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A financial analysis of cage and cage-free eggs production in the United States

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ABSTRACT

This study compares profitability of conventional and cage-free eggs production in the United States. By using discounted cash flow valuation, we estimate rates of return for both production systems and a breakeven price, the potential output price that would equate profitability of conventional and cage-free production. We find that while both production systems provide a rate of return at least as high as an estimated opportunity cost, conventional production is more profitable. Furthermore, in order both production systems to yield the same rate of return, price of eggs under cage-free production at the farmer gate should roughly double prices under conventional production.

Introduction

This study contributes to the nascent literature on the economic impacts of regulations to improve farm animal welfare (Mullally and Lusk 2017), focusing on an analysis of egg production systems in the United States (US). Recently, on November 6, 2018, the Prevention to Cruelty Farm Animals Act (Proposition 12) was passed, requiring all eggs sold in California to be produced from cage-free hens by 2022. Proposition 12 advances Proposition 2 –implemented in 2015–, by providing specific housing production size requirements (i.e., egg-laying hens must have 1 square foot of space by 2020 until 2022 when hens must be raised in cage-free environments) and by extending these requirements to out-of-state farmers selling eggs to California (Keller and Heckman LLC 2018).

Mullally and Lusk (2017) studied the economic effects of Proposition 2 finding that egg production in California fell by 35% and egg prices increased, on average, by 22% about two years after its implementation in 2015. Given the importance of California in the US eggs industry –it is ranked 7th in terms of number of laying hens by the United Egg Producers–[1], and a push by major US retailers and restaurant chains to sell cage-free eggs, these findings hint the potential impact of the most recent regulation, which may be extended to other states.

Major food buyers such as Target, Walmart and Whole Foods have expressed intentions to only sell cage-free eggs by 2025, according to Humane Society of the United States (Pershan 2018). This movement to cage-free eggs is followed by a long list of buyers including restaurants and distributors (USDA 2016), suggesting that cage-free egg production is a consumer driven trend and would be difficult to revert. In the foreseeable future, cage-free production is expected to have multiplicative effects. For example, Cal-Maine Foods, the largest producer and marketer of eggs in US, filed a report of 'unscheduled material events or corporate event' (i.e., 8K report) with the Securities Exchange Commission on January 4, 2019, in regards to Proposition 12, stating (Cal-Maine Foods 2019, 1): "We are closely monitoring industry developments surrounding the recent passing of Proposition 12 in California… While this referendum will clearly affect sourcing and production of eggs in California, we also expect it to affect future supply and pricing in other areas of the country… Cal-Maine Foods is well positioned to capitalize on this opportunity to expand our operations or consider potential acquisitions."

While there is room for cage-free egg production growth in the US given that current share of cage-free production is below 20% of total eggs production volume, potential barriers include the relatively high cost of converting conventional production to cage-free systems (Promar International 2009; Agralytica Consulting 2012) and consumers' willingness to pay the premium that would be required given high conversion costs (Welshans 2018). This study starts to investigate the profitability and risk profiles of cage-free and conventional caged hen production.

[1] https://unitedegg.com/facts-stats/. Accessed December 1, 2018.

Overall, our findings indicate that while both production systems provide a rate of return at least as high as an estimated opportunity cost, conventional production is more profitable. Furthermore, in order both production systems to yield the same rate of return, price of eggs under cage-free production at the farmer gate should roughly double prices under conventional production.

Materials and Methods

Capital budget modelling is implemented to financially assess conventional and cage-free production systems in the US. Forecasted free cash flows of ten 15-month laying flocks are evaluated with discounted cash flow valuation, which is commonly used to forecast stock returns in capital markets (Schill 2017). The Modified Internal Rate of Return (MIRR) is estimated to compare profitability for both technologies (Brigham and Houston 2017). Parameters for the capital budgeting model are compiled from the literature, with the baseline model using mainly the investments and cost structures in Matthews and Summer (2015). Other production factors are parameterized using ranges from USDA and Extension budgets (USDA:APHIS 2014). Historical prices by the USDA Agricultural Marketing Service reports and forecasted prices by USDA Office of the Chief Economist (2019) serve as the basis to forecast long-term prices.

