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## **Demand for Beef Associated with Country of Origin Labeling**

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## **Abstract**

With the major concern of the COOL policy being the cost incurred by meat producers, retail chain stores, and others within the supply chain, a number of individuals and organizations have formulated estimates of the extra costs and elasticities related to the implementation of COOL. As supporters of the law claim it provides valuable information to consumers, opponents on the other hand suggest its cost far outweighs any possible benefits and poses financial burden on U.S. meat producers. This paper estimates the demand for beef associated with Country of Origin Labeling. A Linear Approximate/Almost Ideal Demand System model is used to demonstrate the supply and demand functions and relationships for beef, pork and chicken. Quantities of beef, pork, and chicken are separately regressed on average quarterly U.S. retail price, in a system of equations setting. Estimated elasticities for beef, pork and chicken were used to calculate the relative changes in price and quantity in response to the COOL-induced supply and demand. Results indicated that, the own-price elasticity of beef is inelastic after the implementation of COOL.

**Keywords: Country of Origin Labeling, Linear Approximate/Almost Ideal Demand.**

## **Background**

Since the 1930s, U.S. tariff law required almost all imports to carry labels so that the “ultimate purchaser,” usually the retail consumer, can determine their country of origin. However, certain products, including a number of agricultural commodities in their “natural” state, such as meats, fruits and vegetables, were excluded and were not part of the law in the 1930’s (Juneras, 2010).

The Farm Security and Rural Investment Act of 2002 (Farm Bill, 2002) the 2002 Supplemental Appropriations Act (Appropriations, 2002) and the Food, Conservation and Energy Act of 2008 (Farm Bill, 2008) amended the Agricultural Marketing Act of 1946 (Act) (7 U.S.C. 1621 et seq.) to require retailers to notify their customers of the country of origin of covered commodities. Covered commodities include muscle cuts of beef (including veal), lamb, chicken, goat, and pork; ground beef, ground lamb, ground chicken, ground goat, and ground pork; wild and farm-raised fish and shellfish; perishable agricultural commodities; macadamia nuts; pecans; ginseng; and peanuts. AMS published a final rule for all covered commodities on January 15, 2009, which took effect on March 16, 2009. On March 12, 2013, AMS published a proposed rule to amend the country of origin labeling provisions for muscle cut covered commodities (78 FR 15645), (Chite, 2014).

This final rule amends the Country of Origin Labeling (COOL) regulations to change the labeling provisions for muscle cut covered commodities to provide consumers with more specific information and amends the definition for “retailer” to include any person subject to be licensed retailer under the Perishable Agricultural Commodities Act (PACA). The COOL regulations are issued pursuant to the Agricultural Marketing Act of 1946. The Agency is issuing this rule to make changes to the labeling provisions for muscle cut covered commodities to provide consumers with more specific information and other modifications to enhance the overall operation of the program.

With the implementation of this law largely expected to affect U.S agriculture and food industries and trade relations with trading partners, uncertainty is still rife about its effect; supporters of the law claim a demand increase for U.S agriculture products, while opponents suggest its cost far outweighs any possible benefits. COOL supporters argued that, numerous studies show that consumers want country-of-origin labeling and would pay extra for it. Analysis accompanying USDA’s interim and final rules concluded that, while benefits are difficult to

quantify, it appears they will be small and will accrue mainly to consumers who desire such information. Umberger (2004), suggests that consumers might be willing to pay a premium for “COOL meat” from the United States, but only if they perceive U.S. meat to be safer and of higher quality than foreign meat. USDA earlier had estimated that purchases of (i.e., demand for) covered commodities would have to increase by 1% to 5% for benefits to cover COOL costs, but added that such increases were not anticipated. Simulation results by Brester, Marsh and Atwood et al. (2004) using equilibrium display model and elasticity estimates showed that retail beef and pork demand would have to experience one-time, permanent increases of 4.05% and 4.45%, respectively, if feeder cattle and hog producers were to experience no loss of producer surplus. Because COOL applies only to beef and pork muscle cuts and ground products sold through retail outlets, this sector of the beef and pork industries must generate the entire demand increase. Results obtained from Lusk and Anderson et al. (2004), suggest a 2% increase in aggregate demand (including all meat cuts and meat consumed at home and away from home) for pork would offset the negative impact on producer surplus. Several economic studies that aimed to model COOL impacts appear to fall within this range.

More importantly, the implementation of mandatory Country of Origin Labeling for meat and livestock products in the U.S has been coupled with incremental costs incurred by producers, wholesalers, distributors, retail chain stores, consumers and others within the supply chain in complying with this policy. These incremental cost associated with COOL is complicated because, these cost may be distributed along the supply chain, and it is not readily clear how these costs are reflected in retail prices and who bears what percentage of the incremental cost and how these costs will be recovered by the bearers of the associated incremental cost.

The costs of implementing these requirements will be incurred by intermediaries (primarily packers and processors of muscle cut covered commodities) and retailers subject to requirements of mandatory COOL. The Agency considers that the total cost of the rule is driven by the cost to firms of changing the labels and the cost some firms will incur to adjust to the loss of the flexibility afforded by commingling. Perhaps a more significant problem with existing cost estimates for COOL is the fact that none provide insight into the impact COOL will have on meat prices and production, and ultimately on producer and consumer welfare.

As the U.S. meat processing sector geared up to implement COOL in mid-2008, Canada and Mexico expressed concern that COOL would adversely impact their livestock sectors. Indeed, U.S. cattle imports from Canada and Mexico and hog imports from Canada dropped in both 2008 and 2009 from year-earlier levels. Some analyses supported claims that, COOL hampered livestock imports. Other analysts pointed out that factors such as exchange rates and inventory levels were also affecting import levels and that decline could not be entirely attributed to COOL (Yeboah et al, 2012). According to the study, the share of imported beef from Australia and pork from Denmark had declined while the share of pork from Canada and lamb from Australia had increased indicating that the Mandatory COOL appears to have had mixed effect on imports on U.S. import demand based on the source of each meat product.

Given the assumption that the demand for beef is inelastic (as almost all past research would suggest), what does this mean, from a theoretical approach, for the distribution of costs of implementing mandatory country-of-origin labeling regulations among the sectors of the beef supply chain (Hanselka 2004). The theory of how added costs from labeling will affect the demand for beef remains to be seen (Smith 2002). John Motley, of the Food Marketing Institute, states, “it will increase costs, and these costs will be 42 absorbed and reduce returns for retailers, packers/processors and producers, or be passed on to the consumers. This could decrease demand for products affected by elasticity wherein a slight cost increase results in a substantial quantity demanded decrease (Smith 2002). In the absence of a demand increase, consumers would only pay the entire costs of COOL if consumer demand for beef products is completely inelastic. If consumer demands are not completely inelastic and demand increases are not large enough to maintain or increase equilibrium quantities, the incidence of COOL costs (i.e. the effects of increased marketing and marginal production costs on market-level prices) depends primarily on relative supply and demand elasticities at each level of the marketing chain (Tomek and Robinson 1990).

The USDA’s study on the Mandatory Country of Origin Labeling of Imported Fresh Muscle Cuts of Beef and Lamb reveals that some livestock producer organizations and farmer organizations supported mandatory labels, while importers, meatpackers, food processors, and grocers were opposed (FSIS, 2000). For U.S. farmers to benefit financially from mandatory labels, consumers would have to prefer domestic products to imports. If consumers do prefer

domestic products, labels would allow consumers to discriminate between imports and domestic products. As a result, demand for domestic meat products in the United States would rise along with domestic meat prices. Further, domestic products would increase their market share at the expense of imports. However, if consumers do not generally prefer domestic products, labeling will not confer any financial benefits to domestic producers. These incremental costs incurred by producers, wholesalers, distributors, retail chain stores, consumers and others within the supply chain has necessitated the essence to estimate the demand shifts for beef associated with the implementation of COOL.

The objective of the present paper is to estimate the demand for beef associated with country of origin labeling by demonstrating the supply and demand functions and relationships for beef, pork and chicken using the Linear Approximate/ Almost Ideal Demand System model. This is achieved by separately regressing quantities of beef, pork and chicken on average annual U.S. retail price, in a system of equation setting. Estimated elasticities for beef, pork and chicken will be used to calculate the relative changes in price and quantity in response to the COOL-induced supply and demand.

### **Methodology**

Estimation of demand functions consistent with economic theory has been a highly published area in the last forty years. The majority of the currently influential papers have appeared following the adoption of flexible functional forms, which rely heavily on duality theory. The Generalized Leontief (Diewert, 1971), the Translog (Christensen et al., 1975), the Rotterdam (Theil, 1965, 1975; Barten, 1964, 1968, 1977), and the Almost Ideal Demand System or AIDS (Deaton and Muellbauer, 1980) are examples of widely used demand models (Barnett and Seek, 2007).

The Almost Ideal Demand System (AIDS) of Deaton and Muellbauer is mostly used because of its flexible demand specifications. The AIDS model has many desirable properties but it may be difficult to estimate based on simplification and the problem of estimation. This therefore, necessitated the application of the Linear Approximate Almost Ideal Demand System which has many empirical applications of the AIDS model, with several formulas to compute elasticities. Several of these studies shows that, the use of differential forms of the index in the LA/AIDS provides results that compare reasonably well to the AIDS model (Asche and Wessels, 1997).

As discussed earlier, the only difference between the AIDS and its linear version, LA/AIDS, lies in the specification of price index.

The Rotterdam model which was proposed by Barten (1964) and Theil (1965), prior to the development of the most widely used LA AIDS model which has flexible functional forms and the advent of duality theory. Though the Rotterdam model has been thought to be unduly restrictive, and this may explain why it has been used less often than the LA model, at least in the recent agricultural economics literature. However, the Rotterdam model is now known to be as flexible as any other locally flexible functional form (Mountain). Thus, its popularity is rising, and we predict that it will be the main alternative to the LA model in the next few years (Alston and Chalfant, 1993).

The two modes are similar in many respects. They are second-order locally flexible functional forms have identical data requirements, are equally parsimonious with respect to numbers of parameter, and are linear I parameters. Because they each have all these characteristics, and most alternatives do not, these two models are likely to continue to be chosen more often than any others.

The Almost Ideal Demand System (AIDS) model proposed by Deaton and Muellbauer was used to estimate demand elasticities for beef, pork and chicken in the United States. The Linear Approximate version of the AIDS (LA/AIDS) model is presented as follows:

$$w_i = \alpha_i + \sum_{j=1}^m \gamma_{ij} \ln p_j + \beta_i \ln \left( \frac{x}{P} \right), \quad i = 1, 2, 3, \dots, m, \quad (1)$$

Where;  $w_i$  denotes the expenditure share of good  $i$ ,  $p_j$  is the price of the  $j$ th commodity, and  $x$  is the total expenditure on all  $m$  commodities. Finally,  $P$  is the Stone's geometric price index, defined as:

$$\ln P = \sum_{j=1}^m w_j \ln p_j \quad (2)$$

The theoretical restrictions of this demand system require;



$$\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = 0, \quad \sum_i \beta_i = 0, \quad \text{adding-up,}$$

$$\sum_i \gamma_{ij} = 0, \quad i = 1, 2, 3, \dots, m, \quad \text{homogeneity} \quad (3)$$

$$\gamma_{ij} = \gamma_{ji} \quad \text{Symmetry}$$

It must be noted that the adding-up conditions are automatically satisfied, but homogeneity and symmetry need to be imposed during estimation of the system. To avoid singularity of the variance-covariance matrix in the estimation of this system, one of the equations is arbitrarily dropped. The coefficients of the dropped equation are then recovered by using the adding-up conditions.

We find that the problem of autocorrelation is resolved by estimating the model in first differences. This confirms what earlier researchers found concerning autocorrelation in the data, that is, differencing the data can achieve stationary parameter estimates. McGuirk et al. noted that, generally, estimating the AIDS model in differences gets rid of autocorrelation problems (Yeboah and Naanwaab, 2012). Therefore, we re-estimate the LA/AIDS model in levels as a first differenced LA-AIDS model as follows:

$$\Delta w_i = \alpha_i + \sum_{j=1}^m \gamma_{ij} \Delta \ln p_j + \beta_i \Delta \ln \left( \frac{x}{p} \right) \quad (4)$$

