BROILER AND SWINE INFORMATION
AND EARLY WARNING SYSTEM

by

Nenita T. Yanson and Eleanore V. Ramos

For additional information, please contact:

Author’s name          Nenita T. Yanson
Designation             Officer-In-Charge, Livestocke & Poultry Statistics Division
Affiliation             Bureau of Agricultural Statistics
Address                 Benlor Bldg., 1184 Quezon Avenue, Quezon City, Metro Manila
Tel. no.                +632-3321543
E-mail                  ntyanson@bas.gov.ph

Co-author’s name        Eleanore V. Ramos
Designation             Statistician III
Affiliation             Statistical Research and Training Center
Address                 104 Kalayaan Avenue, Diliman, Quezon City
Tel. no.                +632-4260620
E-mail                  evramos@artc.gov.ph
BROILER AND SWINE INFORMATION
AND EARLY WARNING SYSTEM

by

Nenita T. Yanson and Eleanore V. Ramos

ABSTRACT

The Department of Agriculture (DA) recognizes the need to continually address concerns on concrete and reliable data and information on the situation and outlook of supply and demand of broiler meat and pork in the country. This is in line with the government’s policy on poultry breeder importations, chicken meat and pork importation and price stabilization. Thus, the Bureau of Agricultural Statistics (BAS), the statistical arm of the Department, spearheaded the development of a Broiler and Swine Information and Early Warning System (BSI-EWS). One of the system’s integral components includes the development and enhancement of statistical models for forecasting the production, supply and demand of chicken meat and pork in the country. The models utilize economic principles, that is, production is affected by input variables such as grandparent stock (GPS) and parent stock (PS) for broiler and live inventories of sow and finishers and corn production for swine while supply rely on the price of the commodity. Demand is affected by the price of the commodity, price of substitutes, income and lifestyle change. Time series data compiled by the core BSI-EWS partner agencies were used for model building, hence the developed models are those that also considers auto-correlated errors. The forecasts will be validated using the results of BAS surveys. These may serve as advanced information for policy decision making by DA officials in order to create an environment conducive for a globally competitive agribusiness and market development planning for the broiler and swine sub-sector.

KEYWORDS AND PHRASES: forecasting, broiler, swine, production, supply, demand

I. INTRODUCTION

A. Background

The Bureau of Agricultural Statistics was given a special project fund by the Department of Agriculture GMA-Livestock entitled “Diversified Farm Income and Market Development Project” (DFIMDP). It is in support to the generation of statistics, compilation, and analysis of data and information needed by the stakeholders in the industry, and the Department of Agriculture for sound policy decision making.

The funds were downloaded for the implementation of the research and training components of the Early Warning System Project for Broiler and Swine. This was in sequel to the previous SRTC project, which the BAS implemented in 2001. The 2001 project was designed to develop an appropriate methodology for a responsive early warning system for agricultural commodities. The commodities covered for livestock and poultry are broiler, swine and chicken eggs. For broiler, a life-cycle model was developed to forecast production of broiler for a minimum of three (3) months to a maximum of thirty three (33) months ahead. Another model was developed using regression technique to forecast supply of broiler meat. For swine, two models were also developed using a “survey-based method” to forecast fatteners for slaughter, and regression technique to forecast pork production.

The BAS utilized the EWS forecasting tools for broiler and swine to validate current estimates, and provide indication of future trends.
The pressing issue of “boom and bust” in the broiler supply impelled the forecasting team (BAS) to refine further its “life-cycle forecasting model”. The problem of highly erratic supply of broilers was perceived as a failure of the industry and the government, which issue permits for DOC breeder imports to read future demand vis-à-vis supply. The cyclical trend in supply and prices of swine also remained unpredictable which posed great risks to swine commercial operators. Swine raisers are in quandary as to what causes the low farm prices, ‘Is it demand or supply?’

Because of this, the new project enhanced the models for production and supply and developed a model for demand so as to have a guide on the surplus or deficit for pork and broiler meat in the country. This year, on its fourth phase, BSI-EWS concepts are being replicated to three pilot regions (Regions III, IV-A, and X) which are the top producers of the two commodities

B. Objectives of the Paper

Provide an enhanced supply and demand forecasting models for broiler meat and pork developed for the BSI-EWS project and its uses in policymaking.

