A Differential Examination of the Effect of Mandatory Country of Origin Labeling on the Beef Sector

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Abstract: The introduction of mandatory country of origin labeling in the agricultural sector promises to yield consumer benefits by providing additional information to consumers. However, these benefits will be partially offset by the cost of labeling paid by producers. This study derives the labeling cost required to offset consumer gains from labeling.

Keywords: economic surplus, break-even labeling cost

On October 30, 2003 the Agricultural Marketing Service of the United States Department of Agriculture (USDA/AMS) posted 7 CFR Part 60 "Mandatory Country of Origin Labeling of Beef, Lamb, Pork, Fish, Perishable Agricultural Commodities, Peanuts; Proposed Rule" which has become known as Mandatory Country of origin labeling (MCOOL). MCOOL would "…require retailers to notify their customers of the country of origin of covered commodities beginning September 30, 2004." Ostensively this rule was for the consumer's benefit "[T]he intent of this law is to provide consumers with additional information on which to base their purchasing decisions." However, the proposed law also has the potential to increase the price received by domestic producers by adding a transaction cost to foreign product. This paper examines the potential impact of MCOOL on total economic surplus using an approach proposed by Moss, Schmitz, and Schmitz (2004).

Modeling the Welfare Implications of MCOOL

To analyze the potential effect of MCOOL, we start with the market equilibrium for beef written as

$$S_T(p) = S_D(p) + S_I(p) = D(p) \tag{1}$$

where $S_T(p)$ is the total supply of beef which is composed of a domestic supply ($S_D(p)$) and a supply of imported beef ($S_I(p)$), and the domestic demand for beef ($D(p)$) where the supply and demand of beef is a function the price of beef (p). We then modify this basic equilibrium to account for MCOOL by introducing transaction costs associated with labeling (τ) and a demand shift associated with the consumer benefits from knowing the country of origin of beef (ψ). In addition, we incorporate the possibility that MCOOL could benefit the domestic supply by reducing the probability of a disease occurrence (i.e., reduce the possibility of a BSE incident in the United States). This is depicted by a supply shift (ϕ). The new market equilibrium is represented as

$$S_T^*(p,\phi,\tau) = (1+\phi)S_D(p) + S_I(p-\tau) = (1+\psi)D(p) \tag{2}$$

where the supply function is now a function of the animal health effects and the labeling costs and consumer demand is affected by knowing where the beef they consume originated. Specifically, knowing the country of origin of a product may reduce the cost of uncertainty with regards to its health effect or quality.

Consumer Perceptions under Uncertainty

The introduction of labeling costs for foreign producers in feeder cattle market reduces economic surplus by reducing the consumer surplus, since the price paid by consumers will increase, and producer surplus accruing to foreign producers (as depicted in Equation

2). However, these loses are partially offset by gains to domestic producers through higher prices. In general foreign producers could benefit from the introduction of country of origin labeling if the reduction in uncertainty causes a sufficiently large shift in demand. Alternatively, exports in some countries whose goods are deemed less risky may fare better than producers in other countries.

Equation 2 allows two mechanisms to offset the negative effect of the introduction of labeling cost: increased consumer confidence in the food system from the introduction of MCOOL and the possibility of a supply shift resulting from increased animal health in the United States. In this section we briefly develop the possible shift in demand that could result from increased consumer confidence in the food system.

Oi (1973) presented a formulation of the consumer's decision based on the possibility of consuming a defective product. In this context, Oi specified the consumer's budget constraint as

$$PX + W\left(X - Z\right) + Y = M \qquad (3)$$

Where P is the cost of the consumption good, X is the quantity of the consumption good purchased, W is the cost of any damages caused by defective goods, Z is the quantity of non-defective goods $\left(Z \leq X\right)$, Y is the quantity of other goods consumed, and M is the level of monetary income. In this framework the consumer decides to purchase X quantity of a good that is risky in the sense that some of these goods will be defective. In total $X - Z$ of this quantity are defective and cause some damage to the consumer. Maximizing the expected utility based on the budget constraint in Equation 3 yields

$$\hat{U} = \int_0^X U\left(Z, M - PX - WZ\right) dG\left(Z\right) \quad (4)$$

where $\hat{U}$ denotes expected utility, $U\left(Z,Y\right)$ is a utility function, and $dG\left(Z\right)$ represents the change in the cumulative distribution function of the defective good.