Operating costs

We refer to both cost of goods sold and expenses as operating costs. Operating cost categories in the poultry enterprise include: (1) pullets, (2) feed, (3) labor, (4) depreciation, and (5) other costs. *Pullets*– cost per 19-week old pullets for the first flock of conventional production is the national average of 2018 monthly prices compiled by the Egg Industry Center (EIC) (Ibarburu 2019). Pullet prices are updated every year using forecasted inflation rates.

Pullets for cage-free laying production need to be acculturated to such system, and are therefore reared in a cage free rearing barn, which is more expensive than conventional rearing due to higher space requirements and feed consumption (Matthews and Sumner 2015). We use a pullet cost premium, defined as the price paid for conventional pullets over the price paid for cage-free pullets minus 1. A pullet cost premium = 0.41, documented as the simple average of two flocks by Matthews and Summer (2015), is used as our baseline parameter. Total pullet cost per flock is calculated as Price per Pullet $_{\text{per technology}}$ times Inflation Factor times Number of Pullets Purchased $_{\text{per technology}}$. As is standard in the literature, the cost of pullets per dozen eggs is calculated as the Total Cost of Pullets divided by the number of dozen eggs produced over the complete flock, without accounting for bird mortality. Laying rates, expressed in dozens of eggs produced per technology, are values in Matthews and Summer (2015).

Feed – We estimated the price for a typical layer feed ration using forecasted commodity prices and accounting for potential inflation rates (Ibarburu and Bell 2014). The feed ration has 67% corn, 22% soybean meal, 8% calcium, and 3% other ingredients. Corn and soybean meal prices are yearly forecasts from 2019 to 2018 by the OEC (USDA:OCE 2018, 2019). Calcium, other ingredients, and transportation and milling costs estimates as of 2019 are by EIC (Ibarburu 2019) and updated by inflation for the other years.

Feed consumption per laying hen is 3.58 pound per dozen eggs produced over the flock for conventional production. This parameter is estimated by multiplying the national average feed consumption rate per bird by the EIC (Ibarburu 2019), 3.14 pounds per dozen, times an adjustment factor equal to 34.5/30.23, the dozen of eggs reported by Ibarburu (2019) divided by the dozen of eggs reported by Matthews and Summer (2015). This adjustment allows comparison of this cost with other costs reported by Matthews and Summer (2015) on a per dozen eggs basis. Matthews and Summer (2015) reports that feed consumption of hens under cage-free production is reported to be slightly higher than under conventional production consistent with the literature which shows reduced feeding efficiency comparing conventional and cage-free production (Aerni et al. 2005; Karcher et al. 2015). We incorporate the increase in feed demand in the budgets.

Total feed cost is calculated, for each technology, by multiplying feed consumption (which differs by technology) times forecasted feed prices (same for both technologies) times dozen of eggs over the flock (which differs by technology) times the number of pullets purchased (which differs by technology). This overall feed cost per dozen eggs per hen housed will account for the differences in production type, bird placement, and feed efficiency.

Labor– Labor cost estimates in $2011 prices by Matthews and Summer (2015), are re-expressed in 2018 dollars using the production price index. Labor estimates are expressed in dozen eggs, with labor cost for cage-free technology around 3 times higher than under conventional production.

Depreciation– Depreciable assets are expended equally during ten flocks according to a straight depreciation system schedule.

Other costs– The budgets include energy and miscellaneous costs in Matthews and Summer (2015), re-expressed in 2018 dollars; and management salaries, assumed as 2% of total revenues. Manure cleaning cost at the end of each production cycle is not budgeted, assuming that this cost equals manure revenue plus spent hen revenues, which neither is budgeted. All other costs are updated every year according to inflation rates.

Inflation rates– Forecast inflation rates vary around 2% to 2.4% during the 10-years period, according to the International Monetary Fund for the first half of the projection and from the USDA (2018) for the second half.

