MODELING THE EFFECTS OF COUNTRY OF ORIGIN LABELING ON MEAT PRODUCERS AND CONSUMERS

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Abstract

Although several studies have estimated the costs of implementing and maintaining country of origin labeling (COOL), no previous study has documented how increased costs imposed by COOL will be distributed throughout the livestock sector and how producer and consumer welfare will ultimately be affected. This paper develops an equilibrium displacement model of the farm, wholesale, and retail markets for beef, pork, and poultry that is able to document how producers and consumers will be affected by added costs of COOL. In addition the model is able to determine the level of increased consumer demand needed to make producers welfare neutral to the policy. Empirical results indicate that as COOL costs are shifted from the producer to the processor and retailer, producers are made increasingly better off while consumers are made increasingly worse off. Empirical model results also indicate that an increase in aggregate consumer demand (willingness-to-pay) on the magnitude of 2% to 3% is likely sufficient to offset lost producer welfare due to increased costs imposed by COOL.

Executive Summary

- Several studies have estimated the costs to the livestock sector of implementing and maintaining country of origin labeling (COOL) as required by the 2002 Farm Security and Rural Investment Act. However, no previous study has documented how increased costs imposed by COOL will be distributed throughout the livestock sector and how producer and consumer welfare will ultimately be affected.

- This paper develops an equilibrium displacement model of the farm, wholesale, and retail markets for beef, pork, and poultry. The model incorporates three potential effects of COOL: the added cost to producers, the added cost to processors and retailers, and the potential increase in consumer demand.

- Analytical results indicate that if *all* COOL costs are borne by processors and retailers, then producers could actually benefit from COOL *even if* consumer demand for meat does not change, so long as the elasticity of substitution between meat and marketing inputs is greater than the absolute value of the own-price elasticity of demand for meat. In general, the magnitude of increased consumer demand needed to make producers no worse off than before the policy was implemented depends on five factors: the increased costs borne by the producers, the increased costs borne by the processors and retailers, the elasticity of substitution between farm and marketing inputs, the own-price retail elasticity of demand for meat, and the farmers' share of the retail dollar.

- Empirical model results indicate that as COOL costs are shifted from the producer to the processor and retailer, producers are made increasingly better off while consumers are made increasingly worse off.

- Empirical results from the model imply that as COOL costs are shifted from the processor and retailer to the producer, consumer demand must increase to make producers no worse off than before the policy was implemented.

- Under the most likely scenario, empirical model results indicate that an increase in aggregate consumer demand (willingness-to-pay) on the magnitude of 2% to 3% is likely sufficient to offset lost producer welfare due to increased costs imposed by COOL.

- If consumer demand for beef and pork is relatively unaffected by COOL, poultry producer welfare will improve due to COOL because consumes will substitute away from the beef and pork, whose prices will increase due to added costs.

- Results of this study indicate that the way in which USDA interprets the COOL provisions of the Farm Bill will have a tremendous impact on who benefits and who is harmed by COOL. Specifically, if costs are imposed primarily on processors and retailers and demand remains constant, consumers will experience relatively large welfare losses and producers will experience relatively low welfare losses. On the other hand, if costs are imposed primarily on producers, the opposite case will hold.

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Introduction

The 2002 Farm Security and Rural Investment Act (FSRIA) includes a provision that will require meat, fruits and vegetables, and peanuts to be labeled as to their country of origin. For the first two years of the program, labeling will be voluntary; however, beginning on September 30, 2004, country of origin labeling (COOL) will be mandatory, with potentially hefty fines authorized for retailers who knowingly violate labeling requirements.

Terms of the COOL legislation stipulate that

> "…a retailer of a covered commodity shall inform consumers, at the final point of sale of the covered commodity to consumers, of the country of origin of the covered commodity" (Farm Security and Rural Investment Act of 2002 Title X, Subtitle I, Sec. 10816, Subtitle D, Sec. 282(a)(1)).

Covered commodities defined in the legislation include beef, pork, and lamb (both ground and muscle cuts), fish (both wild and farm-raised), fruits and vegetables, and peanuts. In order to receive a U.S. country of origin label, a livestock product must come exclusively from an animal that was exclusively born, raised, and processed in the United States. Labeling requirements do not apply to food service establishments (e.g., restaurants and cafeterias) nor do they apply to processed foods (e.g., beef in a can of beef stew).

A number of individuals and organizations have put forth estimates of the cost of COOL implementation, focusing primarily on the beef and/or pork sectors. These estimates vary widely depending on the assumptions underlying the analysis. Given that USDA has not decided exactly how to implement mandatory COOL, it is impossible to know whose assumptions are accurate. Perhaps a more significant problem with existing COOL cost estimates is the fact that none provide any real insight into the impact COOL will have on meat prices and production or ultimately on producer and consumer welfare. Further, no previous study has rigorously assessed how anticipated costs or potential benefits of COOL will be distributed amongst producers and consumers.

The purpose of this research is to determine how COOL will affect the welfare of participants in the livestock sector. This research uses existing estimates of the cost of COOL and investigates the impact of theses costs on producer and consumer surplus. Sensitivity analysis is used to determine how the incidence of costs (i.e., whether it is borne by producers or processors and retailers) affects the welfare of market participants. This research also investigates how much consumer demand would have to increase to offset COOL costs, whether

they are borne by the producer or processor. These objectives are accomplished using an equilibrium displacement model adapted from Wohlgenant (1993).

In several respects, this work represents an important extension of existing COOL studies. First, previous estimates of the impact of COOL have focused on costs without considering the more important issue of welfare (as measured by producer and consumer surplus). Simply reporting cost estimates can be misleading because costs, to some extent, can be passed through a marketing channel. The issue that is more relevant is how producer *welfare* is affected by a cost increase. Second, results of this research are not dependent upon a single set of assumptions regarding the details of mandatory COOL implementation. Indeed, the impact of any number of different cost estimates—all based on different assumptions—are examined here. Finally, this paper uses an equilibrium displacement model that explicitly models the vertical structure of the livestock industry from producer to processor to consumer as well as the horizontal relationship between beef, pork, and poultry sectors. The advantage of this approach is that it reveals how the implementation of mandatory COOL in the beef and pork sectors will affect producer surplus in the closely-related poultry sector.

Review of Previous COOL Studies

In November 2002, USDA's Agricultural Marketing Service published a Notice of Request for Emergency Approval of a New Information Collection (USDA-AMS). In this notice, AMS reported their estimate for the potential record-keeping costs associated with COOL. Their total estimate of first year record-keeping costs (in all industries covered by COOL) was $1.968 billion. This estimate was based on projected costs for producers of $1billion, for food handlers of $340 million, and for retailers of $627.75 million.

Since the publication of the USDA-AMS cost estimate, other individuals and groups have weighed in with their own estimates of costs (both direct and indirect) associated with COOL. Notably, VanSickle et al. take exception with the USDA estimate. They argue that mandatory record keeping at the producer level is not required to satisfy either the spirit or the letter of the law. They advocate labeling all imported products while assuming U.S. origin for any product not labeled as an import. Using this assumption, they estimate that the record keeping costs associated with COOL will be between $69.86 million and $193.43 million.

At the other end of the spectrum, a report by Sparks Companies, Inc. and Cattle Buyers Weekly estimates that COOL will contribute to an increase in total costs amounting to $3.66 to $5.60 billion dollars (and this does not include the lamb and peanut sectors, which are also covered by the COOL regulation). This estimate is based on the assumption that improved record keeping systems will be required throughout the supply chain in order to ensure verification of country of origin labels. Hayes and Meyer also conclude that costs of COOL implementation will be significant. They estimate that satisfying COOL requirements will raise farm-level production costs in the pork sector by $10.22/head (or by a total of just over $1.0 billion).

Hayes and Meyer explore potential impacts of COOL beyond the direct costs of implementation. They infer that, based on an own-price elasticity of pork of about –0.70, their projected $10/head increase in costs will result in a 7% decrease in retail pork demand. Further,

they estimate that by 2010, U.S. pork exports could be reduced by 50% as a result of COOL regulations. Grier and Kohl also predict several negative consequences of COOL for the pork industry including the loss of over 1,000 independent pork producers, the eventual closing of 3 to 5 U.S. pork packing plants, lower hog prices, and an aggregate loss of economic activity in the U.S. of over $4 billion.

Van Sickle et al. are decidedly more optimistic in their evaluation of COOL i+mpacts. Extrapolating from willingness-to-pay estimates by Umberger et al., they calculate an "aggregate willingness-to-pay" in the beef industry alone of almost $3.0 billion. They also note other potential benefits such as increased consumer confidence in the labeled product. Plain and Grimes question the relevance of using willingness-to-pay estimates to project benefits from COOL. They note that 69% to 73% of survey respondents in the study by Umberger et al. indicated a willingness to pay a premium for beef labeled as a U.S. product. They argue that since almost 90% of muscle cuts of beef and about 75% of ground beef are already of U.S. origin, consumers will not have to pay a premium for U.S. beef even though a fairly large percentage of them express a willingness to do so.

As with any economic analysis, the results of existing COOL analyses depend upon underlying assumptions. With respect to the COOL issue, it is very difficult to evaluate whether a given assumption is reasonable (particularly with respect to costs) since regulations have not yet been written. For this reason, a more flexible approach to evaluating the potential impact of COOL is needed—an approach that permits consideration of alternative assumptions. This research introduces such an approach based on the equilibrium displacement model.

Model

To determine the effects of COOL on meat producers and consumers, we use the equilibrium displacement model used by Wohlgenant (1993). In general, the model is comprised of horizontally linked beef, pork, and poultry demands at the retail level as well as the vertical linkage of farm, wholesale, and retail sectors. Importantly, the model permits variable proportions by incorporating the elasticity of substitution between farm and marketing inputs. The benefit of employing this model is that it provides a straightforward means of incorporating the three potential effects of COOL on meat producers: the added cost to producers, the added cost to processors and retailers, and the potential increase in consumer demand.

