0.002)	0.018	***	(0.001)
Bird age*Feed Intake	0.000	-	(0.000)	0.000	***	(0.000)	0.000	***	(0.000)
Feed Price	0.001	***	(0.000)	0.000	-	(0.000)	0.000	-	(0.000)
Av.Graded Egg Weight				0.020	***	(0.001)			
Housing order (reference: housed)									
Free range: Pre-housed	-0.008	***	(0.001)	-0.041	***	(0.009)	-0.030	**	(0.010)
Free range: Post-housed	0.002	-	(0.001)	0.017	-	(0.013)	0.030	*	(0.014)
Shed environment (reference: single tier deck)									
Multideck	0.017	**	(0.006)	-0.245	***	(0.051)	-0.160	**	(0.056)
Production Cycle (reference: first cycle)									
Second Cycle	-0.037	***	(0.001)	-0.047	***	(0.011)	-0.030	*	(0.012)
Random part									
Farm	0.006		(0.002)	0.021		(0.007)	0.020		(0.007)
Residual	0.010		(0.000)	0.108		(0.123)	0.123		(0.003)
Wald Chi²	6333.8	***		1199.9	***		567.4	***	
Log Likelihood	2790.0			702.5			599.3		
LR Test	216.8	***		15.2	***		8.7	**	

Conclusions

Imposing housing orders on free-range poultry systems is, along with heightened biosecurity measures, a common intervention for limiting the impact of HPAI transmission between commercial and wild bird species.

We find a positive effect on margins over feed costs, principally due to the benefits of controlled nutrition leading to higher returns. Whilst there will be variance in severity of impact on individual businesses this paper finds some support for imposing housing orders over other interventions as they minimise private economic costs and provide societal benefits from reducing external threats from the disease.

Whilst these data are typical of a type of commercial flock enterprise, they cannot be representative of the entire commercial free-range egg sector. The sector is composed of a large body of medium and smaller scale producers that may suffer incrementally more damage from a housing order due to lack of labour, appropriate housing and the ability to cover additional costs of feed.

Acknowledgements

We are grateful to the British Egg Industry Council and its members for their assistance in providing information that was included in this report The opinions expressed are those of the authors. This work was funded by the Scottish Government Rural and Environment Science and Analytical Services Division, as part of the Centre of Expertise on Animal Disease Outbreaks (EPIC). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript