Animal Identification and Traceability in the United States: Market Impacts and Implications

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Abstract: Livestock traceability has increasingly become a focus for the USDA, the National Cattlemen's Beef Association, high-volume beef-exporting states, and other beef industry stakeholders. The focus on traceability within the United States began after several international animal disease outbreaks and continues to be of importance with African Swine Flu spreading across Asia. Mitigating adverse future disease outbreaks, as well as maintaining export markets through a positive international perception of U.S. beef has become a top priority. Implementing a national disease traceability program would enable the industry to track and reduce the potential losses due to an outbreak. However, such a system comes at a large cost, mainly to cow-calf producers. This study utilizes an equilibrium displacement model (EDM) to determine the impacts of a beef cattle disease traceability system in the United States. Utilizing the EDM allows us to provide a comparison of how the various beef sectors would need to respond to offset the costs of a national disease traceability program.

Introduction

The United States is relatively "behind" other countries in implementing a national traceability program. Other large beef exporters, including Argentina, Australia, Canada, European Union, New Zealand, and Uruguay, all have government mandated systems (Schroeder and Tonsor 2012). Despite the lack of a national traceability program, U.S. beef has remained internationally competitive and generally accepted as a safe source. This, along with fear of increased cost and other long-term implications, has led some industry stakeholders to disapprove of potential government-mandated traceability programs (Golan et al. 2004).

Beef production in the United States is highly segmented, often resulting in several changes of ownership between the time animals are weaned and slaughtered. The primary product of cow-calf operations is weaned calves, which are sold to stocker operators, backgrounding lots, or feedlots. Calves from cow-calf operations generally follow one of two paths. They can be transferred directly to feedlots at or around the time of weaning, in which case they are referred to as "calf-feds" that remain in the feedlot for 240 days or more before being harvested. The largest share of the calf population, usually 60% or more, is first placed into a backgrounding or stocker operation, or a combination thereof, to be grown for a period of time before fattened on high-concentrate diets (USDA 2018). Most cattle pass through a feedlot at some point before reaching slaughter. The segmentation, production differences, and geographical disbursement further complicates the tracing and tracking system.

In addition, there are over 103 million head of cattle in the United States, with 192,000 head, and over 2.6 billion pounds of beef exported in 2018 (USDA 2018a & 2018b). This high volume of production and global demand for U.S. beef complicates the ability to trace, or physically track a product, through the typical U.S. beef supply chain.

Several studies, including Coffey et al. (2005), have assigned an opportunity cost to the expected impact of a disease outbreak, specifically BSE, in the United States. These studies support the positive impact that a traceability program could have on the U.S. beef industry in avoiding lost export markets and loss of inventory. Measuring the potential impacts of an outbreak has been considered from many different perspectives and all suggest a significant negative impact to the industry; so much so that the National Cattlemen's Beef Association included traceability in their Long-Range Plan for 2016-2020 (NCBA 2017). However, determining the true costs and impacts of a traceability program within the United States is difficult due to the nature of the U.S. supply chain, but is crucial as a national traceability program is eminent. Understanding the potential economic impact of a traceability program is important, especially in a large beef producing state such as Kansas. In addition, it is important to recognize which segments of the industry may be affected the most.

The objective of this study is to analyze the economic impacts of an animal identification and traceability system. Specifically, we calculate the direct costs of implementing an animal identification and traceability system, called CattleTrace, for each segment in the U.S. beef industry. Next, we incorporated the cost estimates into a partial equilibrium model of the U.S. livestock and meat industry to determine the short- and long-run economic impacts to the various segments of the U.S. beef industry.

In 2018, the CattleTrace pilot program was launched with the support of industry stakeholders to begin directing the beef industry towards a cohesive traceability program. The CattleTrace program extends from beginning-to-end of the beef industry and includes participants from all segments of production. Current participation from beef industry stakeholders includes many cow-calf producers, 12 livestock markets, 2 backgrounders, 16 feedlots, and 3 major packers (4 locations). While the CattleTrace program began in Kansas, multiple states are now part of the system with various private and public organizations establishing partnerships in an effort to illustrate how a national traceability program may look in the future. The following analysis is based on the cost estimation of implementing a national traceability program structured as CattleTrace.