Three-Good Model

The basic model, ignoring trade for the moment, is given as follows:

(1) $\hat{Q}_B^R = \eta_{BB}(\hat{P}_B^R - \delta_B) + \eta_{BP}(\hat{P}_P^R - \delta_P) + \eta_{BC}(\hat{P}_C^R - \delta_C)$

(2) $\hat{Q}_P^R = \eta_{PB}(\hat{P}_B^R - \delta_B) + \eta_{PP}(\hat{P}_P^R - \delta_P) + \eta_{PC}(\hat{P}_C^R - \delta_C)$

(3) $\hat{Q}_C^R = \eta_{CB}(\hat{P}_B^R - \delta_B) + \eta_{CP}(\hat{P}_P^R - \delta_P) + \eta_{CC}(\hat{P}_C^R - \delta_C)$

(4) $\hat{P}_B^R = S_B\hat{P}_B^F - \gamma_B$

(5) $\hat{P}_P^R = S_P\hat{P}_P^F - \gamma_P$

(6) $\hat{P}_C^R = S_C\hat{P}_C^F - \gamma_C$

(7) $\hat{Q}_B^F = -(1-S_B)\sigma_B\hat{P}_B^F - \sigma_B\gamma_B + \hat{Q}_B^R$

(8) $\hat{Q}_P^F = -(1-S_P)\sigma_P \hat{P}_P^F - \sigma_P \gamma_P + \hat{Q}_P^R$

(9) $\hat{Q}_C^F = -(1-S_C)\sigma_C \hat{P}_C^F - \sigma_C \gamma_C + \hat{Q}_C^R$

(10) $\hat{P}_B^F = (1/\varepsilon_B)\hat{Q}_B^F - k_B$

(11) $\hat{P}_P^F = (1/\varepsilon_P)\hat{Q}_P^F - k_P$

(12) $\hat{P}_C^F = (1/\varepsilon_C)\hat{Q}_C^F - k_C$

where the superscript R denotes retail prices and quantities, the superscript F denotes farm prices and quantities, and the subscripts B, P, and C denote beef, pork, and chicken. $\hat{Q}_i^j$ and $\hat{P}_i^j$ are percent changes in quantity and price of the i^{th} meat at the j^{th} market level, respectively (i.e., $\hat{X} = d\ln X \approx dX/X$). Demand elasticities are represented by η_{ik}, S_i is the farmers' share of the retail dollar for the i^{th} meat, σ_i is the elasticity of substitution between meat i and marketing inputs, and ε_i is the supply elasticity of meat i. Equations (1)-(3) are demand equations for beef, pork, and chicken, respectively, in elasticity form; equations (4)-(6) are mark-up equations for each meat (or inverse retail supply curves) assuming constant returns to scale in meat processing and retailing; equations (7)-(9) represent derived demand for beef, pork, and chicken, respectively, assuming constant returns to scale in meat processing and retailing; and equations (10)-(12) are farm-level inverse supply curves for beef, pork, and chicken, respectively. Exogenous shocks to the system of equations are given by δ_i, γ_i, and k_i. δ_i represents the percentage change in initial equilibrium price for meat i due to an exogenous demand shift (e.g., the percent increase in consumer willingness-to-pay for the initial quantity of meat i due to the new labeling policy). Parameters γ_i, and k_i represent exogenous shocks, expressed in percentage terms, to marketing and farm supply, respectively. In the case of COOL, γ_i, and k_i will be negative to represent added costs to the system. The assumptions of the model are as follows: the meat processing and retailing industries are characterized by constant returns to scale, the supply curve of marketing inputs is perfectly elastic, the products (beef, pork, and chicken) are independent in production with no specialized factors in common, the displacement of supply and demand curves are parallel, and all sectors are characterized by perfect competition.

Once parameter values have been assigned, the above system of equations can be solved using matrix algebra. The result is an explicit solution for changes in endogenous variables, which are percent changes in prices and quantities of beef, pork, and chicken at the retail and farm level. Once these values have been determined, the change in producer surplus for meat i can be calculated as:

(13) $\Delta PS_i = P_i^F Q_i^F (\hat{P}_i^{F*} + k_i)(1 + 0.5\hat{Q}_i^{F*})$

where the asterisks in the superscripts denotes the solutions to the system of solved equations.

Simple One-Good Model

In addition the model outlined in equations (1)-(12), we also consider a simpler one-sector model of the beef and pork industries. Although the simpler model ignores important issues such as substitutability between meats at the retail level and international trade, we use it here for two reasons. First, in the above model, one cannot determine the effect of an exogenous shock on the welfare of consumers (see Alston). Because one of the primary issues with COOL is determining how costs are shared across the system, we are interested in determining how the increased cost due to COOL will be borne by producers *and* consumers. To accomplish this, we

employ a one-sector model. Second, the simpler model provides clearer insight into a number of issues as analytical solutions are readily obtained and manipulated. The one-sector model is:

(14) $\hat{Q}_i^R = \eta_{ii}(\hat{P}_i^R - \delta_i)$

(15) $\hat{P}_i^R = S_B \hat{P}_i^F - \gamma_i$

(16) $\hat{Q}_i^F = -(1-S_i)\sigma_i \hat{P}_i^F - \sigma_i \gamma_i + \hat{Q}_i^R$

(17) $\hat{P}_i^F = (1/\varepsilon_i)\hat{Q}_i^F - k_i$

where i denotes either beef or pork depending upon which sector is analyzed. As before, solutions for the above model can be determined using matrix algebra; however, for sake of discussion, the analytical solutions for changes in farm price and quantity are given in equations (18) and (19)

(18) $$\hat{P}^{F*} = \frac{-\varepsilon k - \gamma(\eta+\sigma) - \delta\eta}{\varepsilon + \sigma(1-S) - \eta S}$$

(19) $$\hat{Q}^{F*} = \frac{-\varepsilon[\delta\eta + \gamma\eta + \gamma\sigma + k(\eta S - \sigma(1-S))]}{\varepsilon + \sigma(1-S) - \eta S}$$

where the subscripts denoting meat type have been dropped for convenience.[1] Given these solutions, then changes in producer surplus can be calculated using equation (13). Changes in consumer surplus are given by:

(20) $\Delta CS = -P^R Q^R (\hat{P}^{R*} - \delta)(1 + 0.5\hat{Q}^{R*})$.

