McImpact: Welfare Impacts of All Day Breakfast after HPAI Outbreak

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Introduction

Animal disease outbreaks can have negative impacts on consumers and producers. The duration of these negative impacts are tied to the outbreak timing, disease management strategies, and ability for the affected industry to recover from losses in animal stocks. In addition, there are external decisions that can exacerbate the impacts of a disease outbreak.

Private industry makes decisions weighing the short-, medium-, and long-run returns. Typically these decisions can be divided into two overarching categories: short-run payoffs or long-run positioning. Short-run payoff strategies have a short to medium return goals that can be complementary to long-run strategy or offer diverging strategies from long-run goals.

Long-run positioning are those strategies that determine the direction and overall business strategy for a company. Decisions focused on the long run can have negative short-run implications. Depending on the size of an operation, these losses can be sustained in order to make a profit in the long run. When businesses choose long-run positioning strategies, it is possible to have negative welfare effects on the market, especially when coupled to a market disruption.

A recent example of a business making a long-run decision that has potential to exacerbate a market is the decision by McDonald's to begin to serve an all day breakfast. While the decision to expand their menu offerings is in line with a long-run strategy to increase foot traffic and drive profitability, the decision also was made during a shortage of eggs in the United States due to an outbreak of highly pathogenic avian influenza (HPAI). The menu expansion decision has been successful for increase in profitability for McDonalds franchisees, but can have negative welfare effects on consumers. The objective of this analysis is to estimate the welfare effect of McDonald's all day breakfast on producers and consumers that potentially occurred in addition to the HPAI outbreak.

Background

McDonald's is one of the largest food retailers in the world with more than 14,350 locations in the United States. McDonald's is the largest fast food consumer of U.S. eggs, having captured one-fifth of the breakfast market (Strom, 2015a). McDonald's traditional breakfast menu use accounts for more than 4% of total U.S. eggs produced (Strom, 2015b), or two billion eggs annually (Baertlein & Ramakrishnan, 2015).

The decision to increase the menu options to an all day breakfast was part of long-term strategy to bolster sales. McDonald's earnings had decreased by 0.9 to 1.6 percent across the U.S. franchises for the second quarter in 2015, a continuing decline from previous quarters. The all day breakfast initiative was a way to meet demand for all day breakfast by consumer and to increase store foot traffic (Whitten, 2015). Early projections have estimated the success of the all day breakfast to increase McDonald's profits by 2.5 percent (Patton, 2015).

HPAI Outbreak

However, during the same period McDonalds chose to increase menu availability immediately after the final case of HPAI in U.S. poultry. In December 2014 the first case of HPAI in U.S. flocks was detected, eventually affecting more than 48 million birds by July 2015. The vast majority of affected birds were layer birds (67%) (USDA-APHIS, 2016), or those birds that lay eggs to be consumed as either table eggs or further processed egg products. This shortage of eggs on the U.S. market led to an increase in the price of eggs. For example, the price for grade A, large table eggs in August 2015 was $2.94, a 49% increase over August 2014 table egg prices (U.S. Department of Labor, Bureau of Labor Statistics, 2015). While McDonald's has a relatively small share of the total egg market, the decision by McDonald's to increase their menu offering increased the demand for eggs during a time when many restaurants were reducing menu offerings due to egg shortages (Kieler, 2015).

Methodology

To estimate the impacts of McDonald's all day breakfast, a quarterly, partial equilibrium model of the U.S. egg industry is used. First, U.S. egg prices will be estimated using the number of birds affected during the 2015 outbreak of HPAI in U.S. layers as a shock to the 2014 baseline. These results will be compared to the McDonald's scenario that incorporates the additional supply pressure. Consumer welfare impacts will be estimated comparing these two scenarios.

Model Framework

The partial equilibrium model representing the U.S. egg industry accounts for the movement of eggs from farm to processor, diversion to type of final egg product, and finally from processor to consumer. Egg layers produce either hatching eggs or nest-run shell eggs, more commonly called shell eggs. For this analysis, hatching eggs are excluded as they are produced through special breeder houses and are not substitutable at the market level for consumption eggs. Shell eggs are then diverted into the two types of products: table eggs and breaker eggs (to be further processed into specific final consumption products). Prior to packaging into cartons, table eggs must be processed which includes: grading, washing, and sanitizing. These cartons are then shipped to retailers or final consumers.