Data & Methods

A multi-market, multi-species partial equilibrium model of the U.S. livestock and meat industry is used to estimate the impacts of industry costs incurred through the adoption of CattleTrace on U.S. livestock and meat producers. In general, as additional costs are incurred throughout a vertically-related marketing chain, livestock and meat prices and quantities are impacted. Furthermore, changes in prices at the retail level for beef will influence the demand for substitute products (e.g., pork and poultry). A traceability system could also positively influence domestic and international demand for U.S. beef. However, the extent of these potential changes is difficult to forecast.

The economic model utilized in this study is an updated version of the multi-market, multi-species partial equilibrium model documented in Pendell et al. (2010), Pendell et al. (2013) and Dennis et al. (2018). An equilibrium displacement model (EDM) allows for the estimation of the

potential impact of a particular shock on the market, in this case we are looking at how implementing a national traceability program will impact livestock and meat markets. Such a model allows for changes in both supply and demand across multiple markets, in this case between beef, pork, poultry, and lamb.

The shock to the EDM model is the implementation of CattleTrace. The cost of implementing CattleTrace was estimated for each segment of the industry and also took into account economies of scale. The EDM model also relies on given elasticity estimates to properly estimate how the markets will respond to supply and demand changes. The base year price and quantity data are from 2018 and reported in Table 1 (LMIC 2019). The remaining market parameters, including the supply and demand elasticities for the different commodities across the various sectors, were retained as defined in Dennis et al. (2018).

The five segments of the U.S. beef industry in this study include: cow/calf, backgrounder/stocker, sale barn, feedlot, and packer. The total cost estimates for each segment are $129.82 million (cow/calf), $7.67 million (backgrounder/stocker), $6.44 million (sale barn), $9.64 million (feedlot), and $0.51 million (packer) (Table 2). The five group subtotals were summed to obtain the annual total cost for the entire beef cattle industry of adopting CattleTrace, $154.09 million. Costs associated with the cow/calf and sale barns sectors are aggregated in the feeder cattle sector, backgrounder and feedlots are aggregated in the slaughter cattle sector, and packer costs are referred to as wholesale costs in this economic analysis.

The annual beef industry CattleTrace costs are distributed as: $0.51 million to the wholesale beef sector, $17.31 million to the slaughter cattle production sector and $136.26 million to the farm sector (Table 3). Using 2018 average prices and quantities for each market level, these cost estimates represent the following percentage increases in CattleTrace costs relative to total value at each sector: 0.0009% at the wholesale beef level, 0.0333% at the slaughter cattle level, and 0.2548% at the farm level (Table 3). The percentage changes in costs at each market level are estimated in a similar manner for all scenarios.

Scenarios

Four scenarios are considered when quantifying the economic impacts of CattleTrace. The first two scenarios differ in the proportion of costs borne by the producer. The final two scenarios focus on U.S. beef demand responses by domestic and international consumers. It is assumed that 100% of producers would adopt CattleTrace.

The scenarios are separated into four areas:

1) Effects of CattleTrace Costs with No Benefits

The impacts of increased costs resulting from CattleTrace are simulated. This simulation assumes both domestic and international consumer demand for U.S. beef is unaffected by CattleTrace. In other words, we estimate the impacts of the costs associated with 100% adoption of CattleTrace assuming that no benefits accrue to the U.S. beef industry.

2) Effects of a Government Cost-Share of CattleTrace Costs with No Benefits

According to recent research by Mitchell, Tonsor and Schultz (2019), “results show that policies would be most effective at reducing costs at the cow-calf level or offering cost-shares for feedlot producers who want to procure cattle with electronic traceability”. Similar to Scenario 1, we simulate the impacts of increased costs resulting from CattleTrace. However, we assume 1/3 of the costs for RFID ear tags and electronic readers are borne by the producer while the government is responsible for the remaining 2/3 of those costs. Like Scenario 1, this simulation assumes both domestic and international consumer demand for U.S. beef is unaffected by CattleTrace. In essence, we measure how a government cost-share program for CattleTrace would impact the U.S. beef industry.

3) Increases in International Beef Demand Needed to Offset CattleTrace Costs

Adoption of CattleTrace, or any other animal identification and traceability system, could increase foreign consumer confidence in the U.S. beef system. We estimate the increase in U.S. beef export demand (assuming constant domestic demand) that would be needed to offset producer costs of CattleTrace adoption costs.

4) Increases in Domestic Beef Demand Needed to Offset CattleTrace Costs

Similar to Scenario 3, we estimate how much of a domestic beef demand enhancement would be required (assuming constant export demand) to offset producer costs of CattleTrace adoption costs.