Investments

Capital expenditures (CAPEX) is assumed to occur at the beginning of the project only, with subsequent repair expenses budgeted as part of miscellaneous costs. The investment values of the facilities are from Matthews and Summer (2015). The conventional housing + equipment system was built in 2004 and the cage-free housing + equipment system was built in 2011. Matthews and Summer (2015) re-expressed investment values as of 2011 to make them comparable. We further re-expressed investment values as of the end of 2018. These 2018 values are comparable to current market values according to industry pricing elicited from equipment suppliers.[2] Investment in working capital is assumed zero in this analysis.

Output Prices

For conventional production, long-term forecasted prices of eggs, from 2019 to 2028, by USDA Office of the Chief Economist (2019) are used to estimate revenues. For cage-free production, we estimate the simple average of the price premium paid for cage free egg over conventional egg every month in 2017 and 2018, from prices compiled by the EIC (Ibarburu 2018, 2019), and assume, for the baseline estimation that this price premium remains the same over the eight flocks business horizon evaluated. Total revenues are estimated for each production system by multiplying USDA forecasted annual prices per dozen eggs times the number of dozen eggs in Matthews and Summer (2015) times (1-% of non-marketable eggs). The percentage of non-marketable eggs, which varies per production system, is from Summer et al. (2008).

Discounted Cash Flow (DCF) Model

DCF valuation is used to analyze profitability, risk, of both production systems. Free cash flows (FCF) are estimated for each 15-month laying cycle of production. FCF is the incremental cash flow attributable to each production house accruing to equity and debt holders and is computed as $FCF = NOPAT + DEP - CAPEX$; where $NOPAT$ is net operating income after taxes, computed

[2] Several telephone contacts were made with various equipment industry participants in order to verify the cost structure presented by Matthews and Summer (2015).

as revenues minus cost of goods sold and all operating expenses –including depreciation– minus income taxes; DEP is depreciation expenses; and $CAPEX$ is capital expenditures, defined as investments in fixed assets. Assumed income tax rate is 33%, the median income tax rate of Cal-Main during 2014 to 2018.

Following Bir et al. (2018), we forecasted annual $FCFs$ for 15-month laying cycles, equivalent to twelve years, as the business horizon to evaluate both production systems. The FCF series for each production system are used to estimate the MIRR, which is the rate of return that makes the NPV equals zero; providing a rate of return per flock that would satisfice both debt holders and shareholders. The MIRR has been used in agricultural enterprise valuations and has been argued to be a superior metric relative to the traditional Internal Rate of Return.

The MIRR estimation requires a risk-adjusted rate of return or opportunity cost. According to surveys, most firms in the US use the weighted average cost of capital (WACC) as a discount rate (Graham and Campbell 2001) for capital budgeting valuations. WACC is a weighted average of the annual cost of debt and cost of equity. We estimate WACC of Cal-Maine, Inc., a publicly traded firm specializing in egg production and marketing, and used it as reference for the opportunity cost of capital investment in this industry.

Results

Table 1 provides our preliminary cost estimates for the first flock, assumed to start production in 2019, compared to estimates from previous studies. We estimated total cost per dozen=\$0.602 for conventional production and for cage-free production=\$0.847. This implies that cage-free production costs 41% more than conventional production in terms of dozen eggs commercialized. These estimates are lower than Matthews and Summer's (2015), at \$0.687 and \$0.961, respectively. However, the relative difference between conventional and cage free production in Matthews and Summer (2015), at 40%, is similar to our estimate. This was expected since most of our assumptions related to relative differences between production systems are from Matthews and Summer (2015). Table 1 also provides current cost estimates by EIC (Ibarburu 2019), with total cost for conventional production estimated at $0.618 per dozen. EIC does not provide estimates for cage-free production. Thus, our estimates are similar to EIC's (for conventional production) and lower than Matthews and Summer's (2015).