Given the analytical solutions in equations (18) and (19), we can now address a couple of relevant issues. One question that is often asked in the COOL debate is how consumers will respond to the new labeling policy? At present, it is clear that COOL will introduce a cost to the productions system (via γ and/or k in the model). Although evidence on consumer response to the policy is sparse, we can ask how much consumer demand would have to increase to offset any producer surplus losses that would be incurred from COOL. To analytically determine this value, first note that in equation (13), changes in producer surplus can be characterized by investigating changes in ($P^{F*} + k$). We set ΔPS equal to zero (meaning producers, in the aggregate, are neither benefited nor harmed by COOL), use equation (18) and solve ($P^{F*} + k$) for δ. After a bit of algebra, the change in consumer demand needed to offset COOL costs is given by:

(21) $$\delta^* = \frac{k(\sigma(1-S) - \eta S)}{\eta} - \frac{\gamma(\eta+\sigma)}{\eta}$$

Equation (21) can be used to address several issues. First, it is apparent that if $\sigma = 0$ (market is characterized by fixed proportions) and $\gamma = 0$ (costs are all borne by producers), then $\delta^* = -kS$, which implies, for example, that if producer costs are increased by 1% due to COOL, then retail demand must increase by $(0.01)S\%$ to make producers welfare neutral, where again S is the farmers' share of the retail dollar. Some simple comparative statics from equation (21) yield the following insights: a) if producers' costs increase (i.e., k becomes more negative) then consumer demand must increase to make producers welfare neutral, b) if packers' and retailers' costs

[1] The analytical solutions presented in Wohlgenant (1993) contain typographical errors. The formulas in equations (18) and (19) are the correct solutions.

increase (i.e., γ becomes more negative) then consumer demand must increase to make producers welfare neutral, c) if COOL costs are totally borne by the producer ($\gamma = 0$; $k < 0$) and if σ (the elasticity of substitution between farm and marketing inputs) increases, then consumer demand must increase to make producers welfare neutral, and d) if COOL costs are totally borne by the packers and processors ($\gamma < 0$; $k = 0$) and if σ (the elasticity of substitution between farm and marketing inputs) increases, then consumer demand must *decrease* to make producers welfare neutral.

The simple model outlined by equation (14)-(17) can also be used to address an additional issue: how are producers affected by increased cost imposed on the meat packers and retailers? To address this issue, we again return to equation (13) and note that the sign of (13) is determined by the sign of $(P^{F*} + k)$. So, we seek to determine when $(P^{F*} + k) > 0$; that is, what conditions must hold for producer surplus to *increase* when packers and processors incur additional costs, such as that imposed by COOL. After a bit of algebra, we find that for producer surplus to *increase* when packers and processors incur additional costs (assuming producers bear none of the COOL costs) that $|\eta| < \sigma$. In other words, if the absolute value of the retail elasticity of demand for beef is less than the elasticity of substitution between beef and marketing inputs, then producers might actually benefit from COOL if all COOL costs are borne by packers and retailers *even if* consumer demand for beef does not increase. As we show later in the analysis, this condition is a plausible scenario for the beef sector, but is less likely to occur for pork.

Three-Good Model Incorporating Trade

Because one of the primary issues surrounding COOL is the effect of the policy on trade, we extend the model as outlined by equations (1)-(12) to incorporate imports of beef and pork. Most trade models simply treat imported and exported goods as identical products at the retail level, but with COOL, consumers will be able to differentiate between imported and domestic meats. As such, five interrelated demand equations are needed: demand for domestic beef, demand for foreign beef, demand for domestic pork, demand for foreign pork, and demand for chicken (which we treat as a single homogenous commodity). We now must also incorporate five supply equations, the first three being identical to equations (10)-(12) for domestic production and two additional equations denoting foreign supplies of beef and pork to the US. To complete the model, we add in the corresponding equations at the marketing level for foreign meats. The complete model contains 20 equations: five retail demand equations, five mark-up equations, five derived demand equations, and five supply equations. To conserve space, we do not present the entire model here, but it is available from the authors upon request.

Methods

To apply the model to the beef, pork, and chicken industries, we need to assign values to the model parameters. Table 1 reports model parameters and sources for the parameter values. The three-good model outlined in equations (1)-(12) makes use of all the parameters defined in table 1. The single-good model outlined in equations (14)-(17) only makes use of the parameters relating to beef or pork, depending upon which sector is analyzed. The three-good model with trade uses all values outlined in table 1 along with additional demand parameters that specify how domestic meat demand responds to changes in prices of foreign beef and pork and vice versa. In general, we set these values equal to their domestic counterparts, but use economic

intuition to determine the remaining values.[2] We also set the foreign elasticities of supply at 10 following Lemieux and Wohlgenant.

