Determining the Market Potential of Livestock and Poultry in the Philippines: An Application of the Almost Ideal Demand System

Apolinares, R.J.V., Digal, L.N., and J.M.P. Sarmiento

ABSTRACT

Estimating demand especially on agricultural commodities has been an interest for many economists to help draw appropriate policies. This study was conducted to determine the demand of pork, beef, and chicken in the Philippines using provincial cross-section data across three time-periods 1995, 2000, and 2009 using the Almost Ideal Demand System. This study aimed to provide a comprehensive analysis on the responsiveness of the consumers to change in prices, price of substitutes and the income level. Moreover, the study also determines the market potential of the meat commodities. AIDS was employed using the Restricted Ordinary Least Squares (ROLS) and Restricted Seemingly Unrelated Regression (RSUR) system methods observing the theoretical restrictions of adding-up, homogeneity and Slutsky symmetry with the aid of GRETL software. Contemporaneous correlation of the error terms was present, thus, RSUR was preferred over ROLS. It was found out that pork is a necessity good with market potential higher compared to chicken and beef but decreases over time. Chicken, on the other hand, has grown to become a necessity good next to Pork with growing market potential. Lastly, beef with its high retail prices, are perceived by Filipinos as a luxury commodity with decreasing market potential.

Keywords: Demand Estimation, Price Elasticity, Expenditure Elasticity, Restricted Ordinary Least Squares, Restricted Seemingly Unrelated Regression
INTRODUCTION

Generally, livestock are important to humans because of its uses. It serves as a food source, may vary from raw to processed meat, which provides protein for the body and helps refurnish damage muscle tissues. Moreover, poultry products are very important to human’s dietary requirement since it contains unsaturated fats that helps lower cholesterol in the body and a wide range of body building nutrients such as protein, calcium, vitamins E and A, and folate. Currently, the Philippines is importing these commodities to supply and sustain the level of demand of the Filipino people. Statistics shows that Philippine trend in importing beef, carabeef and pork has been increasing over time (BAS, 2010).

![Figure 1. Supply Imports of Beef, Carabeef, and Pork in the Philippines (1980-2009), in metric tons.](image)

Thus, it is important to determine how different factors affect the livestock and poultry in the Philippines. The study explored the following questions: (1) How responsive are the Filipino consumers on the changes of the prices of meat commodities and their substitutes? (2) How responsive are the Filipinos in their meat consumption to changes in their income level? (3) What meat commodity exhibits high level of market potential? (4) What meat commodity shows a growing or decreasing trend of market potential?

The study made use of secondary data provided by the Bureau of Agricultural Statistics. Data used where per capita consumption in kilogram and retail prices of meat commodities across provinces in the periods of 1995, 2000, and 2009.
REVIEW OF LITERATURE

There are two basic approaches in estimating demand systems: (1) the use of utility functions that satisfy specific postulates of choices and (2) the use of arbitrary demand systems. Stone's (1954) model of Linear Expenditure System has been the pioneer literature of this study but has its limitations such as proportionality of income and price elasticity, and ruling out of complementary relationship among goods or the disability to create cross-price elasticity. This led the way to the creation of more flexible models such as the Rotterdam model of Theil (1965) and Translog model of Christensen et al. (1975).

More recently, Deaton and Muellbauer (1980) proposed, a more flexible demand system - the Almost Ideal Demand System (AIDS). The model combines the best theoretical features of both Rotterdam and the Translog Model (Ingco, 1991). It makes use of a system approach wherein the demand is restricted with impositions of different axioms and laws in order to conform to the consumer theory. The model also gives the most robust estimates among demand models.

AIDS has also been developed to enhance the model's dynamism in explaining empirical results according to the consumer theory. Several AIDS extensions have been developed, to name few; the inverse AIDS of Moschini and Vissa (1992) and the quadratic AIDS by Banks et al (1997).