$$\Delta \ln P = \sum_{j=1}^m \Delta w_j \Delta \ln p_j$$

Where;  $\Delta$  is the first-difference operator (for a given series  $Y$ ,  $\Delta Y = Y_t - Y_{t-1}$ ). Significant intercepts ( $\alpha_i$ ) in (4) are interpreted as time trends in expenditure shares of each commodity  $i$ . Upon estimating (1) or (4), demand and expenditure elasticities can be recovered as follows:

$$\eta_i = \frac{\beta_i}{w_i} + 1 \quad (\text{income elasticity}), \quad (5)$$

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} - \frac{\beta_i w_j}{w_i} \quad (\text{uncompensated price elasticity}), \quad (6)$$

Where  $\delta_{ij}$  is the Kronecker delta, equal to unity for  $i = j$  and zero otherwise. The LA/AIDS model was estimated by a system of equation settings, subject to the restrictions of adding up, homogeneity and symmetry in using iterative seemingly Unrelated Regression method of Zellner. The chicken equation from the analysis was dropped to avoid singularity of the variance and covariance matrix. The adding up conditions was used to recover the chicken equation. The first-differenced LA-AIDS model (1), which corrects for autocorrelation, was estimated using Zellner's Seemingly Unrelated Regression.

### **Data and Study Period**

The data used to estimate the model are quarterly retail prices of beef, pork and chicken obtained from USDA ERS cattle and beef statistics over the period of 2004-2013, (<http://ers.usda.gov/topics/animal-products/cattle-beef/data.aspx>). The quarterly retail quantity of beef, pork, and chicken were also obtained from USDA ERS from cattle and beef statistics over the period of 2004-2013 (<http://www.ers.usda.gov/data-products/livestock-meat-domestic-data.aspx>).

The factors that guide our choice of the study period of 2004-2013 were proponents and opponents assertion to the impacts of COOL since its implementation, where proponents of the law, claim a demand increase for U.S agriculture products, while opponents suggest its cost far outweighs any possible benefits. Therefore, we anticipate that using more recent data will show current trends in retail and quantities before and after the implementation of COOL. This will help to identify the impact of COOL on the various meat prices and quantities under consideration.

Most existing research on COOL was conducted prior to the law's implementation, but now that COOL has been in place for over 4 years, an ex post analysis of the impacts on realized demand shift in beef is possible. Tonsor et al. (2012) identified in their work that across a series of demand system models estimated using retail grocery scanner data of mandatory COOL (MCOOL) covered products; changes in consumer demand following MCOOL implementation were not detected. That is, no evidence of a demand increase in covered beef, pork, or chicken products, as a result of MCOOL, was identified.

Preliminary exploratory data analysis was done to determine trends in previous retail prices of beef, pork and chicken as regressed on the quantity demanded and the impact of COOL on the prices and quantities after its implementation.

## **Results and Discussion**

The parameter estimates of the first-differenced LA-model with homogeneity and symmetry restrictions before and after the implementation of COOL, imposed are presented in Tables 1 and 2, respectively. The own-price coefficient estimates before the implementation of COOL for beef, pork and chicken were all statistically significant at the 5% level. Only two cross-price coefficient estimates (beef with respect to pork, and Chicken with respect to pork) were significant. After the implementation of COOL, the own-price coefficient estimates of beef and pork were significant at the 5% level except for chicken which was not significant at 5% level; all the cross-price coefficient estimates were significant at the 5% level.

Tables 3 and 4 show the uncompensated demand elasticities. Before the implementation of COOL the beef and chicken own-price elasticities were negative except for pork. This is not different after the implementation of COOL, as the beef and chicken own-price elasticities were negative except for pork. If the own price of beef went up by 1% before the implementation of COOL, consumers demand decreases by 0.30%. This is not different after the implementation of COOL, as beef and chicken retain the negative price elasticity except for pork. In other words, a 1% increase only cause a decline of 0.13% in the demand of beef. This is not as significant as opponents of the law claim decrease would adversely affect consumer consumption of beef. This implies that, consumer demand for beef after the implementation of COOL do not significantly fall as suggested by other researchers, that consumers might be willing to pay a premium for 'COOL meat' from the U.S. if they perceive U.S meat to be safer and of higher quality than foreign meat.