II. MAINTENANCE OF BROILER AND SWINE INFORMATION AND DATABASE

A holistic approach for the early warning system (EWS) has four (4) components namely: a) ground monitoring or improved data collection methods, b) database development/enhancement, c) forecasting d) publication and information dissemination. Development of forecasting tools and their applications are the core components of the EWS which serve to foresee and mitigate impending crises. The databases used for the model building process are the following statistical data series:

A. Swine
1. Volume of Production in kilogram live weight and carcass
2. Supply and demand
3. Importation of live and meat
4. Prices
   a. Live farmgate, wholesale and retail in public markets
   b. Retail Pork cuts in supermarkets
   c. Commercial Feeds Wholesale
   d. Wholesale Feed ingredients
5. Slaughter data
6. Inventory or population by farm type and age group
7. Personal Consumption Expenditures data on food
8. Family Income and Expenditures data on pork

B. Broiler
1. DOC Imports and meat
2. DOC Export and meat
3. Volume of production in kilogram liveweight and carcass
4. Prices
   a. Live farmgate, wholesale integrators ex-plant and retail in public markets
   b. Retail Fully dressed in supermarkets
   c. DOC Wholesale
   d. Commercial Feeds Wholesale
   e. Wholesale Feed Ingredients
5. Dressing Plant data
6. Frozen inventory
III. ENHANCEMENT OF AN EARLY WARNING SYSTEM - FORECASTING TOOL

A. SWINE/HOG/PORK

1. MODEL FRAMEWORK

The enhanced models were developed based on the following framework:

![Figure 4 - Framework for Pork Production, Supply and Demand](image)

It shows the perceived association of the parameters from production to consumption. The inventory of fatteners and sow serves as inputs that affect the level of hog production. The production of yellow corn has a direct proportional effect on production as it serves as the main feed for swine. The ratio of grower to sow serves as a measure on the effect of diseases as it shows the mortality rate of the litters born to a sow. The selling price of pork affects the quantity of supply which the hog raisers produced. Factors that affect demand is the consumers income (represented by the per capita GNP), price of substitutes (retail price of chicken), and consumers’ lifestyle change (employed women). The consumption or quantity demand was estimated using the per capita personal consumption expenditure, and the family expenditure for pork derived from the Family Income and Expenditures Survey (FIES).

2. MODEL ENHANCEMENTS

The forecasting models were developed using regression analysis. Each model was constructed based on economic theories and principles. Each model was subjected to statistical tests required by the regression analysis, and satisfied the following: (i) Normal distribution of the error terms, (ii) No multicollinearity, (iii) No first and higher order serial autocorrelation, (iv) No heteroskedasticity, and (v) Cointegration for models with MA and AR terms.

All the prices used in the estimation of the models were the average of the quarter’s price.

Model 1. Production forecasting model
\[ H_{Prod} = f(Fatt, Sow, Grow2Sow, YCornProd, Q4) \]
\[ H_{Prod_i} = \beta_0 + \beta_1 Fatt_{t-2} + \beta_2 Sow_{t-2} + \beta_3 Grow2Sow_{t-2} + \beta_4 YCornProd_{t-2} + \beta_5 Q4_t + \varepsilon_i \]
\[ \varepsilon_i = \theta_0 \alpha_{i,1} + \theta_2 \alpha_{i,3} + \alpha_i \]

where:
- \( H_{Prod_i} \): Volume of hog production at current quarter (in '000 mt)
- \( Fatt_{t-2} \): Inventory of fatteners two quarters ago (in '000 heads)
- \( Sow_{t-2} \): Inventory of sow two quarters ago (in '000 heads)
- \( YCornProd_{t-2} \): Corn production two quarters ago (in million mt)
- \( Grow2Sow_{t-2} \): Ratio of grower to sow two quarters ago (Grower/Sow, in units)
- \( Q4_t \): Dummy for 4th quarter (1 if quarter 4, 0 otherwise)
- \( \beta, \theta \): Parameters in the equation
- \( a_t \sim NID(0, \sigma^2) \)

Model 2. Supply forecasting model

\[ P_{Supply} = f(WPPork, Q4) \]
\[ P_{Supply_i} = \beta_0 + \beta_1 WPPork_{t-4} + \beta_2 Q4_t + \varepsilon_i \]
\[ \varepsilon_i = \theta_0 \alpha_{i,1} + \theta_2 \alpha_{i,3} + \alpha_i \]

where:
- \( P_{Supply_i} \): Volume of pork supply (in '000 mt)
- \( WPPork_{t-4} \): Wholesale Price of pork four quarters ago (P/kg)
- \( \beta, \phi, \theta \): Parameters in the equation
- \( a_t \sim NID(0, \sigma^2) \)