The remaining values needed to implement the models are cost estimates. In the subsequent analysis, we analyze several different scenarios. These scenarios vary by the magnitude of the cost estimate in addition to who bears the cost. To determine the potential costs of COOL, we use the estimates reported by VanSickle et al. to get a low estimate of COOL costs, and estimates reported by Sparks Companies, Inc. to get a high estimate of COOL costs. To translate the cost estimates reported in these papers into the percentage cost shifts (γ and k) required for the model, we follow Unnevehr, Gomez, and Garcia and divide total annual costs from COOL by total annual revenue of the respective industry.

Statistics reported by VanSickle et al. imply that (ignoring initial start-up costs) reoccurring annual costs from COOL would range from about $36 million to $132 million (depending upon whether producers bear any COOL costs) for the beef sector and $25 million to $32 million for the pork sector. Dividing these values by the revenue figures reported in table 1 implies that COOL would increase costs by about 0.5% for beef and about 0.25% for pork. These values are taken to represent the lower-bound costs cost estimates of COOL.

To obtain an upper-bound on COOL cost estimates, we use the statistics reported by Sparks Companies, Inc. Sparks reports that COOL would cost the beef sector approximately $1.620 billion and the pork sector approximately $452 million. Dividing these statistics by the revenue figures reported in table 1 implies that COOL would increase costs by about 6.5% for beef and about 3% for pork.

For both lower-bound and upper-bound estimates, we investigate several scenarios in the analysis where these costs are borne in different proportions by producers and marketers (processors and retailers).

Results

The single-market equilibrium displacement model discusses above is used to examine the effect of COOL on producer and consumer surplus. Tables 2 and 3 present results of the single market model for beef, assuming different own-price elasticity of demand in each table. Note that in both of these tables, three different levels of cost increase are considered and we assume, for the moment that demand is unchanged by COOL. In addition to investigating the impact of different levels of cost increases, this analysis considers the incidence of cost increases (i.e., whether the cost increase is borne by producers or marketers). Four possibilities are considered for the incidence of cost increases: that all of the increase is imposed on producers, that the increase is split equally between producers and marketers, that one-fourth of the increase is borne by producers and three-fourths by marketers, and that all of the cost increase is borne by marketers.

Table 2 reveals that in every scenario, the effect of an increase in costs due to COOL is negative for consumer surplus. Declines in consumer surplus range from -$23.06 million (when cost increases are at the low end of estimates and are all borne by producers) to -$3,550.87 million (when cost increases are at the high end of estimates and are all borne by marketers).

[2] The complete set of values is available from the authors upon request.

In three of the four cost scenarios, producer surplus declines as costs increase; however, perhaps the most striking result in Table 2 is that when all of the cost increase is borne by marketers, producer surplus actually increases *even though* consumer demand is left unchanged in the model. As noted in discussion of the analytical model, this outcome is a result of the fact that the absolute value of the own-price elasticity of demand for beef is less than the value of the elasticity of substitution between beef and marketing inputs. In table 2, the absolute value of the own-price elasticity of demand for beef is 0.56, and the value of the elasticity of substitution is 0.72.

In the literature it is possible to find estimates for the own-price elasticity of demand for beef that fall above and below the elasticity of substitution. As such, we also report results from a single market model for beef using an own-price elasticity of demand that is larger (in absolute value) than the elasticity of substitution as shown in Table 3. Note that in this case, producer surplus declines with any cost increase, regardless of the incidence of the cost. Changes in producer surplus range from -$8.14 million when cost increases are at the low end of estimates and all borne by marketers to -$1,315.62 when costs are at the high end of estimates and all borne by marketers.

One interesting result that can be noted in tables 2 and 3 is that as costs are increasingly borne by the processors and retailers, consumers are made increasingly worse off. Such a situation poses a complex problem for proposals such as that put for forth by VanSickle et al., that advocate passing all costs of COOL on to marketers. Such an approach, while beneficial for producers, is quite harmful to consumers.

Tables 2 and 3 also report the magnitude of demand increase that would be required to exactly offset any loss in producer surplus due to the cost increase. For example, results in table 3 indicate that if all costs are borne by producers and COOL increases producers' costs by 6.5%, then consumer demand (willingness-to-pay) must increase by 6.24% to make producers no worse than they were before the policy was imposed. As costs increase and as producers bear a larger portion of the cost, the magnitude of the shift in demand needed to offset the impact of the cost increase becomes greater. With reference to Table 2, given a large cost increase that is paid entirely by producers, it would take about a 7.5% increase in demand to make up for lost producer surplus.

Table 4 presents results of the single-market model for pork.[3] Estimates of cost increases for the pork industry due to COOL are considerably lower than for beef due to the more integrated structure of the pork market. Thus, for this analysis, the three levels of cost increase considered for the pork industry are lower than the increases considered for the beef industry. For pork, declines in consumer surplus range from -$15.30 to -$1,263.58. Producer surplus losses range from -$13.01 to -$202.20 million. The increase in demand required to offset the loss in producer surplus range from a demand increase of 0.12% corresponding to a small cost increase borne exclusively by marketers to an increase of 1.92% corresponding to a large cost

[3] Given that the elasticity of substitution between pork and marketing inputs is quite low in relation to the absolute value of common estimates for the own-price elasticity of pork, it seems unnecessary to conduct sensitivity analysis on the value of the own price elasticity. Thus only one table of results is presented for the pork model.

increase born exclusively by producers. Again, as costs are moved from the producers to the processors and retailers, consumers are made increasingly worse off.