Cross price elasticity of beef with respect to pork and chicken are -0.26 and 0.12 respectively. Put differently, if the price of beef goes up by 1% consumers decrease their demand for pork by 0.26% and increase their demand for chicken by 0.12%. However, after the implementation of COOL, the price of beef with respect to pork and chicken are -0.51 and -0.28. Thus pork remained negative but it was different for chicken. This implies that, the demand for chicken declines as the price of beef increases by 1%.

## **Conclusion**

Information availability enables U.S consumers to choose domestic beef because of preferences for domestically produced products (Brester, 1999). And as the campaign of COOL continues to dominate the U.S beef industry, consumers with preference for domestically produced beef will continually consume meat products originated from the U.S.

As this study seeks to find, the demand shift in beef associated with COOL which would adversely impact the beef industry. The result shows otherwise. The demand for beef under COOL induced high prices was not elastic to confirm the claims of opponents of the law that, the cost outweighs any possible benefits. The result is otherwise. More consumers perceive that U.S meat products are safer and of higher quality than foreign meat products, their preference for domestic beef would increase to negate any losses due to the implementation of COOL, because the results show that, after the implementation of COOL, the own-price elasticity of beef is inelastic.

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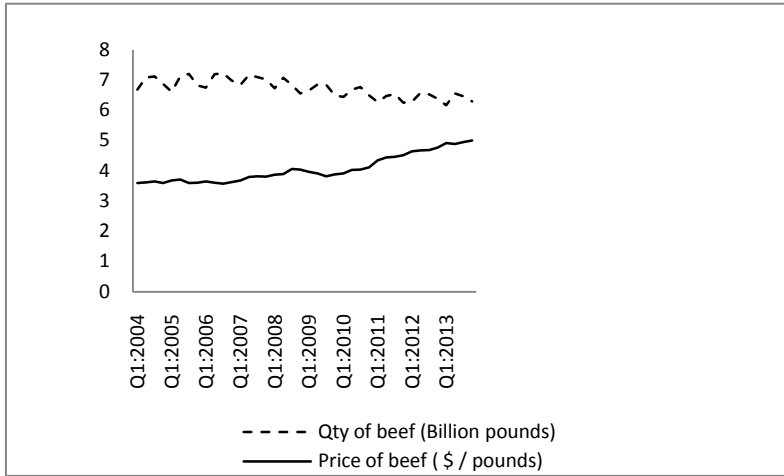
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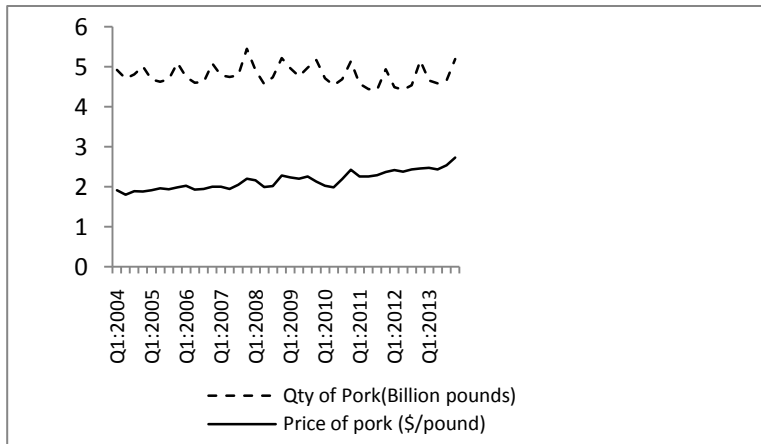
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Figure 1