Model 3. Demand forecasting model

\[ P_{Demand} = f(PGNPConst, LForceEm, RPchk, Q4) \]
\[ P_{Demand_i} = \beta_0 + \beta_1 PGNPConst_{t-2} + \beta_2 LForceEm_{t-5} + \beta_3 RPchk_{t-4} + \beta_4 Q4_t + \varepsilon_i \]
\[ \varepsilon_i = \theta_0 \alpha_{i,1} + \alpha_i \]

where:
- \( P_{Demand_i} \): Volume of pork demand at current quarter (in '000 mt)
- \( PGNPConst_{t-2} \): Personal consumption expenditures two quarters ago (in '000 pesos)
- \( LForceEm_{t-5} \): Employed Women in the Labor force five quarters ago (in million persons)
- \( RPchk_{t-4} \): Retail price of chicken four quarters ago (in P/kg)
- \( Q4_t \): Dummy for 4th quarter (1 if quarter 4, 0 otherwise)
- \( \beta, \theta \): Parameters in the equation
- \( a_t \sim NID(0, \sigma^2) \)

3. RESULTS AND ANALYSIS

a. Hog Production

The production model for hog (HProd) is a function of fatteners, sow, grower to sow ratio, corn production, the 4th quarter, and moving average of order three. Below is the estimated regression equation:
\[ H_{\text{Prod}} = -123.97 + 0.044Fatt_{t-2} + 0.19Sow_{t-2} + 40.96\text{Grow2Sow}_{t-2} + 0.02Y\text{ComProd}_{t-2} + 76.95Q4 + \hat{\epsilon}_t \]

\[ p-value \quad (0.00) \quad (0.00) \quad (0.00) \quad (0.04) \quad (0.01) \quad (0.00) \]

where:

\[ \hat{\epsilon}_t = 0.63\hat{\epsilon}_{t-1} + 0.35\hat{\epsilon}_{t-3} \]

(0.00) (0.00)

The forecasting model for production is statistically significant as shown by the computed p-value of the F-statistics, 0.00. The coefficient of determination (R²) suggests that the regressors explain 96.46 percent of the total variation in hog production.

The estimated coefficients are all statistically different from zero. The equation can be interpreted as estimated production which would increase by 4.4 tons for every 1000 heads increase in fatteners, other factors constant, and so on for the other variables. On the average, the model’s forecast is off by 3.05 percent of the actual production.

**Figure 5 - Forecast vs. Actual Hog Production, 1998-2009**

**Figure 6 - Average, Lower and Upper Production Forecast**

Figure 5 shows the forecast against actual hog production. Figure 6 shows lower, average and upper production forecasts generated by the model. Table 2 shows the expected growth forecasts.
Table 2 - Quarterly Hog Production, 2007-2009F

<table>
<thead>
<tr>
<th>Period</th>
<th>2007</th>
<th>2008</th>
<th>2009 F</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Mean</td>
<td>Max</td>
<td>08/07</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Min</td>
</tr>
<tr>
<td>Q1</td>
<td>462.08</td>
<td>442.70</td>
<td>463.09</td>
<td>494.59</td>
</tr>
<tr>
<td>Q2</td>
<td>454.58</td>
<td>434.25</td>
<td>438.34</td>
<td>468.31</td>
</tr>
<tr>
<td>Q3</td>
<td>483.97</td>
<td>441.57</td>
<td>431.41</td>
<td>462.79</td>
</tr>
<tr>
<td>Q4</td>
<td>530.98</td>
<td>537.22</td>
<td>549.00</td>
<td>525.07</td>
</tr>
<tr>
<td>Total</td>
<td>1,886.01</td>
<td>1,855.74</td>
<td>1,826.83</td>
<td>1,951.26</td>
</tr>
</tbody>
</table>

b. Pork Supply

The supply model for pork is a function of the wholesale price of pork, autoregression of order two, and moving average of order one. Below is the estimated regression equation:

\[ P_{\text{Supply}} = 216.80 + 0.88WPork_{-4} + 53.44Q4_t + \hat{\varepsilon}_t \]

\( p-value \) (0.00) (0.00) (0.00)

Where:

\[ \hat{\varepsilon}_t = 0.97\hat{\varepsilon}_{t-1} + 0.83\hat{\varepsilon}_{t-2} \]

(0.00) (0.00)

About 97.15 percent of the total variation in quantity supplied is explained by wholesale price of pork, the 4th quarter, AR and MA process. On the average, the forecasted quantity supplied is 3.11 percent off from the actual value.