Eggs that are diverted to processing are called breaker eggs, as they will be broken and processed into liquid, dried, or frozen eggs. These egg products can be packaged and sold as processed eggs or used as inputs in other food products. For this study, these final processed egg products are aggregated into one group called, "processed eggs," so as to model the diversion of shell eggs into the two processing methods.

The partial equilibrium model used in this analysis models the diversion of farm eggs to the final end consumer.[1] This includes the processing decision to produce table or processed eggs. The model is written in its fully differentiated form such that all variables represented are percent changes (E is used to denote dln, e.g., dlnP is noted as EP_i). Price equations are given by:

(1) $$EP_i = \theta_{l,i}\, Ew + \theta_{e,i}\, EP_e + \theta_{k,i}\, Er_i.$$

Price of output egg type i (*te*: table eggs; *pe*: processed eggs) is determined by the price of inputs used in production (w), the price of shell eggs (P_e), and returns to capital (r). θ represents the unit revenue share for input (labor (l), shell eggs (e), and capital (k)). Shell egg supply is represented as:

(2) $$\phi ES = \lambda_{e,te}\, Eq_{te} + \lambda_{e,pe}\, Eq_{pe} + \lambda_{e,te}\, Ea_{e,te} + \lambda_{e,pe}\, Ea_{e,pe},$$

where shell egg supply (S) is a function of the quantity of eggs demanded (q_i) and the per-unit derived demand for eggs of different consumption types ($a_{e,i}$). λ represents the factor share of production. Exogenous shocks to egg supply, such as depopulated poultry, can be applied using ϕ. Additionally, shell egg supply is a function of the producer price of shell eggs times the own price elasticity of shell eggs (ε) as follows:

(3) $$ES = \varepsilon\, EP_e.$$

[1] For this analysis shell eggs relate to eggs at the farm gate (i.e., those produced by layer birds), table eggs are cartons of eggs consumers purchase, and processed eggs are an aggregation of final egg products of breaking eggs.

This additional equation is applied to derive the change in shell egg price that drives changes in final demand prices. Industry capacity is represented as:

(4) $Ek_i = Ea_{k,i} + Eq_i$

Industry capacity (k_i) is a function of the quantity and the per-unit derived demand of the i^{th} egg type (Eq. 4). While there could be some asset fixity in egg processing capital, the assumption in this model is that there are marginal changes in efficiency in production given price incentives, thus allowing for changes in industry capacity to occur. Substitutability of inputs are shown in the following equations:

(5) $Ea_{e,i} - Ea_{k,i} = -\sigma_{e,k|i}(EP_e - Er_i)$

(6) $Ea_{l,i} - Ea_{k,i} = -\sigma_{l,k|i}(Ew - Er_i)$

Equation 5 indicates substitutability of capital and shell egg inputs that depend on the returns to capital and returns to shell eggs. Equation 6 allows for the substitution between labor and capital. For both equations, σ represents the elasticity of substitution between the two inputs. Equation 7 represents an adding up condition:

(7) $\theta_{e,i}\, Ea_{e,i} + \theta_{l,i}\, Ea_{l,i} + \theta_{k,i}\, Ea_{k,i} = 0,$

which dictates changes to the per-unit derived demand multiplied by its respective unit revenue share should sum to zero. Market clearing equations are:

(8) $q_i Eq_{\ i} + I_{i,t-1} EI_{\ i,t-1} = (X_i - M_i)E(X_i - M_i) + D_i ED_{\ i} + I_{i,t} EI_{\ i,t}$.

These insure that the market clears such that net exports (exports (X_i) minus imports (M_i)), domestic consumption (D_i) and ending stocks (I_i) in the current period (t) should equal production and begging stocks ($I_{i,t-1}$) in the previous period (t-1). This condition holds for both table eggs and processed eggs. Ending stocks (I_t) are a function of the price of shell eggs defined by equation 9 for current time period t,

(9) $EI_t = \varepsilon_{I,i} EP_e$.

Domestic demand is represented as:

(10) $ED_i = E\gamma_i + \varepsilon_{i,i}\, EP_i + \varepsilon_{i,j}\, EP_j$.