Instead of solving Equation 4, Oi proposes solving for the full price of consumption assuming that an insurance policy can be written to cover the risk of defective goods. Defining the portion of non-defective goods as π, the number of non-defective goods can be derived as $\pi X = \hat{Z}$. The cost of consuming X units of the original commodity $\left(\hat{C}\right)$ then becomes

$$\hat{C} = PX + W\left(X - \hat{Z}\right) \quad (5)$$

The full price (i.e., price including risk) of consuming the expected quantity of non-defective good $\left(P^*\right)$ is then

$$\begin{aligned} P^* &= \frac{\hat{C}}{\hat{Z}} = \frac{P}{\pi} + W\left(\frac{1-\pi}{\pi}\right) \\ &= \hat{P} + W\gamma \end{aligned} \quad (6)$$

Where $\hat{P} = P/\pi$ is the warranty price and $\gamma = \left(1-\pi\right)/\pi$ is the actuarial price to cover the damages from the defective goods.

To integrate the effects of MCOOL into this framework, we assume two possible sets of goods X_1 and X_2. We assume that X_1 has a higher fraction of non-defective goods than X_2 $\left(\pi_1 > \pi_2\right)$. In this case the warranty price of good 1 must be higher than the warranty price of good 2

$$P_1^* = \hat{P}_1 + W\gamma_1 > \hat{P}_2 + W\gamma_2 = P_2^* \quad (7)$$

where the expected cost of the damages is the same for each good. Based on this formulation, there exist a break-even damage $\left(W^*\right)$ that leaves the consumer indifferent between the two goods. This break-even level of damages can be computed as

$$W^* = \frac{\hat{P}_1 - \hat{P}_2}{\gamma_2 - \gamma_1}. \tag{8}$$

If we assume that the perceived cost of damages from consuming a defective good varies across the population, the demand for each good (i.e., X_1 and X_2) becomes

$$\begin{aligned} X_1 &= \int_{W^*}^{\infty} g\left(W\right) dW \\ X_2 &= \int_{0}^{W^*} g\left(W\right) dW \end{aligned}. \tag{9}$$

The perceived cost of damages divides the market.

Applying this to MCOOL, we assume that consumers originally cannot discern between a foreign product and a domestic product. As a result, their perception of π is some weighted average between product originating from domestic or foreign sources. After the introduction of country of origin labeling, consumers can make a choice about foreign or domestic products based on differences in the perceived probability of damages. In aggregate such change could not result in an inward shift in total demand. If π_1 and π_2 are equal or the country of origin labeling is uninformative the overall demand would remain unchanged. However, if the probabilities of defective goods were different, then at least one consumer could be made better off by observing the label so that the demand for that consumer would shift to the right. Hence, the introduction of MCOOL would imply no decrease in aggregate demand and the possibility of an increase in aggregate demand under Oi's formulation. Thus, $\psi \geq 0$ in Equation 2. However, this result does not imply that this increase in demand would be sufficient to cover the cost of country of origin labeling.

Modeling Changes in Economic Surplus

We derive the overall economic welfare in the beef market conditional on labeling costs, animal health effects, and consumer perceptions as

$$W(\tau,\phi,\psi)=\int_{\bar{p}_D}^{p^*}(1+\phi)S_D(p)\,dp+\int_{\bar{p}_I}^{p^*-\tau}S_I(p)\,dp+\int_{\infty}^{\underline{p}}(1+\psi)D(p)\,dp \tag{3}$$

where p^* is the price that clears the beef market for a specific ϕ, τ, and ψ, $\bar{p}_D$ is the choke price for beef supply for the domestic market, and $\bar{p}_I$ is the choke price of imported beef. Note that we have defined the welfare based on the integrals in price space as opposed to commodity space. Totally differentiating this welfare function with respect to ϕ, τ, and ψ yields

$$\begin{aligned}
&\frac{\partial p^*}{\partial\phi}\left[\int_{\bar{p}_D}^{p^*}(1+\phi)S_D(p)\,dp+\int_{\bar{p}_I}^{p^*-\tau}S_I(p)\,dp-\int_{p^*}^{\underline{p}}(1+\psi)D(p)\,dp\right]d\phi+\\
&\frac{\partial p^*}{\partial\tau}\left[\int_{\bar{p}_D}^{p^*}(1+\phi)S_D(p)\,dp+\int_{\bar{p}_I}^{p^*-\tau}S_I(p)\,dp-\int_{p^*}^{\underline{p}}(1+\psi)D(p)\,dp\right]d\tau-\\
&\frac{\partial p^*}{\partial\psi}\left[\int_{\bar{p}_D}^{p^*}(1+\phi)S_D(p)\,dp+\int_{\bar{p}_I}^{p^*-\tau}S_I(p)\,dp-\int_{p^*}^{\underline{p}}(1+\psi)D(p)\,dp\right]d\psi+\\
&\left(\int_{\bar{p}_D}^{p^*}S_D(p)\,dp\right)d\phi+\left(\int_{\bar{p}_I}^{p^*-\tau}\frac{\partial S_I(p)}{\partial\tau}\,dp\right)d\tau+\left(\int_{\bar{p}_D}^{p^*}D(p)\,dp\right)d\phi=dW(\tau,\phi,\psi)
\end{aligned}\quad . \tag{4}$$

As found in Moss, Schmitz, and Schmitz (2004), the change in direction of the impact of MCOOL on aggregate welfare is undetermined. A large shift in demand for the imposition of a small labeling cost implies an increase in societal surplus while the imposition of labeling cost without perceived consumer benefits implies a loss of overall welfare.

Empirical Implementation of the MCOOL Model

To compute the combinations of labeling cost, demand shift, and shift in domestic supply due to improved animal health (i.e., the reduction in disease in domestic herds resulting from increased information) that leave the overall economic surplus unchanged, we will use the constant elasticity of demand model by proposed by Lichtenberg and Zilberman (1986) as implemented by Schmitz (2005) to model the demand for feeder cattle. We use a similar function to model supply that allows for a non-zero shut-down cost. Both of these approximations are parameterized using supply and demand elasticities estimated by Marsh (1994).

Using the constant elasticity of demand model proposed (Lichtenberg and Zilberman 1986), the inverse demand for feeder cattle is specified as:

$$p = \alpha_T q^{\beta} \tag{5}$$

where α_T is a scaling parameter and β_T is the price flexibility of demand. Inverting this function yields

$$q_T = D(q) = \left[\frac{1}{\alpha_T} p\right]^{1/\beta_T} \quad . \tag{6}$$

Note that the price elasticity of demand given the demand specification in Equation 6 is $1/\beta_T$. We complete this specification by setting $1/\beta_T = -0.887$ and computing the α_T using the market equilibrium from 2003. In 2003 32.983 million calves were produced in the United States (USDA 2004). This supply was augmented by 0.816 million head imported from Mexico and 1.687 million head imported from Canada. While the cattle imported from Mexico are largely lighter cattle, cattle imports from Canada include fat cattle and cull cows as well as lighter weight cattle. To adjust for this, we assume that 50 percent of the cattle imported from Canada are lighter weight cattle. Thus, the total quantity of feeder cattle consumed in 2003 was 34.643 million head. Assuming that each feeder calf weighs 750 pounds yields 25.982 billion pounds of feeder cattle consumed in 2003. Taking the season average price for feeder cattle of $0.8985/pound (USDA 2005) yields a computed value of α_T of 16.156.