Figure 7 - Forecast vs. Actual Pork Supply, 1998-2009

Figure 7 shows the actual supply of pork against its forecast. Figure 8 indicates the result of the pork supply model including three forecasts scenarios, the upper, mean and lower boundaries.
Table 3 - Quarterly Pork Supply, 2007-2009F (in ‘000 metric tons)

<table>
<thead>
<tr>
<th>Period</th>
<th>2007</th>
<th>2008</th>
<th>2009 F</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Mean</td>
<td>Max</td>
<td>08/07 Min</td>
</tr>
<tr>
<td></td>
<td>325.51</td>
<td>314.72</td>
<td>320.67</td>
<td>396.05</td>
</tr>
<tr>
<td>Q1</td>
<td>320.88</td>
<td>318.89</td>
<td>322.97</td>
<td>338.41</td>
</tr>
<tr>
<td>Q2</td>
<td>312.33</td>
<td>322.49</td>
<td>317.34</td>
<td>331.58</td>
</tr>
<tr>
<td>Q3</td>
<td>374.93</td>
<td>379.81</td>
<td>360.08</td>
<td>375.55</td>
</tr>
<tr>
<td>Q4</td>
<td>325.51</td>
<td>314.72</td>
<td>320.67</td>
<td>396.05</td>
</tr>
<tr>
<td>Q1</td>
<td>320.88</td>
<td>318.89</td>
<td>322.97</td>
<td>338.41</td>
</tr>
<tr>
<td>Q2</td>
<td>312.33</td>
<td>322.49</td>
<td>317.34</td>
<td>331.58</td>
</tr>
<tr>
<td>Q3</td>
<td>374.93</td>
<td>379.81</td>
<td>360.08</td>
<td>375.55</td>
</tr>
</tbody>
</table>

Table 3 shows expected growth based on the model forecasts from 2008 to 2009.

c. Pork Demand

The demand for pork is a function of per capita GNP at constant prices, employed women in the labor force, retail price of dressed chicken, the 4th quarter and moving average of order one. Estimated regression equation is indicated below:

\[
P_{Demand_t} = 35.96 + 40.59PGNPK_{t,2} + 5.27L^2ForceEm_{t,5} + 0.56R^2Chk_{t,4} + 21.54Q4_t + \hat{\epsilon}_t
\]

\(p\)-value (0.70) (0.00) (0.00) (0.00) (0.00)

Where:

\[\hat{\epsilon}_t = 0.80a_{t-1}\]

(0.00)

The computed p-value of the F-statistics suggests that the forecasting model for demand is statistically valid. The estimated \(R^2\) explains 96.53 percent of the total variations in quantity demanded. From the actual demand, the model’s forecast is off by 2.72 percent on the average.
Figure 9 shows how the point forecast compares with actual data. Figure 10 shows the three forecasts scenarios of demand for pork from Q1 1998 to Q1 2009.

Figure 11 – Quarterly Pork Demand with all Forecasts, 1998-2009F
The graphical illustration (Figure 11) showed the demand (blue line) from 1998 to 2008 linking the average forecast for 2009 represented by the green line. Also shown were the upper and lower forecast bounds for demand which are the violet and red lines.

Table 4 - Quarterly Pork Demand, 2007-2009F (in '000 metric tons)

<table>
<thead>
<tr>
<th>Period</th>
<th>2007</th>
<th>2008</th>
<th>2009 F</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td></td>
<td></td>
<td></td>
<td>08/07</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td>09F/08</td>
</tr>
<tr>
<td>Max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>307.27</td>
<td>312.11</td>
<td>303.66</td>
<td>323.99</td>
</tr>
<tr>
<td>Q2</td>
<td>325.72</td>
<td>321.38</td>
<td>330.78</td>
<td>351.52</td>
</tr>
<tr>
<td>Sem2</td>
<td>632.99</td>
<td>633.49</td>
<td>634.44</td>
<td>675.51</td>
</tr>
<tr>
<td>Q3</td>
<td>328.14</td>
<td>333.57</td>
<td>325.43</td>
<td>346.74</td>
</tr>
<tr>
<td>Q4</td>
<td>372.51</td>
<td>368.85</td>
<td>372.47</td>
<td>393.02</td>
</tr>
<tr>
<td>Sem2</td>
<td>700.65</td>
<td>702.42</td>
<td>697.91</td>
<td>739.76</td>
</tr>
<tr>
<td>Total</td>
<td>1,333.64</td>
<td>1,335.91</td>
<td>1,332.34</td>
<td>1,415.27</td>
</tr>
</tbody>
</table>

F - Forecast

Table 4 summarizes the actual data on demand and forecasts derived out of the demand model for pork. Current period, the output of the model derives one quarter forecast.