Domestic demand for good *i* is a function of own prices (P_i) and elasticities ($\varepsilon_{i,i}$) as well as cross prices (P_j) and cross price elasticities ($\varepsilon_{i,j}$) (Eq. 10). Demand shock (γ) represents a possible shock to demand preferences during a disease outbreak. There are few studies on the impacts of HPAI on U.S. egg consumption. A case study for Italian consumers (Beach, Kuchler, Leibtag, & Zhen, 2008) could be drawn upon to represent U.S. demand changes, but due to differences in consumer buying ability and additional factors such as specific attitudes regarding diseases that have not been researched for U.S. consumers, the exogenous change in demand is assumed zero for this analysis. Net exports are a function of the world reference price and shocks to net exports,

(11) $E(X_i - M_i) = \delta_i + \varepsilon_{x-m,i} EP_i^w$.

Net exports are regional exports (X_i) minus regional imports (M_i) by product *i*. This provides a means to model international trade embargos as a result of disease outbreak. Exogenous trade shocks are represented by δ_i. The world reference price is shown in equation 12:

(12) $P_i^w EP_i^w = P_i\, EP_i + c_i E t_i$.

The world reference price, P^w, is assumed to be a function of U.S. domestic prices plus transportation costs (*c*) This reference price helps the markets clear within the model. The above system of equations (equations 1 – 12), expanded to the 22 behavioral equations for both table eggs and processed eggs, is reduced, using substitution, to three equations to simplify the search for feasible solutions. In reduced form, the model is solvable using inverse matrix algebra. Solutions are then fed back in the behavioral equations to provide solutions for all endogenous variables.

To estimate the consumer and producer welfare measures Wohlgenant's (2013) estimation of changes in producer and consumer, which calculate a linearized partial equilibrium model, were used (Eq. 13 and 14):

$$\Delta CS = -(1+\eta)^{-1} P_0 Q_0 (e^{(1+\eta)EP-\eta\delta} - 1) \quad (13)$$

$$\Delta PS = (1+\varepsilon)^{-1} P_0 Q_0 (e^{(1+\varepsilon)EP-\varepsilon k} - 1), \quad (14)$$

where P_0 and Q_0 are the original baseline price and quantity, η is the price elasticity of demand, ε is the price elasticity of supply, δ is a demand shock, and k is a supply shock.

Model Scenarios

There are two model scenarios used in this analysis: HPAI and McDonald's. Both scenarios account for the HPAI outbreak in U.S. poultry, but the McDonald's scenario also accounts for the increased demand of table eggs by the fast food chain. Model scenarios use USDA-APHIS reported number of affected birds during the second quarter of 2015 as the baseline HPAI scenario (USDA-APHIS, 2016). For the second quarter of 2015, there were 32,453,700 affected layer birds throughout the Midwest. This number of affected birds enters the economic model as calculated shocks to the quantity of shell eggs, which are calculated using the annual eggs per laying hen equivalency.

For the McDonald's scenario, the supply shock described above is incorporated into the exogenous shock, as well as a demand shock that increases the demand of table eggs. These values are entered into the economic model stochastically using a triangular distribution that limits the lower end of change in demand to zero, with an upper end as a two percent increase in egg use, which represents a 50 percent increase in egg usage by McDonald's.

Using Simetar (Richardson, Feldman, & Schuemann, 2003), the model was repeatedly estimated for 500 iterations, which provides the mean solutions reported as well as the variation around these estimates. The estimated consumer welfare was estimated for a single quarter. While pricing implications can extend beyond this period in terms of market impacts, repopulation of layer birds is an ongoing process, which reduces the duration of the disease impacts and the increased demand is incorporated into egg demand.

Data

Baseline data for supply and demand are collected from multiple USDA resources including the Agricultural Marketing Service (AMS), Economic Research Service (ERS), National Agricultural Statistics Service (NASS), and the World Agricultural Supply and Demand Estimates (WASDE). Data includes egg use, consumption, beginning and ending stocks, imports, exports, and egg prices for all levels of production. These data are used to create the baseline data for the analysis.