Our lower estimates relative to Matthews and Summer's (2015) are mainly explained by feed costs, which are estimated at $0.347 ($0.356) for conventional (cage-free) compared to $0.425 ($0.436) in Matthews and Summer (2015). Matthews and Summer (2015) conducted their field study in 2011, when commodity prices, specifically corn and soybean meal, that are part of the feed ration were higher than current and projected prices. For instance, corn prices were traded at $6.80 per bushel in 2011 compared to $3.70 in 2018 (Macrotrends 2019). These exceptionally high prices were related to increased demand for bioethanol due to government subsidies as well as other production and market factors. The demand for corn subsequently caused changes in planting patterns leading to increased prices for most commodities due to limited supply, even with modified feed rations. Besides the layer feed implications, pullet costs are also directly impacted by commodity prices since pullets are fed during 19 weeks before purchased for laying purposes.

Costs provided in Table 1 are those related to the first production flock only. Costs (and prices) for the other nine flocks in the business horizon vary every year as a function of feed cost, output prices, and inflation rates. Financial metrics evaluating the complete ten flocks are provided in Table 2.

Table 2 provides rates of returns (MIRR) for both production systems and opportunity cost (WACC) to benchmark returns. Conventional production is more profitable than cage-free production, yielding 22.7% rate of return per 15-months flock compared to 9.2% for cage-free production. In this estimation, output prices for conventional production are forecasted prices per dozen eggs by USDA. Output prices for cage production are assumed to be 13% higher than forecasted conventional egg prices. This 13% cage-free premium price is the simple average of monthly cage-free price premia during 2017 and 2018 for negotiated prices, compiled by the EIC. Figure 1 shows cage-free price premia for both negotiated and contracting production.

Table 2 also shows an opportunity cost estimation, which is the weighted average cost of capital estimated as of the end of 2018 for Cal-Maine, used in this study as the benchmark in this industry. WACC is the annual rate of return that would satisfy expectations of both equity holders and debtholders. According to the results in Table 2, both production systems would yield returns at least equal to expected returns, implying both production systems are positive net present value enterprises. However, cage-free production estimated rate of return is only slightly above the expected rate of return, 9.4% vs 9.2%. The MIRR for cage production depends on the cage-free price premium, which is highly variable, as Figure 1 shows. It also depends on the commercialization practice (i.e., contracting or negotiated) chosen by the farmer.

Finally, we estimated how large the cage-free premium would need to be in our models in order both production systems to be equally profitable (i.e., yield 22.7% MIRR). This premium needs to be 109%, as shown in the last column of Table 2.

Conclusion

This study compares profitability rates of conventional eggs production and cage free production over ten flocks using cost and investment structure budgets in the literature and forecasted feed prices and output prices. Preliminary results show that conventional production is more profitable than cage-free production. This result is consistent with anecdotal evidence suggesting that some farmers who started to produce cage-free in Tennessee, switched back to conventional production after realizing that cage-free production is not as economically attractive as conventional production. Furthermore, we estimated that in order for both production systems to yield the same profitability, cage-price prices at the farm gate need to be about 2 times the conventional prices.

With the changing food production environment driven by consumer demanding particular production practices, this work provides an avenue of discussion on the feasibility and financial prospects of converting to a cage-free system in the US egg layer industry. Our analysis, however, provides results for a baseline deterministic scenario only, resting mainly on differential cost and investment structures observed from a previous study that compared both production systems during two flocks. Additional analysis should provide alternative scenarios and incorporate uncertainty under stochastic simulation of production parameters in the literature and output prices.

Table 1- Cost estimation ($ per dozen eggs) in this study compared to previous studies