Figure 12 - Quarterly Pork Supply vis-a-vis Demand: 2007-2009F ('000 metric tons)

Table 5 - Pork Supply and Demand, 2008-2009F ('000 metric tons)

<table>
<thead>
<tr>
<th>Yr/Qtr</th>
<th>Min_D</th>
<th>Mean_D*</th>
<th>Max_D</th>
<th>Min_S</th>
<th>Mean_S</th>
<th>Max_S</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>312.11</td>
<td>321.38</td>
<td>333.57</td>
<td>368.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2</td>
<td>330.78</td>
<td>351.52</td>
<td>372.27</td>
<td>393.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1F</td>
<td>303.66</td>
<td>323.99</td>
<td>344.32</td>
<td>360.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2F</td>
<td>330.78</td>
<td>351.52</td>
<td>372.27</td>
<td>393.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3F</td>
<td>325.43</td>
<td>346.74</td>
<td>368.05</td>
<td>380.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q4F</td>
<td>372.47</td>
<td>393.02</td>
<td>413.56</td>
<td>375.55</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Page 9 of 20
4. Issues and Limitations/Further Enhancement

Only the wholesale price of pork was used for building the model for supply. It could further be enhanced if the frozen inventory will be included as a regressor. However, the data for the frozen inventory for pork was only initialized in 2007, and would still need a few years before it can be included in the model. Another enhancement, would be to determine the lag time before the effect of corn price representing the price of inputs, could affect the supply.

The demand model could be enhanced if it can determine which of the past values of the pork retail price could be included in the model. The baseline data of demand could also be improved if the estimates can be based on actual data, like beginning inventory minus the ending inventory, than on FIES which is based on the perception of the family's expenditure for pork.

All the models will be maintained, and only be re-estimated after a year.

<table>
<thead>
<tr>
<th></th>
<th>Surplus/Deficit (Min Supply)</th>
<th>Surplus/Deficit (Mean Supply)</th>
<th>Surplus/Deficit (Max Supply)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min_D</td>
<td>Mean_D</td>
<td>Max_D</td>
</tr>
<tr>
<td></td>
<td>17.01</td>
<td>(3.32)</td>
<td>(23.65)</td>
</tr>
<tr>
<td></td>
<td>(7.81)</td>
<td>(28.55)</td>
<td>(49.29)</td>
</tr>
<tr>
<td></td>
<td>(8.10)</td>
<td>(29.41)</td>
<td>(50.71)</td>
</tr>
<tr>
<td></td>
<td>(12.39)</td>
<td>(32.93)</td>
<td>(53.47)</td>
</tr>
</tbody>
</table>
1. MODEL FRAMEWORK

The framework illustrates the associations of variables from the production to consumption. The volume of imported grandparent stocks (GPS) and parent stocks (PS) as inputs affect the level of broiler production. The idea was based on the life cycle model developed during the Phase I of the project. The volume of production, costs of production such as price of corn and soybean meal, and the previous period's price of chicken in the dressing plant affect the current price offered by the suppliers (based on economic principle that price must be equal to marginal cost to maximize profit). The xplant price explained the level of supply. The higher the xplant price the more quantity of broiler meat would be supplied in the market, and vice-versa (law of supply). Retail price of broiler meat reacts as xplant price changes. The reaction is called the vertical price transmission. As xplant price changes, retail price of broiler meat also changes and so with quantity demanded. Consumers are willing to buy more when the retail price is low and buy less when the retail price is high (law of demand). Estimated volume of supply and demand determines the possible surplus or deficit in the market.

2. MODEL ENHANCEMENTS

The forecasting models were developed using regression analysis following a holistic approach that describes the market for broiler. Aside from the economic theories and principles as bases for constructing the models, diagnostic tests required by the regression analysis were also satisfied such as (i) Normal distribution of the error terms, (ii) No multicollinearity,(iii) No first and higher order serial autocorrelation, and (iv) No heteroskedasticity.