Some studies of AIDS involve assessing tourism demand (Durbarry, 2002), and energy sources (Labandeira et al. 2005) among others. In the Philippines, AIDS was used in assessing the demand of agricultural commodities (Mutuc et al. 2006) and determining market power (Digal, 2009). A similar study was conducted by Dumanig (2009) reporting broiler chicken as responsive to own price while beef and pork being price inelastic. Furthermore, pork and broiler chicken were normal goods while beef was an inferior item.

A dynamic modelling approach in studying demand in the Philippines mainly on livestock and poultry is relatively new. Moreover, many of the demand studies use time series data on the national level and very few uses a lesser aggregated data such as within the provincial level. Thus, this study is an addition to the few existing
AIDS literature in the country which may be of interest to researchers and policy makers.
MATERIALS AND METHODS

AIDS shows a dynamic and more reliable estimate in demand modelling because it conforms to the economic theory of demand. Using the specification of the linear AIDS, demand represented by the budget share \( w \) of good \( i \) is affected by its price, price of the other substitutes, and the income level of the consumer. It is defined as follows:

\[
    w_i = a_i + \sum_{i}^{n} \gamma_{ij} \ln p_j + \beta_i \ln \left( \frac{X_i}{P_i} \right) + \mu_i
\]  

(1)

where \( w_i \) - is the share associated with the \( i^{th} \) good

\( \alpha_i, \beta_i \) - are the parameters to be estimated

\( \gamma_{ij} \) - is the slope coefficient parameter associated with the \( j^{th} \) good in the \( i^{th} \) share equation

\( p_j \) - is the price on the \( j^{th} \) good

\( X_i \) - is the total expenditure on the system of good given by

\[
    X = \sum_{i=1}^{n} p_i q_i
\]

(2)

where \( q_i \) is the quantity demanded of the \( i^{th} \) good

\( P_i \) - is the price index defined as

\[
    \ln P = \alpha_o + \sum_{i=1}^{n} \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j
\]

(3)

However, this price index makes the AIDS non-linear in parameters in which in some accounts makes it very difficult to use in generating estimates. To make it
linear, the original price index is substituted using Stone’s geometric price index defined as

\[
\ln P = \sum_{i=1}^{n} w_i \ln p_i
\]  

Any demand system as stated by Blanciforti, Green, and King (1986) should satisfy the following conditions to conform to the consumer theory:

- **Adding-up, Engel Curve Aggregation**

\[
\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \gamma_{ij} = 0
\]

- **Homogeneity**

\[
\sum_{j=1}^{n} \gamma_{ij} = 0
\]

- **Slutsky’s Symmetry Condition**

\[
\gamma_{ij} = \gamma_{ji}
\]

Expenditure Elasticity is expressed in (8) while elasticity formulas are presented in Table 1.

\[
\eta_p = 1 + \frac{\beta_p}{w_p}
\]

Table 1. Marshallian and Hicksian elasticity formulas.
An AIDS model was estimated using two system methods - OLS and SUR using the GRETL software. Linear restrictions were imposed and contemporaneous correlation of the error terms was tested.

<table>
<thead>
<tr>
<th>Price Elasticity</th>
<th>Marshallian</th>
<th>Hicksian</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Own-Price</strong></td>
<td>$\varepsilon_p = -1 + \left( \frac{\gamma_p}{w_p} \right) - \beta_p$</td>
<td>$e_p = -1 + w_p + \frac{\gamma_p}{w_p}$</td>
</tr>
<tr>
<td></td>
<td>$\varepsilon_{R(z)} = \left( \frac{\gamma_{R(z)}}{w_p} \right) - \beta_p \frac{w_R}{w_p}$</td>
<td>$\varepsilon_{R(z)} = \left( \frac{\gamma_{R(z)}}{w_p} \right) - \beta_p \frac{w_R}{w_p}$</td>
</tr>
<tr>
<td><strong>Cross-Price</strong></td>
<td>$\varepsilon_{R(z)} = \left( \frac{\gamma_{R(z)}}{w_p} \right) - \beta_p \frac{w_R}{w_p}$</td>
<td>$e_{R(z)} = \varepsilon_{R(z)} + \eta_p \cdot w_C$</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSIONS

Meat has become an important ingredient in Filipino dishes especially pork, beef, and chicken. For more than a decade, Filipino consumption on these meat products have grown and become variable. Pork, beef and chicken are the major meat consumed in the country compared to the other livestock and poultry that comprises less than a percent of the Filipino budget share. To have a better picture on the movement of prices and consumption of the meat commodities, Table 2 shows their average growth rate across three time-periods.