Exogenous shocks for the analysis were calculated as a percent change from the baseline egg production. The parameters used in the analysis are summarized in Table 1. Calculated parameters are derived through substitution of the behavioral equations using parameters and initial baseline values where appropriate. Stocks, net exports, and price elasticities are estimated, as they are specific to the type of product.

Table 1: Summary of Parameters used in Model Analysis and their Sources

Parameters	Description	Value	Source
$\theta_{l, te}$	Unit revenue shares	0.160	Bell, (2001); Industry Expertise
$\theta_{e,te}$	Unit revenue shares	0.515	Bell, (2001); Industry Expertise
$\theta_{k,te}$	Unit revenue shares	0.325	Bell, (2001); Industry Expertise
$\theta_{l, pe}$	Unit revenue shares	0.164	Bell, (2001); Industry Expertise
$\theta_{e,pe}$	Unit revenue shares	0.532	Bell, (2001); Industry Expertise
$\theta_{k,pe}$	Unit revenue shares	0.304	Bell, (2001); Industry Expertise
$\lambda_{e, te}$	Factor Share	0.700	USDA – AMS (2015)
$\lambda_{e, pe}$	Factor Share	0.300	USDA – AMS (2015)
$\varepsilon_{y,te}$	Income Elasticity	0.346	USDA – ERS (2013)
$\varepsilon_{y,pe}$	Income Elasticity	0.346	USDA – ERS (2013)
$\varepsilon_{I, te}$	Stock Elasticity	-1.315	Author's Calculation
$\varepsilon_{I, pe}$	Stock Elasticity	-0.108	Author's Calculation
$\varepsilon_{x, te}$	Net Export Elasticity	0.590	Author's Calculation
$\varepsilon_{x,pe}$	Net Export Elasticity	0.250	Author's Calculation
$\varepsilon_{te,pe}$	Cross Price Elasticity	0.149	Author's Calculation
ε_{te}	Own Price Elasticity	-0.538	Author's Calculation
ε_{pe}	Own Price Elasticity	-0.801	Author's Calculation
$\sigma_{e,k: te}$	Substitution Elasticity	0.436	Ollinger, MacDonald, & Madison (2005)
$\sigma_{l,k: te}$	Substitution Elasticity	0.436	Ollinger, MacDonald, & Madison (2005)
$\sigma_{e,k: pe}$	Substitution Elasticity	0.436	Ollinger, MacDonald, & Madison (2005)
$\sigma_{l,k: pe}$	Substitution Elasticity	0.436	Ollinger, MacDonald, & Madison (2005)
ε_{e}	Egg Price Elasticity	-0.088	USDA – ERS (2013)
η_{e}	Raw Egg Supply Elasticity	1.000	USDA – ERS (2013)

Parameters Derived from Model Specification

Parameters	Description	Value	Source
$\eta_{te, w}$	Input Elasticity	0.215	Calculation
$\eta_{te, e}$	Input Elasticity	0.692	Calculation
$\eta_{te, te}$	Supply Elasticity	0.907	Calculation
$\eta_{pe, w}$	Input Elasticity	0.321	Calculation
$\eta_{pe, e}$	Input Elasticity	0.762	Calculation
$\eta_{pe, pe}$	Supply Elasticity	0.996	Calculation

Results and Discussion

While McDonalds has a large share of the market for breakfast eggs, it uses a relatively small percentage of total U.S. eggs produced. The impact of HPAI and McDonald's all day breakfast are presented in Table 2. The main driver of price changes is the reduction of layers due to the HPAI outbreak. The disease outbreak led to euthanasia of more than thirty two million layers, and removing these from production leads to a reduction in total egg supplies. The modeled increase in shell egg price is 32.6 percent. Adding the additional supply pressure by McDonald's all day breakfast, there is an additional 0.07 percent change in the shell egg price. When comparing these results to the final product prices, table eggs are impacted by an additional 0.17 percent higher price increase due to the additional demand.