Model 1. Production forecasting model

\[
BProd_t = f(GPS, PS) = \beta_0 + \beta_1 GPS_{t-5} + \beta_2 PS_{t-3} + \epsilon_t
\]

where:

- \(BProd_t\) - Volume of broiler production (in birds)
- \(GPS_{t-5}\) - Volume of imported day-old chicks of grandparent stocks five quarters ago
- \(PS_{t-3}\) - Volume of imported day-old chicks of parent stocks three quarters ago
- \(\beta, \phi, \theta\) - parameters in the equation
- \(a_t\) - ~ NID \((0, \sigma^2)\)
Model 2. Supply forecasting model

\[ \text{BSupply} = f (\text{XPchk}) \]

\[ \text{BSupply}_t = \beta_1 \text{XPchk}_{t-1} + \beta_2 \text{XPchk}_{t-2} + \varepsilon_t \]

where:

- \( \text{BSupply}_t \) - Volume of broiler meat supply (in metric tons)
- \( \text{XPchk}_{t-1,2} \) - Price of chicken meat in the dressing plant one and two quarters ago (Peso per kilogram)
- \( \beta_1, \beta_2, \theta \) - parameters in the equation
- \( a_t \sim \text{NID} (0, \sigma^2) \)

Model 3. Price transmission model

\[ \text{RPchk} = f (\text{XPchk}) \]

\[ \text{RPchk}_t = \beta_0 + \beta_1 \text{XPchk}_{t-1} + \varepsilon_t \]

where:

- \( \text{RPchk}_t \) - Retail price of chicken
- \( \text{XP}_{t-1} \) - Price of chicken meat in the dressing plant one quarter ago (P/kg)
- \( \beta, \phi, \theta \) - parameters in the equation
- \( a_t \sim \text{NID} (0, \sigma^2) \)

Model 4. Demand forecasting model

\[ \text{BDemand} = f (\text{PCE}, \text{RPchk}) \]

\[ \text{BDemand}_t = \beta_0 + \beta_1 \text{PCE}_t + \beta_2 \text{RPchk}_t + \varepsilon_t \]

where:

- \( \text{BDemand}_t \) - Volume of broiler meat demand for quarter \( t \) (in metric tons)
- \( \text{PCE}_t \) - Personal consumption expenditures (in million pesos)
- \( \text{RPchk}_t \) - Retail price of chicken
- \( \beta, \phi, \theta \) - parameters in the equation
- \( a_t \sim \text{NID} (0, \sigma^2) \)

3. FORECASTING RESULTS AND ANALYSIS

a. Broiler Production Model

The production model for broiler (BProd) is a function of grandparent stock (GPS) and parent stock breeders (PS), autoregressive process of order four, and moving average of order one. Below is the estimated regression equation:

\[ B\hat{Pr}od_{it} = 119,000,000 + 123.7818 G\hat{P}S_{it-5} + 16.3013 P\hat{S}_{it-3} + \hat{\varepsilon}_t \]

\( p-value \) (0.00) (0.03) (0.04)

Where:

\[ \hat{\varepsilon}_t = 0.47 \hat{\varepsilon}_{t-3} + 0.41 \hat{\varepsilon}_{t-4} + 0.51 \hat{a}_{t-1} \]

(0.00) (0.00) (0.00)

The forecasting model for production is statistically significant as shown by the computed p-value of the F-statistics, 0.0000. The coefficient of determination \((R^2)\) suggests that
volume of imported grandparent stocks, volume of imported parent stocks with AR and MA processes already explained 85.94 percent of the total variation in broiler production.

The coefficients are all statistically different from zero. Estimated production would increase by 123 birds for every day-old grandparent stock imported five (5) quarters ago, other factors constant. Imported day-old parent stock in the past three (3) quarters would increase the broiler production by 16 birds, other things being the same. Estimated residuals for the past 3 quarters and 1 year ago (represented by the AR terms) and random shock of the past 1 quarter affect the current broiler production.

On the average, the model’s forecast is off by 4.52 percent of the actual production.

Figure 13 - Actual vs. Forecast Broiler Production, 1998-2009

Figure 13 shows the forecast against actual broiler production. The solid line represents the actual broiler production from first quarter of 1998 to fourth quarter of 2008. The dotted lines indicates the upper point, and low production forecasts. Figure 14 shows the low point, and high production forecasts generated by the model.

The production model generates one-year forecast. Table 7 summarizes the actual quarterly data from 2007 to 2008 and the four-quarter forecasts for 2009. The point forecasts (mean) for the first-three quarters of 2009 indicate a positive growth compared to the same periods in 2008, while the forecast for the 2009 fourth quarter shows negative growth. Using the upper forecasts, the growth rates are positive for all quarters of 2009.
Table 7 - Quarterly Broiler Production, 2006-2009F
(in ‘000 million heads)