Table 2. Average Growth rate of Consumption and Retail Prices of Meat Commodities.

<table>
<thead>
<tr>
<th>Period</th>
<th>PORK (%)</th>
<th>BEEF (%)</th>
<th>CHICKEN (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consumption</td>
<td>prices</td>
<td>Consumption</td>
</tr>
<tr>
<td>1995-2000</td>
<td>2%</td>
<td>6%</td>
<td>21%</td>
</tr>
<tr>
<td>2000-2009</td>
<td>8%</td>
<td>3%</td>
<td>-41%</td>
</tr>
<tr>
<td>1995-2009</td>
<td>10%</td>
<td>10%</td>
<td>-29%</td>
</tr>
</tbody>
</table>

From 1995 to 2000, beef showed the highest rate of growth in consumption with 21%. This is justified with the reduced retail price in the same year interval of 5%. This behaviour supports the fact that beef is very responsive in the changes of its prices. From 2000-2009, chicken has a noticeable growth in consumption. The very significant growth in the consumption of chicken can be explained by the absence of growth in its price. However, pork, even in the increase of its prices, is observed to have an increase in consumption. Moreover, with the increase in the price of beef by 9%, its consumption has decreased to 41%, an evidence of price responsiveness. Lastly, accounting all the years considered in this study from 1995-2009, chicken have shown a high rate of growth in consumption among the commodities. Over time, chicken has decreased in retail prices, which can be the reason of its high growth in consumption. On the other hand, pork having the highest retail price increase with 10% still shows a growth in consumption of 10%, an indication that pork has grown to be a necessity good to Filipino consumers. Beef, with 4% increase in retail prices, responded with a reduction in consumption by 29%.
A model of AIDS under ROLS was generated using the GRETL software and contemporaneous correlation of error terms was checked. Zellner (1962) suggested that in analyzing cross-section data, SUR estimation is an alternative tool for efficient analysis because it captures the correlation in the error of cross-section units. With Decision Rule: Reject Ho if P-value is less than alpha 0.05 assuming Ho: without contemporaneous error while Ha: with contemporaneous error, results are shown in Table 3. It is shown that all the periods have p-values less than the alpha, which means that the errors generated in the OLS are correlated and that the modelling is better be handled using the system method of Seemingly Unrelated regression (SUR).

Table 3. Test for Contemporaneous Correlation of Errors

<table>
<thead>
<tr>
<th>Period</th>
<th>Chi Squared</th>
<th>P-value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>48.3676</td>
<td>0.0000</td>
<td>Errors are all</td>
</tr>
<tr>
<td>2000</td>
<td>53.6145</td>
<td>0.0000</td>
<td>contemporaneously</td>
</tr>
<tr>
<td>2009</td>
<td>51.0306</td>
<td>0.0000</td>
<td>correlated</td>
</tr>
</tbody>
</table>

Table 4 shows the values of the parameters in the generation of the model of the three periods: 1995, 2000, and 2009 under RSUR system method. These models were generated using GRETL and restrictions were imposed to follow the demand theory. As presented in Table 4 below, the coefficients are all statistically significant at 0.01 level of significance.

Table 4. Restricted SUR Estimates of the Parameters of the Three Time Periods.