Although the single market models are useful for investing how costs are distributed in a system and for determining how consumer demand would have to change to offset a particular cost, the model ignores consumers' ability to substitute between different meats as prices change due to COOL. As previously noted, in the multiple-market model it is impossible to arrive at analytical solutions for changes in consumer surplus; however, changes in producer surplus for all sectors represented in the model can be readily obtained. Table 5 presents results from the interrelated beef, pork, and chicken market model under a number of different scenarios related to the level of cost increase, the incidence of the cost increase, and changes in demand.

A couple of points about table 5 bear special mention. First, under the assumption of constant demand (i.e., consumer demand does not change after COOL is implemented), any increase in costs for beef and pork associated with COOL (regardless of who pays those costs) increases producer surplus in the poultry industry. Second, under the assumption of constant demand, beef and pork producers are generally worse off under COOL if they have to pay any more than about one-fourth of the cost increase. Finally, assumptions related to demand clearly have an important impact on resulting producer surplus estimates. For example, if beef and pork demand increase by as little as 2%, producer surplus in the pork industry will increase in spite of COOL costs except in the case where costs are at the high end of estimates and borne completely by producers.

A final specification of the equilibrium displacement model was used to examine the impact of COOL on producer surplus when trade is considered. Assumptions related to cost levels and demand shifts are the same as in the model without trade (Table 5). Regarding the incidence of cost, it is assumed that foreign producers bear none of the costs associated with COOL. Domestic and foreign marketers bear a cost that is proportional to their aggregate share of the market. For example, if domestic beef accounts for 88% of total supply in the U.S. retail market, then any cost for COOL allocated to the marketing sector would be paid 88% by domestic marketers and 12% by foreign marketers.

Table 6 presents results of the multiple-market model with trade. Overall, results are similar to those presented in Table 5. While the level of changes in producer surplus are different when trade is considered, the basic pattern of gains and losses in relation to cost and demand changes remains the same.

Summary and Conclusion

In this study, an equilibrium displacement model was constructed to investigate the impact of cost increases associated with COOL requirements on producer and consumer welfare. The approach employed in this study is unique in two respects. First, this methodology yields results that are not contingent upon any single set of assumptions related to COOL implementation. Second, this approach permits an investigation of the impact of COOL, while explicitly considering the relationship between beef, pork, and poultry markets. Third, rather than simply discussing aggregate costs of COOL; this approach permits costs to be passed throughout the

market via supply and demand elasticities and provides insight into how costs will be distributed amongst producers and consumers of various meats.

Results of this study illustrate an important issue for policy makers (and those charged with implementing policy): the way in which USDA interprets COOL provisions of the Farm Bill in writing regulations for its implementation will have a tremendous impact on who benefits from and who is harmed by COOL. Results of the single-market models indicate that a regulatory structure in which most costs are borne by marketers, with producers exempt from all but minimal requirements for documentation and record-keeping, will have a relatively small negative impact on producers but a relatively large negative impact on consumers (unless COOL does, as some argue it will, lead to an increase in demand). On the other hand, a regulatory structure in which most costs are ultimately borne by producers will have a much larger negative impact on producer surplus. In addition, because a regulatory structure of this type would be consistent with high cost estimates for COOL implementation, the negative impact on consumers would likely be large as well.

Results from the multi-market model again highlight the importance of the incidence of COOL costs. If half or more of costs are ultimately borne by producers (which, as noted, would also likely imply high implementation costs) the negative impact on producer surplus will be quite large. In fact, in this scenario, the most likely beneficiaries of COOL will be chicken producers, who will benefit from the substitution from pork and beef.

A final point to note: consumers' reaction to COOL will have a major impact on the ultimate welfare effects of the legislation. If COOL contributes to an increase in demand for covered products, losses in producer surplus will be offset. The degree to which the effect of higher costs is offset obviously depends on the magnitude of any demand shift resulting from COOL. Results of this study indicate that a 2% increase in aggregate demand for pork would offset the negative impact on producer surplus unless cost increases are quite large and borne almost exclusively by producers. A 2% increase in demand for beef would be sufficient to offset negative impact on consumer surplus if COOL implementation costs are low; however, if COOL implementation costs fall into the upper half of current estimates, a 2% demand increase may not be sufficient to offset reductions in producer surplus.