<table>
<thead>
<tr>
<th>Period</th>
<th>2007</th>
<th>2008</th>
<th>2009 F</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Mean</td>
<td>Max</td>
<td>08/07</td>
</tr>
<tr>
<td></td>
<td>Min</td>
<td>Mean</td>
<td>Max</td>
<td>09F/08</td>
</tr>
<tr>
<td>Q1</td>
<td>115.38</td>
<td>126.30</td>
<td>118.65</td>
<td>132.12</td>
</tr>
<tr>
<td>Q2</td>
<td>110.37</td>
<td>120.68</td>
<td>113.52</td>
<td>126.06</td>
</tr>
<tr>
<td>Semi1</td>
<td>225.75</td>
<td>246.98</td>
<td>232.17</td>
<td>258.18</td>
</tr>
<tr>
<td>Q3</td>
<td>115.01</td>
<td>123.87</td>
<td>122.31</td>
<td>135.03</td>
</tr>
<tr>
<td>Q4</td>
<td>122.16</td>
<td>145.59</td>
<td>125.18</td>
<td>138.40</td>
</tr>
<tr>
<td>Semi2</td>
<td>237.17</td>
<td>269.46</td>
<td>247.49</td>
<td>273.48</td>
</tr>
<tr>
<td>Total</td>
<td>462.92</td>
<td>516.44</td>
<td>479.66</td>
<td>531.61</td>
</tr>
</tbody>
</table>

b. Broiler Supply

The supply model for broiler (BSupply) is a function of the price of dressed chicken in the dressing plant (XPchk) and moving average of order four. Below is the estimated regression equation:

\[
\hat{BSupply}_t = 1065.5210 XPchk_{t-1} + 676.0395 XPchk_{t-2} + \hat{\varepsilon}_t
\]

\[p - value \quad (0.00)\]

\[\hat{\varepsilon}_t = 0.85\hat{a}_{t-1} + 0.78\hat{a}_{t-2} + 0.31\hat{a}_{t-4}
\]

About 78.40 percent of the total variation in quantity supplied is explained by the price of dressed chicken in the dressing plant and MA process. The estimated price coefficient of dressed chicken in the dressing plant is statistically significant. Quantity supplied would increase by 1,065.51 and 676.03 metric tons for every peso increase in the price of dressed chicken in the dressing plant one and two quarters ago, respectively. The moving average of order four also affects the current broiler supply holding MA3 equal to zero. On the average, the forecasted quantity supplied is 5.51 percent off from the actual value.

Figure 15 - Actual vs. Forecast for Broiler Meat Supply, 1998-2009
Figure 15 shows the actual supply of broiler meat against the forecast. Figure 16 indicates the result of the broiler supply model including three forecasts scenarios, the upper forecast, point forecast, and lower forecast.

**Figure 16 - Broiler Meat Supply Forecast with Upper and Lower Bounds**

In Figure 17, the point forecast (bsupply_mean) for 2009 is connected to the actual supply of broiler meat. The dotted lines represent the forecast values with the upper and lower limits, while the solid line is the actual supply volumes from 1998 - 2008. The model generated four quarter forecasts for 2009 as reflected in Table 8. Most likely forecast for 2009 is expected to yield 1.71 percent increment compared to year 2008. From 1st to 3rd quarter, the forecasts generated positive growth rates. However, the fourth quarter produced 9.53 percent negative growth rate compared to the same period in 2008. There will be adequate broiler meat if upper forecast will be realized for all the quarters of 2009.

**Figure 17 - Quarterly Broiler Meat Supply, 1998-2009**

**Table 8 - Quarterly Broiler Supply, 2007-2009F**

<table>
<thead>
<tr>
<th>Period</th>
<th>2007</th>
<th>2008</th>
<th>2009 F</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Mean</td>
<td>Max</td>
<td>2008/07 Min</td>
</tr>
<tr>
<td>Q1</td>
<td>146.22</td>
<td>161.92</td>
<td>158.68</td>
<td>180.72</td>
</tr>
<tr>
<td>Q2</td>
<td>139.01</td>
<td>152.33</td>
<td>161.85</td>
<td>182.68</td>
</tr>
<tr>
<td>Q3</td>
<td>132.87</td>
<td>150.63</td>
<td>148.22</td>
<td>169.06</td>
</tr>
<tr>
<td>Q4</td>
<td>161.13</td>
<td>193.40</td>
<td>153.75</td>
<td>174.97</td>
</tr>
</tbody>
</table>
c. **Broiler Demand**

The demand for broiler (BDemand) is explained by personal consumption expenditure (PCE), retail prices (RPchk) of broiler meat, autoregressive process of order five, and moving average of order four. Below is the estimated regression equation:

\[
\hat{\text{BDemand}}_t = 98,692.50 + 7.92PCE_t + 520.02RPchk_t + \hat{\epsilon}_t
\]

\[
p-value \quad (0.00) \quad (0.00) \quad (0.04)
\]