<table>
<thead>
<tr>
<th>Meat Commodity</th>
<th>PORK</th>
<th>BEEF</th>
<th>CHICKEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant Term</td>
<td>-0.95***</td>
<td>-0.47***</td>
<td>2.42</td>
</tr>
<tr>
<td>Pork Price</td>
<td>-0.19 NA</td>
<td>-0.18 NA</td>
<td>0.37 NA</td>
</tr>
<tr>
<td>Beef Price</td>
<td>-0.18 NA</td>
<td>0.06***</td>
<td>0.12***</td>
</tr>
<tr>
<td>Chicken Price</td>
<td>0.37 NA</td>
<td>0.12***</td>
<td>-0.49 NA</td>
</tr>
<tr>
<td>Expenditure System Parameter</td>
<td>0.13***</td>
<td>0.39***</td>
<td>-0.52***</td>
</tr>
</tbody>
</table>

| 2000           |          |          |           |
| Constant Term  | 0.59 NA  | -0.16 NA | 0.57***   |
| Pork Price     | -0.14*** | 0.01***  | 0.13***   |
The parameters, all being statistically significant, were used to calculate the
Marshallian (compensated) and Hicksian (uncompensated) own-price, and cross-
price elasticity of the three meat groups as well as the income elasticity. The values
of the elasticity are shown in Table 5. Hicksian elasticity, also called “pure” elasticity
was preferred since it is devoid of income effect and considers only the change in
prices. Generally, all the meat groups have negative sign in own price elasticity,
implying, that the demand of the meat commodities decreases as their price
increases. The calculation of own price elasticity can also determine whether the
meat commodities are inferior, necessity, or luxury good.

Table 5. Own Price and Expenditure elasticity of the Meat Commodities.

<table>
<thead>
<tr>
<th>Meat Type</th>
<th>Time Period</th>
<th>Own Price Marshallian</th>
<th>Own Price Hicksian</th>
<th>Interpretation</th>
<th>Exp. Elasticity</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pork</td>
<td>1995</td>
<td>-1.51</td>
<td>-0.87</td>
<td>Growing inelasticity; necessity good</td>
<td>1.25</td>
<td>High market potential but decreasing</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>-1.33</td>
<td>-0.73</td>
<td></td>
<td>1.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>-0.61</td>
<td>-0.05</td>
<td></td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Beef</td>
<td>1995</td>
<td>-0.98</td>
<td>-2.05</td>
<td>Growing elasticity; luxury good</td>
<td>3.64</td>
<td>Decreasing market potential</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>-0.86</td>
<td>-0.78</td>
<td></td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>-0.52</td>
<td>-2.98</td>
<td></td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Chicken</td>
<td>1995</td>
<td>-1.91</td>
<td>0.43</td>
<td>Inelastic but approaching elasticity; necessity but next to pork</td>
<td>-0.52</td>
<td>Increasing market potential</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>-1.16</td>
<td>-0.27</td>
<td></td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td>-1.45</td>
<td>-0.67</td>
<td></td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>
It can be observed that pork has increasing movement in elasticity drawing closer to zero, hence, is approaching perfect inelasticity. Inelastic commodities are less responsive to changes in prices. Despite its increasing retail prices, the sensitivity of consumers to its changes in prices becomes lesser over time. Apparently, this shows that pork has become a necessity good, or it has grown important to Filipinos. This can be attributed to the constant increase in the supply of pork in the market that adds up to the security and availability of its supply.

Beef, on the other hand, has growing elasticity. This implies that consumers are responsive to increase in prices. It is more of a luxury good. This can be attributed to its high price and limited domestic supply compared to the other two commodities.

Lastly, it can be observed that chicken’s responsiveness to changes in price has increased from 2000 to 2009. Chicken has inelastic nature but approaching elasticity. It is still considered a necessity good next to pork. In the production, chicken is next to pork in the most produced meat commodity. The reason for this is probably the preferences of the market. Filipinos have been more into pork than that of the chicken. The increasing and flourishing industry of the fast-food chains in which they mostly serve chicken recipes decreases the availability of chicken in the wet market. Another reason for the lesser availability of chicken in the market is that chicken is less viable and profitable if produced in small numbers as backyard farming relative to pork. In the Philippines, few large producers dominate the chicken industry particularly broiler production.