Table 2: Impact of All Day Breakfast and HPAI Outbreak (Percentage)

	Unit	HPAI Only	HPAI and McDonald's	Difference
Shell Egg Price	$/Dozen Eggs	32.58	32.65	0.07
Table Egg Price	$/Dozen Eggs	19.57	19.75	0.17
Processed Egg Price	$/Equivalent Dozen Eggs	7.54	7.50	-0.05
Production Table Eggs	Dozen eggs	-4.80	-4.69	0.11
Production Processed Eggs	Equivalent Dozen Eggs	-17.32	-17.42	-0.10

Contrarily, the price for processed eggs was estimated to increase by 7.54 percent versus 7.5 percent with the change in demand to table eggs. This is to be expected, as the product demanded by McDonald's are table eggs, which were estimated to have an increase in demand. The difference between the price increases represents the change in final demand. The estimated price change for processed eggs as a response to HPAI and McDonald's increase in demand are conservative, based on modeling assumptions. Some users of processed egg products such as liquid eggs saw prices more than double (Lowe, 2015), which is in response to how industry chose to divert shell eggs.

As expected, production for both table eggs and processed eggs decreased by 4.8 and 17.2 percent respectively for the HPAI only scenario. With the decrease in supply, processing volumes would need to be reduced. What this implies is given the changes in prices of final products, processed egg products are more greatly impacted as a result of the outbreak. When comparing the HPAI scenario to the McDonald's scenario, table egg processing actually benefit by 0.11 percent from the increase in demand by the fast food chain. Processed egg production is worse off by 0.10 percent. The trade off in production is driven by the shortage of supplies, and the subsequent allocation of shell eggs used to meet demand.

Welfare Effects

While the estimated direct impacts, discussed above, show the changes in magnitude of price changes, it does not take into account the total welfare effect. The estimated welfare impacts are presented in Table 3 below.

Table 3: Welfare Impacts of HPAI Outbreak and All Day Breakfast ($1,000)

	HPAI Only	HPAI and McDonald's	Difference
Producer Surplus Change	5,984	6,102	33
Depopulation Producer Impacts	-28,884	-28,884	0
Total Producer Surplus Change	-22,899	-22,867	33
Consumer Surplus Change	-9,828	-10,048	-220
Total Change in Welfare	-32,728	-32,915	-187

Total producer welfare is the combination of calculated changes in producer surplus plus the exogenous cost of the shocks that are imposed. The model does not account for the excess burden on producers infected by HPAI including the explicit costs related to depopulation. The depopulation impacts are based on a conservative estimate of total depopulation costs ($0.89 per bird[2]), including disposal costs, depopulation, cleaning and disinfection, and indemnity, multiplied by the number of affected birds.[3]

Producers able to sell their products during the HPAI outbreak benefit from increased prices, which result from the reduction in supply. Changes in producer surplus are positive across both scenarios. The model-predicted results for the HPAI scenario show an additional $33 thousand as a result of McDonald's all day breakfast. However, once accounting for depopulation impacts that are not included in the model-predicted results, total producer surplus is negative both scenarios.

Consumer surplus changes are negative for both scenarios, as expected due to shortages of egg supplies. Importantly, the difference between the HPAI scenario and the McDonald scenario -$220 thousand, show the exacerbation the all day breakfast were estimate to have on consumers on top of the HPAI outbreak. This value is relatively small compared to the value of all eggs sold in the United States. However, it does show the importance of business decisions by industry actors that have a significant share. McDonald's business strategy to drive profitability has negative effects on traditional egg consumers. The limitation of this analysis would be the lack of estimation of the welfare McDonald's consumers gain by having access to an all day breakfast, which is outside the scope of this analysis.

Conclusions

McDonald's fast food chain has a large share of the breakfast food market, consuming less than five percent of total eggs produced in the United States. The decision to extend

[2] Depopulation costs include the cost of depopulation, including supplies and labor, and estimated indemnity based on industry and government expert opinions.
[3] Indemnity is estimated to be the average value of a layer for weeks 20-110, the typical lifespan of layer birds in commercial layer operations.

the breakfast menu was made at a most inopportune time market wise, as there was a shortage of eggs in the United States due to an outbreak of HPAI. In terms of driving foot traffic, the strategy has been successful, but the long-run decision has impacts across the market, even if only marginally. By estimating the impact of both the 2015 HPAI outbreak in U.S. poultry coupled with the private industry decision to extend the breakfast menu, an approximation of the value of this decision was estimated to be $187 thousand in terms of lost surplus. While marginal in comparison to the value of the U.S. egg industry, this estimation provides an insight into the importance of market actors' decision when making short and long-term strategies.

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