We modify the constant elasticity equation presented in Equation 5 to allow for a non-zero shut-down value. Specifically, we specify the inverse supply of domestic feeder cattle in the United States as

$$p = \alpha_D + \beta_D q^{\gamma_D} \tag{7}$$

where α_D is the shut-down price for domestic producers, β_D is a scaling parameter, and γ_D is related to price flexibility of supply. The price flexibility of supply based on Equation 7 can be derived as

$$\eta = \frac{\partial p}{\partial q}\frac{q}{p} = \gamma_D \frac{1}{\alpha_D / \beta_D \, q^{-\gamma_T} + 1} \tag{8}$$

where η denotes the price flexibility of supply. As the quantity supplied increases $q^{-\gamma_T} \rightarrow 0$ so Equation 7 approaches a constant elasticity of supply model. Inverting Equation 7 yields a supply of domestic feeder cattle of

$$q_D = S_D(p) = \left[\frac{p - \alpha_D}{\beta_D}\right]^{1/\gamma_D}. \tag{9}$$

Using this specification, the 32.983 million calves produced domestically implies 24.738 billion pounds of feeder cattle produced domestically in 2003. Taking the price elasticity of domestic supply as 1.167 from Marsh (1994) (implying a price flexibility of supply of 0.857), a market price for domestic feeder cattle of $0.8985/pound, and a shut-down price of $0.50/pound yields a value of α_D of 0.50, a value of β_T of 0.00080983 and a value of γ_T of 1.9321.

Using a similar specification for import supply as presented for domestic supply yields

$$p = \alpha_I + \beta_I q^{\gamma_I} \quad . \tag{10}$$

Assuming an import supply of 1.687 million head yields 1.245 billion pounds of feeder cattle which assuming a market price of $0.8985/pound implies a α_I of 0.50, a β_I of 0.26101, and a γ_I of 1.9321.

Table 1 presents the initial welfare estimates for MCOOL given this specification. The initial specification yields a domestic producer surplus of $6.496 billion, a producer surplus for foreign producers of $0.327 billion, and a consumer surplus of $183.249 billion, or $190.072 billion in total economic surplus. Incorporating a labeling cost of $0.05335/pound to the import supply function increases domestic producer surplus to $6.529 billion, decreases producer surplus for foreign producers to $0.264 billion, reduces consumer surplus to $183.214 billion. In total, economic surplus declines to $190.007 billion. Thus consistent with our expectations, imposing labeling costs results in gains to domestic producers and loses to foreign producers and consumers if we do not consider an offsetting benefit to consumers from labeling.

An alternative assumption is that consumers benefit from mandatory labeling. Table 1 presents the economic surplus resulting from a 0.035 percent increase in the demand for feeder cattle associated with increased information from mandatory labeling coupled with the $0.05335/pound labeling cost. Under this scenario, the total economic surplus is the same as before the imposition of country origin labeling, however, the composition of the economic surplus changes. Under both labeling cost and increased demand producer surplus increases to $6.532 billion for domestic producers, while the surplus accruing to foreign producers decreases to $0.265 billion and consumer surplus increases to $183.275 billion. Thus, the demand shift due to reduced uncertainty offsets the imposition labeling costs.

Table 2 extends this analysis by presenting the combinations of labeling costs, increased consumer demand from labeling information, and supply shifts due to animal health that leaves economic surplus unchanged. The second column in Table 2 presents the additional labeling cost that would leave economic surplus unchanged in response to an increase in domestic demand given no animal health effect. As presented in Table 1, a $0.05335/pound increase in labeling cost yields on change in economic surplus if it is accompanied by a 0.035 percent increase in the demand for feeder cattle. Thus, a labeling cost of less than $0.05335/pound that resulted in a 0.035 percent increase in consumer demand would improve overall welfare while a labeling cost of greater than $0.05335/pound would lower the aggregate surplus. Note that the break-even labeling cost is an increasing function of the increase in demand. Thus, the greater the perceived benefit, the larger the potential labeling cost that would leave aggregate economic surplus unchanged, as would be expected from economic theory. Examining the first row of Table 2 we see that the break-even labeling cost increases as the effect of labeling on animal health increases.