Where:

\[
\hat{\epsilon}_t = 0.36\hat{\epsilon}_{t-5} + 0.71\hat{\epsilon}_{t-1} + 0.46\hat{\epsilon}_{t-4}
\]

\[
(0.00) \quad (0.00) \quad (0.00)
\]

The computed p-value of the F-statistics suggests that the forecasting model for demand is statistically valid. The estimated \(R^2\) suggests that personal consumption expenditures, retail price of chicken, autoregressive process of order five and moving average of order four holding MA2 and MA3 equal to zero explained about 87.21 percent of the total variations in quantity demanded. A peso increase in the retail price would decrease quantity demanded for broiler meat by 520.02 metric tons, other factors constant. There will also be an increase of 7.92 metric tons in the broiler meat demand for every one million peso increase in personal consumption expenditures, other things being equal. Past values similarly affects the quantity demanded for broiler meat as represented by the AR and MA processes. From the actual demand, the average forecast is off by 4.36 percent.

**Figure 21 - Actual Broiler Meat Demand vs. Forecast**

![Figure 21 - Actual Broiler Meat Demand vs. Forecast](image)

Figure 21 shows the pooled forecast (mean) against the actual demand for broiler meat.
Figure 22 shows the three forecasts scenarios of demand for broiler meat from Q1 1998 to Q1 2009.

The graphical illustration (Figure 23) shows the actual broiler meat demand (solid line) from 1998 to 2008 connecting the most likely forecast (bdemand_mean) for 2009. Also shown are the upper and lower forecasts (bdemand_min and bdemand_max) represented by the dotted lines.

Table 10 summarized the actual and forecasted data on demand. The model yielded one quarter forecast. The demand for broiler meat can provide four quarter forecasts using retail prices from the result of the price transmission model. Results shows that demand for first quarter of 2009 is higher than 2008 looking at the minimum, mean and maximum forecasts scenarios.
d. Model Application

Using the estimated parameters of the supply and demand forecasting models, the supply and demand curves (Figure 24) are plotted in x and y axes.

Figure 24 - Broiler Supply and Demand, by quarter, Philippines, 2005-2009F
(in metric tons)
It is important to have an idea of what would be the xplant price one or more quarters ahead. The future values of xplant price can be estimated using the broiler supply forecasting model. Given the priori information on xplant price, the quantity supply can be estimated using the price transmission model. Using the demand forecasting model and price transmission, the retail price can be estimated. Quantity demand can be estimated given the estimated retail price. Finally, possible surplus or deficit can be determined by comparing the estimated quantity supply and demand.

The information would benefit not only the government, but also the industry players. Depending on the degree of the problem, the government can draw different policy options either by initiating interventions or let the market cure itself. On the other hand, private agribusiness players can go back to review their plans. Given the forecasted deficit in the market for the next quarter, the rationale suppliers would increase their selling price to maximize their profits. Others can react to the market by increasing the production or they can set different marketing options to address the problem.

4. ISSUES AND LIMITATIONS

One of the explanatory variables used in the regression model for broiler demand is the quarterly data series of Personal Consumption Expenditure (PCE) sourced from NSCB. In the absence of quarterly data on disposable income, PCE data was basically considered to capture the Filipino Consumers spending capacity for food, and chicken as indispensable in the household food supply. Specifically food expenditure is one of the biggest share PCE components.

There were limited explanatory variables considered in the broiler models for production, supply, price transmission and demand using the regression analysis due to the unavailability of data which were assumed to have an effect on the variables for each of the model.
IV. PRESENTATION OF THE SITUATION AND OUTLOOK REPORTS

The Situation and Outlook Reports have the following release dates February 15, May 15, July 15 and September 15 or nearest working date after. It was regularly presented to the Task Force on Price and Volume Watch of the Bureau of Animal Industry (BAI) to be validated and commented by stakeholders including DA officials and private agribusiness sector. In this meeting, decisions on importations are discussed and the S&O Reports were one of the major inputs in these decisions. Below are the sample front pages of the reports.

V. FUTURE DIRECTIONS FOR THE BROILER AND SWINE SYSTEM

The Broiler and Swine Information and Early Warning System are currently being enhanced by re-evaluating the models earlier presented. These are also being replicated in the regions by initially establishing the regional databases. Link up with BAI regarding Global Positioning System (GPS) capability for quicker access to data and identify choke points affecting the livestock and poultry sub-sectors are also being done.