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Table 1 – Variable Definitions and Values Used in Analysis

Parameter	Definition	Value
η_{BB}	Own-price elasticity of demand for beef[a]	-0.56
η_{BP}	Cross-price elasticity of beef with respect to pork[a]	0.10
η_{BC}	Cross-price elasticity of beef with respect to chicken[a]	0.05
η_{PB}	Cross-price elasticity of pork with respect to beef[a]	0.23
η_{PP}	Own-price elasticity of demand for pork[a]	-0.69
η_{PC}	Cross-price elasticity of pork with respect to chicken[a]	0.04
η_{CB}	Cross-price elasticity of chicken with respect to beef[a]	0.21
η_{CP}	Cross-price elasticity of chicken with respect to pork[a]	0.07
η_{CC}	Own-price elasticity of demand for chicken[a]	-0.33
S_B	Beef farmers' share of retail dollar[b]	0.48
S_P	Pork farmers' share of retail dollar[b]	0.27
S_C	Chicken farmers' share of retail dollar[b]	0.50
σ_B	Elasticity of substitution between beef and marketing inputs[c]	0.72
σ_P	Elasticity of substitution between pork and marketing inputs[c]	0.35
σ_C	Elasticity of substitution between chicken and marketing inputs[c]	0.11
ε_B	Own-price elasticity of supply for beef[d]	0.15
ε_P	Own-price elasticity of supply for pork[d]	0.40
ε_C	Own-price elasticity of supply for chicken[d]	0.65
$P^F_B Q^F_B$	Total farm revenue for beef (million $)[e]	$24,394
$P^F_P Q^F_P$	Total farm revenue for pork (million $)[f]	$12,883
$P^F_C Q^F_C$	Yotal farm revenue for chicken (million $)[g]	$15,341

[a]Source: Brester and Schroeder (1995)
[b]Source: USDA/ERS, average value from years 1998-2002
[c]Source: Wohlgenant (1989)
[d]Source: Wohlgenant (1993)
[e]Source: USDA/NASS, average value from years 2001-2002 for steers and heifers
[f]Source: USDA/NASS, average value from years 2001-2002 for barrows and gilts
[g]Source: USDA/NASS, average value from years 2001-2002 for broilers

Table 2 – Effect of COOL Costs on Beef Producers and Consumers: Single-Market Model Assuming No Demand Change (own-price elasticity of demand = -0.56)

	Scenarios			
	All Cost Borne by Producers	Cost Shared: 50/50	Cost Shared: 25/75	All Cost Borne by Marketers
Low Cost Estimate (0.5%)				
Change in Producer Surplus (million $)	-$98.87	-$37.15	-$6.27	$24.60
Change in Consumer Surplus (million $)	-$23.06	-$150.76	-$214.54	-$278.28
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	0.57%	0.22%	0.04%	-
Medium Cost Estimate (3%)				
Change in Producer Surplus (million $)	-$592.34	-$222.75	-$37.64	$147.69
Change in Consumer Surplus (million $)	-$138.29	-$900.80	-$1,279.63	-$1,656.84
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	3.45%	1.29%	0.22%	-
High Cost Estimate (6.5%)				
Change in Producer Surplus (million $)	-$1,280.68	-$482.24	-$81.54	$320.16
Change in Consumer Surplus (million $)	-$299.36	-$1,940.32	-$2,749.40	-$3,550.87
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	7.47%	2.80%	0.47%	-

Table 3 – Effect of COOL Costs on Beef Producers and Consumers: Single-Market Model Assuming No Demand Change (own-price elasticity of demand = -0.78)

	Scenarios			
	All Cost Borne by Producers	Cost Shared: 50/50	Cost Shared: 25/75	All Cost Borne by Marketers
Low Cost Estimate (0.5%)				
Change in Producer Surplus (million $)	-$101.58	-$54.87	-$31.51	-$8.14
Change in Consumer Surplus (million $)	-$20.35	-$133.02	-$189.28	-$245.50
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	0.48%	0.26%	0.15%	0.04%
Medium Cost Estimate (3%)				
Change in Producer Surplus (million $)	-$608.54	-$328.94	-$188.95	-$48.85
Change in Consumer Surplus (million $)	-$122.02	-$794.05	-$1,127.44	-$1,459.06
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	2.88%	1.56%	0.89%	0.23%
High Cost Estimate (6.5%)				
Change in Producer Surplus (million $)	-$1,315.62	-$711.85	-$409.12	-$105.81
Change in Consumer Surplus (million $)	-$264.08	-$1,708.07	-$2,417.68	-$3,119.05
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	6.24%	3.37%	1.94%	0.50%

Table 4 – Effect of COOL Costs on Pork Producers and Consumers: Single-Market Model Assuming No Demand Change

	Scenarios			
	All Cost Borne by Producers	Cost Shared: 50/50	Cost Shared: 25/75	All Cost Borne by Marketers
Low Cost Estimate (0.25%)				
Change in Producer Surplus (million $)	-$16.90	-$14.95	-$13.98	-$13.01
Change in Consumer Surplus (million $)	-$15.30	-$60.76	-$83.48	-$106.20
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	0.16%	0.14%	0.13%	0.12%
Medium Cost Estimate (1%)				
Change in Producer Surplus (million $)	-$67.54	-$59.77	-$55.88	-$51.99
Change in Consumer Surplus (million $)	-$61.19	-$242.74	-$333.33	-$423.81
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	0.64%	0.57%	0.53%	0.49%
High Cost Estimate (3%)				
Change in Producer Surplus (million $)	-$202.20	-$178.97	-$167.35	-$155.72
Change in Consumer Surplus (million $)	-$183.41	-$725.65	-$995.15	-$1,263.58
Increase in Demand (Willingness-to-Pay) Needed to Make Producers Welfare Neutral	1.92%	1.70%	1.59%	1.48%

Table 5 – Effect of COOL on Changes in Meat Producer Surplus (in millions of dollars): Multiple-Market Model without Trade