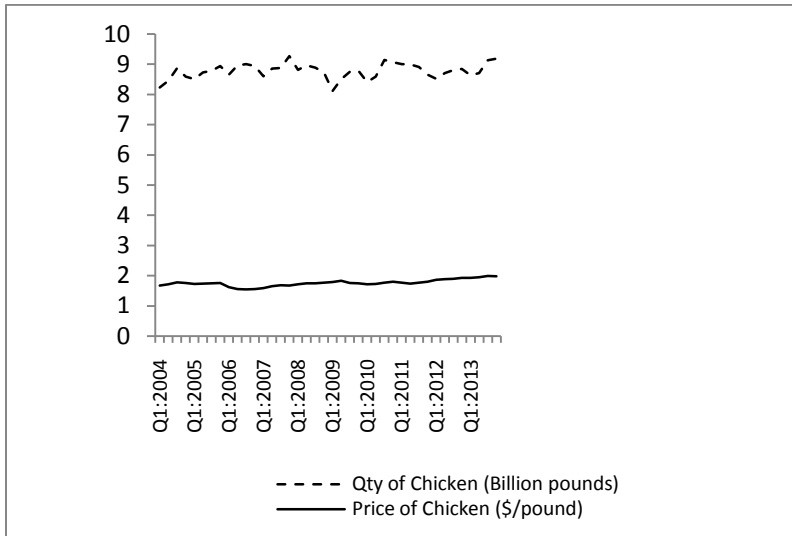
(a) US retail demand for beef (2004-2013)

Figure 2



(b) US retail demand for pork (2004-2013)

Figure 3



(c) US retail demand for chicken (2004-2013)



## List of tables

Table 1: Parameter estimates using a first-differenced LA/AIDS model with homogeneity and symmetry restrictions **before** the implementation of COOL

	<b>Beef</b>	<b>Pork</b>	<b>Chicken</b>	<b>Income coeff</b>
Beef	0.21236** (2.68)	-0.19128*** (-3.35)	-0.02108 (-0.34)	0.447504 (1.35)
Pork	-0.19128*** (-3.35)	0.256855*** (4.12)	-0.06558* (-1.79)	1.930004** (2.20)
Chicken	-0.02108 (-0.34)	-0.06558* (-1.79)	-0.05413** (-2.68)	0.69863* (2.06)

Note: Numbers in parenthesis are t-ratios  
 \*\*\*, \*\*, \*, implies significant at 1%, 5%, and 10%, respectively

Table 2: Parameter estimates using a first-differenced LA/AIDS model with homogeneity and symmetry restrictions **after** the implementation of COOL

	<b>Beef</b>	<b>Pork</b>	<b>Chicken</b>	<b>Income coeff</b>
Beef	0.429356*** (6.19)	-0.27396*** (-5.68)	-0.15539*** (-3.94)	0.926096*** (3.11)
Pork	-0.27396*** (-5.68)	0.32507*** (7.64)	-0.05111** (-2.74)	1.33538* (1.99)
Chicken	-0.15539*** (-3.94)	-0.05111** (-2.74)	-0.06221 (-1.60)	0.93918* (1.77)

Note: Numbers in parenthesis are t-ratios  
 \*\*\*, \*\*, \*, implies significant at 1%, 5%, and 10%, respectively

Table 3: Demand elasticity estimates computed from first-differenced LA/AIDS model with homogeneity and symmetry restrictions **before** the implementation of COOL

<b>Price elasticity of</b>	<b>Beef</b>	<b>Pork</b>	<b>Chicken</b>
Beef	-0.30266* (-1.97)	-0.26495 (-1.71)	0.120108 (0.70)
Pork	-1.45788*** (-3.76)	0.135384 (0.31)	-0.6075 (-2.00)
Chicken	-0.85304*** (-4.65)	-1.21874*** (-8.66)	1.373142*** (6.75)

Note: Numbers in parenthesis are t-ratios

\*\*\*, \*\*, \*, implies significant at 1%, 5%, and 10%, respectively

Table 4: Demand elasticity estimates computed from first-differenced LA/AIDS model with homogeneity and symmetry restrictions **after** the implementation of COOL

<b>Price Elasticity of</b>	<b>Beef</b>	<b>Pork</b>	<b>Chicken</b>
Beef	-0.12544 (-0.81)	-0.51942*** (-4.06)	-0.28124** (-2.14)
Pork	-1.5766*** (-4.61)	0.601084* (2.06)	-0.35986 (-1.56)
Chicken	-0.7833*** (-2.94)	1.151208*** (3.63)	-1.030706*** (-4.99)

Note: Numbers in parenthesis are t-ratios

\*\*\*, \*\*, \*, implies significant at 1%, 5%, and 10%, respectively