Numerically the results presented in Table 2 indicate that a relatively large label cost could be justified by a small improvement in either consumer demand or animal health. For example, a $0.08874/pound label cost (or 9.9 percent of the original market equilibrium price) would be offset by a 0.055 percent shift in the demand and a 0.05 percent increase the domestic supply associated with animal health. The magnitude of the break-even labeling cost that leaves consumer surplus unchanged is largely attributable to relative magnitude of foreign supply of feeder cattle. Under our scenario only 4.8 percent of feeder cattle would be subject to the additional cost of country of origin labeling. However, even with the relatively small effect required to offset the additional labeling cost it is unclear that shift in consumer demand would be forthcoming to offset these additional costs. Specifically, feeder cattle are typically not consumed directly, but placed on feed for slaughter as fat cattle. Undoubtedly the period of the time on feed ameliorates some of the health concerns of consumers as animals are inspected for health in the feedlots and before slaughter.

Discussion and Implications

In 2003 changes in the federal rules and regulations have introduced mandatory country of origin labeling beginning in 2004. This change was introduced, at least in theory, to improve consumer welfare by providing additional information for purchasing decisions. However, the net effect of MCOOL depends on the relative size of the labeling costs versus the informational benefits to consumer. To determine whether the introduction of MCOOL improves societal surplus, this study develops the break-even labeling cost for various shifts in demand associated the improved information in the feeder cattle market in the United States using information available for the 2003 marketing year. Our results indicate that a $0.05335/pound labeling cost is sufficient to offset a 0.035 percent increase in consumer demand associated with the introduction of country of origin labeling. Our results indicate that the break-even labeling cost is an increasing function of the demand shift associated with the introduction of new information. Further, the break-even labeling cost is an increasing function of any supply shift associated with health benefits observed by domestic producers.

The break-even labeling costs derived in this study map the combinations of labeling costs, supply shifts for domestic producers, and changes in consumer demand that leave overall economic benefit unchanged. As such, given any estimate of consumer benefits and supply shift from MCOOL, a labeling cost less than this break-even figure implies that the imposition of MCOOL would improve economic welfare. However, if the cost of imposing MCOOL is above this break-even cost societal welfare would decline. Alternatively, if we knew the cost of meeting the country of origin labeling requirements, our results indicate what levels of consumer benefit would be required to offset those labeling costs. Thus, a demand shift in excess of the break-even shift in demand derived in this study implies that the introduction of MCOOL increases overall economic surplus.

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Table 1. Implications of Labeling for Producer and Consumer Surplus and Aggregate Welfare

	Feeder Calf Price (cents/pound)	Domestic Producer Surplus	Foreign Producer Surplus	Consumer Surplus	Aggregate Welfare
			Labeling Cost =$0.0000/cwt		
0.00000	0.8985	6.496	0.327	183.249	190.072
0.00035	0.8986	6.499	0.327	183.309	190.136
			Labeling Cost =$0.05335/cwt		
0.00000	0.8998	6.529	0.264	183.214	190.007
0.00035	0.9000	6.532	0.265	183.275	190.072

Table 2. Offsetting Labeling Cost

Percent Increase in Domestic Demand	Percent Increase in Domestic Supply					
	0	0.0001	0.0002	0.0003	0.0004	0.0005
0.00010	0.01486	0.01539	0.01593	0.01646	0.01699	0.01753
0.00015	0.02240	0.02294	0.02348	0.02402	0.02456	0.02510
0.00020	0.03002	0.03056	0.03111	0.03165	0.03220	0.03274
0.00025	0.03771	0.03826	0.03881	0.03936	0.03992	0.04047
0.00030	0.04549	0.04605	0.04660	0.04716	0.04772	0.04828
0.00035	0.05335	0.05392	0.05448	0.05505	0.05561	0.05618
0.00040	0.06131	0.06188	0.06245	0.06303	0.06360	0.06417
0.00045	0.06936	0.06994	0.07052	0.07110	0.07168	0.07226
0.00050	0.07751	0.07810	0.07868	0.07927	0.07986	0.08045
0.00055	0.08576	0.08636	0.08695	0.08755	0.08815	0.08874
0.00060	0.09413	0.09473	0.09533	0.09594	0.09654	0.09715