Expenditure elasticity measures the responsiveness of demand to changes in income of the population. Expenditure elasticity is expected to have a positive sign because as income increases, the propensity of a consumer to buy more of the good increases. Results, on the same table, shows that the expenditure elasticity are generally positive. Expenditure elasticity can also be use as a measure for market potential. Furthermore, the income level of the population is expected to increase over time; hence, very income elastic meat commodities are more likely to have higher market potential. The increase in income level would result to the increase in the quantity demanded of the good.
Results have shown that, historically, pork has the largest market potential but diminishes over time while chicken has increasing market potential. Beef has the least market potential at present. It is important to note that, chicken is the only meat commodity that has increasing market potential, and both pork and beef has decreasing market potential. This could be primarily due to the flourishing industry of fast-food chains in the metropolitan and urban centers.

**SUMMARY AND CONCLUSION**

Livestock and poultry are important food commodities in the Philippines. Estimating their demand has long been an interest of economists. In this study, the demand of the primary meat commodities pork, beef and chicken has been estimated using the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980), an approach, which is relatively more dynamic in estimating demand. The data used in the study were the per capita consumption and retail prices 52 provinces across three time-periods provided by BAS. The periods include 1995, 2000, 2009.

Two system methods of simultaneous equations were used to identify the best model for livestock and poultry, Restricted Ordinary Least Squares (ROLS) and Restricted Seemingly Unrelated Regression (RSUR). Imposition of restrictions of homogeneity, adding-up, and slutsky symmetry to conform on economic theory was done successfully. The ROLS was not only used for comparison but to check if there is contemporaneous correlation of residuals. This is an important underlying assumption in SUR to ensure efficiency in the estimation. Results have shown that the RSUR is more efficient than ROLS.

With the estimation of a better model, calculated elasticity are inferred to be relatively reliable. In estimating own-price and cross-price elasticity, the Marshallian and Hicksian elasticities were calculated. Hicksian elasticity, also called “pure” elasticity was preferred since it is devoid of income effect and considers only the change in prices. There was also a separate calculation in the estimation of income elasticity.

Results have shown that the Filipinos consistently treat pork as necessity, its increasing retail prices do not have significant effect on the level of consumption of
Filipinos. Moreover, pork consistently has the highest market potential among beef and chicken but decreasing over time. On the other hand, chicken showed a growing market potential and its elasticities have shown that chicken is considered a necessity good next to pork. On the contrary, because of the high retail price and limited domestic supply, beef considered luxury good is the most elastic in the changes in its prices and has the least and decreasing market potential.
RECOMMENDATION

Since pork has become more inelastic across time this means that pork has become important to Filipino and the demand tends to become steadier even in the changes of prices, the government should provide mechanisms as to how to augment supply, and increase level of sustainability of pork in the country. Furthermore, pork is comprised of small-scale hog raisers, which practice backyard farming. Hence, the government should provide support measures to these farmers in order for them to become more competitive. Support systems may include improvement of infrastructures such as farm to market road; accessibility of market information to the producers and potential producers, consolidators, and even buyers; and technical support, especially on the production and marketing side of the hog raising industry.

Moreover, since chicken emerged to be a necessity good next to pork, it is expected that the demand for chicken will continue to increase. In broiler production where the industry is dominated with big enterprises, measures to lessen the barriers for new entrants that would venture in to chicken growing should be designed. These measures will prevent formation of monopoly or oligopolistic kind of market that may compromise the welfare of the Filipino due to the possible increase in its retail prices. The growing market potentiality of the poultry industry is a great opportunity for agricultural enterprises to venture on this product. Early determination of market potentials could help in establishing business ahead of others and stabilizing it before the market becomes very competitive.

Beef with a relatively lower market potential coupled with increasing level of luxuriance may result to the government resorting to dependence on importation of the good. The reliance of the country to importation of beef should push the government to design measures to protect its people from possible harmful contamination of diseases of the imported meat commodity.

For the academe, currently there already exists AIDS models that have been modified and improved to capture a more dynamic and realistic phenomenon especially on factors that affect demand other than prices and income. Hence, the
researcher recommends using a more dynamic specification such as other complex structures of AIDS (e.g. MAIDS, QuAIDS, Inverse AIDS etc).
REFERENCES