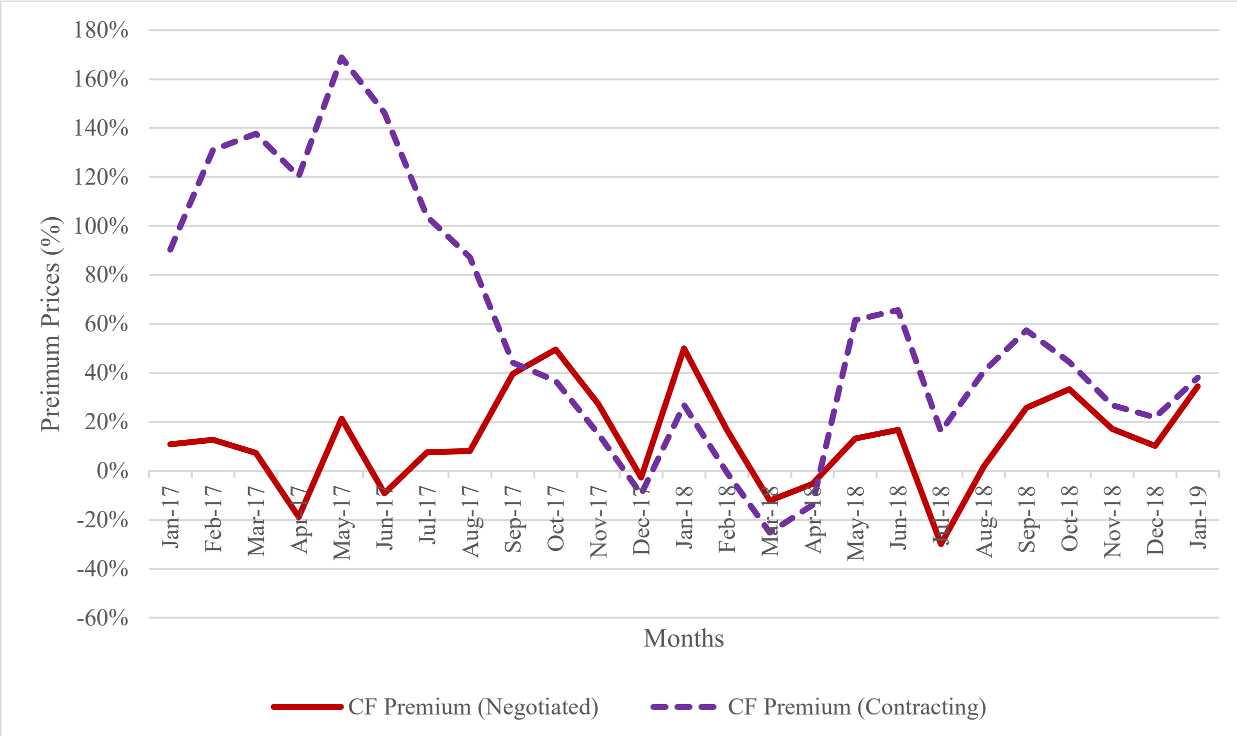
Item	Conventional	Cage free	Difference ($)	Difference (%)
Pullet (this study)	0.129	0.193	0.063	49%
Pullet (EIC)	0.111	NA		
Pullet (M&S)	0.148	0.221	0.073	49%
Feed (this study)	0.347	0.356	0.009	3%
Feed (EIC)	0.333	NA		
Feed (M&S)	0.425	0.436	0.011	3%
Other (this study)	0.126	0.298	0.173	137%
Other (EIC)	0.175	NA		
Other (M&S)	0.114	0.304	0.190	167%
Total (this study)	0.602	0.847	0.245	41%
Total (EIC)	0.618	NA		
Total (M&S)	0.687	0.961	0.274	40%

Notes: Simple average of forecasted eight 15-month production cycles.
Other includes depreciation, labor, utilities, repair and miscellaneous.
M&S are costs in Matthews and Summer (2015), re-expressed in $2018 values using the producer price index. EIC are costs in Ibarburu (2019).

Table 2- Modified Internal Rate of Return

Production System	MIRR	WACC	Price premium
Conventional	22.7%	9.2%	0
Cage Free	9.4%	9.2%	109%

Figure 1-



180%
160%
140%
120%
100%
80%
60%
40%
20%
0%
-20%
-40%
-60%
Preimum Prices (%)
Jan-17
Feb-17
Mar-17
May-17
Jul-17
Aug-17
Sep-17
Oct-17
Nov-17
Jan-18
Feb-18
May-18
Jun-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Months
CF Premium (Negotiated)
CF Premium (Contracting)

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