	Scenarios											
	No Demand Change				2% Demand Increase for Beef and Pork				5% Demand Increase for Beef and Pork			
	All Cost Borne by Producers	Cost Shared: 50/50	Cost Shared: 25/75	All Cost Borne by Marketers	All Cost Borne by Producers	Cost Shared: 50/50	Cost Shared: 25/75	All Cost Borne by Marketers	All Cost Borne by Producers	Cost Shared: 50/50	Cost Shared: 25/75	All Cost Borne by Marketers
Low Cost Estimate (Beef = 0.5%; Pork = 0.25%)												
Change in Beef Producer Surplus	-$97.67	-$31.85	$1.07	$33.99	$191.94	$257.87	$293.14	$387.42	$627.32	$693.43	$726.49	$759.56
Change in Pork Producer Surplus	-$15.17	-$3.87	$1.78	$7.43	$144.53	$155.88	$123.54	$54.77	$385.56	$397.00	$402.72	$408.45
Change in Chicken Producer Surplus	$2.21	$13.24	$18.76	$24.28	-$71.21	-$60.21	-$53.65	-$19.75	-$180.91	-$169.96	-$164.49	-$159.01
Medium Cost Estimate (Beef = 3%; Pork = 1%)												
Change in Beef Producer Surplus	-$587.14	-$199.07	-$4.69	$189.93	-$298.41	$90.36	$285.09	$480.05	$135.66	$525.46	$720.71	$916.20
Change in Pork Producer Surplus	-$57.37	$6.03	$37.78	$69.56	$102.12	$165.84	$197.75	$229.68	$342.84	$407.03	$439.17	$471.35
Change in Chicken Producer Surplus	$12.31	$75.81	$107.62	$139.47	-$61.14	$2.16	$33.87	$65.63	-$170.88	-$107.88	-$76.32	-$44.71
High Cost Estimate (Beef = 6.5%; Pork = 3%)												
Change in Beef Producer Surplus	-$1,266.10	-$417.61	$10.55	$435.36	-$978.58	-$128.57	$301.16	$725.91	-$546.34	$305.95	$736.02	$1,162.71
Change in Pork Producer Surplus	-$179.99	-$35.71	$29.01	$109.22	-$21.10	$123.89	$145.90	$269.54	$218.71	$364.78	$430.29	$511.50
Change in Chicken Producer Surplus	$28.26	$170.85	$234.29	$314.29	-$45.24	$96.91	$169.72	$239.90	-$155.06	-$13.58	$49.37	$128.75

Table 6 – Effect of COOL on Changes in Meat Producer Surplus (in millions of dollars): Multiple-Market Model with Trade

	Scenarios											
	No Demand Change				2% Demand Increase for Domestic Beef and Pork				5% Demand Increase for Domestic Beef and Pork			
	All Cost Borne by Domestic Producers	Cost Shared By Domestic Producers and Marketers: 50/50	Cost Shared By Domestic Producers and Marketers: 27/75	All Cost Borne by Marketers	All Cost Borne by Domestic Producers	Cost Shared By Domestic Producers and Marketers: 50/50	Cost Shared By Domestic Producers and Marketers: 27/75	All Cost Borne by Marketers	All Cost Borne by Domestic Producers	Cost Shared By Domestic Producers and Marketers: 50/50	Cost Shared By Domestic Producers and Marketers: 27/75	All Cost Borne by Marketers
Low Cost Estimate (Beef = 0.5%; Pork = 0.25%)												
Change in Beef Producer Surplus	-$97.63	-$31.31	$1.85	$35.03	$190.63	$257.06	$290.28	$323.51	$623.96	$690.57	$723.88	$757.20
Change in Pork Producer Surplus	-$15.15	-$2.67	$3.58	$9.82	$143.78	$156.33	$162.60	$168.88	$383.65	$396.29	$402.61	$408.93
Change in Chicken Producer Surplus	$2.24	$13.45	$19.06	$24.67	-$72.10	-$60.92	-$55.33	-$49.73	-$183.15	-$172.03	-$166.46	-$160.90
Medium Cost Estimate (Beef = 3%; Pork = 1%)												
Change in Beef Producer Surplus	-$586.92	-$195.42	$0.69	$197.04	-$299.54	$92.66	$289.12	$485.81	$132.49	$525.74	$722.72	$919.93
Change in Pork Producer Surplus	-$57.26	$9.13	$42.38	$75.66	$101.47	$168.19	$201.60	$235.04	$341.02	$408.23	$441.89	$475.58
Change in Chicken Producer Surplus	$12.46	$76.94	$109.24	$141.58	-$61.90	$2.37	$34.57	$66.81	-$173.01	-$109.04	-$76.99	-$44.90
High Cost Estimate (Beef = 6.5%; Pork = 3%)												
Change in Beef Producer Surplus	-$1,265.59	-$410.41	$18.88	$559.77	-$979.42	-$122.72	$307.34	$849.19	-$549.20	$309.79	$740.98	$1,284.27
Change in Pork Producer Surplus	-$179.72	-$22.10	$57.00	$329.64	-$21.60	$136.80	$216.29	$490.27	$217.05	$376.61	$456.69	$732.67
Change in Chicken Producer Surplus	$28.61	$173.50	$246.28	$408.18	-$45.81	$98.63	$171.18	$332.57	-$156.99	-$13.23	$58.97	$219.61