Results

1) Effects of CattleTrace Costs with No Benefits

Table 4 presents the short- (year 1) and long-run (year 10) percentage changes in U.S. livestock and meat prices and quantities resulting from adopting CattleTrace. As expected, changes in prices and quantities for the U.S. beef industry were much larger when compared to the pork, poultry and lamb industries. This is because the U.S. beef industry is the only industry with an increase in costs as a result of CattleTrace. All changes in prices and quantities within the beef industry are consistent with an increase in CattleTrace costs at the wholesale, slaughter and farm levels. An increase in costs at the farm, slaughter and wholesale levels shifts both the primary and derived supply functions, as well as derived demand functions at the slaughter and farm levels. This results in retail and wholesale level beef prices to increase by 0.43% and 0.42%, respectively, while quantities decline by 0.16% and 0.41%. Imported and exported wholesale beef, slaughter and feeder cattle prices and quantities all decline. Pork, poultry and lamb prices and quantities all increase, except for export quantities, by a small amount, as consumers substitute away from beef to relatively cheaper protein sources in response to increased retail beef prices.

Table 5 presents consumer and producer surplus impacts due to the costs implementing CattleTrace. As expected, the short-run impacts (year 1) are much larger than the long-run impacts (year 10). In the short-run, the slaughter and feeder cattle sectors experience the largest losses at $271.7 and $238.0 million, respectively. The wholesale level loses $56.0 million. In the long-run, the feeder and slaughter cattle sectors lose $41.7 and $11.4 million, respectively, while

the wholesale level lose $3.5 million in producer surplus. The cumulative discounted present value of producer surplus losses over 10-years for the feeder cattle, slaughter cattle and wholesale beef sectors are $1,291 million, $1,143 million and $475 million, respectively.

2) Effects of a Government Cost Share of CattleTrace Costs with No Benefits

Table 6 presents the short- and long-run percentage changes in U.S. livestock and meat prices and quantities resulting from a cost-share program with the government. Results are similar to the scenario when producers bear all CattleTrace costs, except the impacts are smaller in magnitude. This results in retail and wholesale level beef prices to increase by 0.27% and 0.27%, respectively, while quantities decline by 0.10% and 0.26%. Imported and exported wholesale beef, slaughter and feeder cattle prices and quantities all decline. Slaughter cattle price and quantity fall by 0.10% and 0.22%, respectively, while feeder cattle price and quantity fall by 0.07% and 0.16%. Pork, poultry and lamb prices and quantities all increase, except for export quantities, by a small amount, as consumers substitute away from beef to relatively cheaper protein sources in response to increased retail beef prices.

Table 7 presents consumer and producer surplus impacts due to the costs implementing CattleTrace. Similar to the previous scenario, the short-run impacts are much larger than the long-run impacts. In the short-run, the slaughter and feeder cattle sectors experience the largest losses at $173.6 and $154.1 million, respectively, while the wholesale level lose $35.5 million. In the long-run, the feeder and slaughter cattle sectors lose $7.4 and $25.5 million, respectively, while the wholesale level lost $2.3 million in producer surplus. The cumulative discounted present value of producer surplus losses over 10-years for the feeder cattle, slaughter cattle and wholesale beef sectors are $813 million, $733 million and $304 million, respectively.

3) Increases in International Beef Demand Needed to Offset CattleTrace Costs

As most major exporting countries have traceability systems, implementing a national traceability program could open new markets or allow for quicker entry back into the market after a disease outbreak. This scenario was performed to determine the increase in international beef demand needed so that the U.S. beef producer sectors do not lose any producer surplus. A permanent 17.7% increase (or 558 million lbs.) in international demand for U.S. beef would be needed such that producers do not lose any surplus. To put this value into perspective, the quantity of U.S. beef exports varied from an increase of 21% to a 12% decreased between 2009 and 2018 (LMIC). Furthermore, 28% (885 million lbs.), 20% (638 million lbs.), and 14% (449 million lbs.) of U.S. beef exports went to Japan, South Korea, and Mexico, respectively, in 2018 (LMIC). Thus, maintaining market access to a single export market could completely offset U.S. beef producer costs of CattleTrace.

4) Increases in Domestic Beef Demand Needed to Offset CattleTrace

As demand for transparency by U.S. consumers continues to increase, implementing a national traceability program could potentially have a positive impact on consumer demand for beef. This scenario was performed to determine the increase in domestic beef demand needed so that the U.S. beef producer sectors do not lose any producer surplus. A permanent 1.9% increase (or 356

million lbs.) in domestic demand for U.S. beef would be needed such that producers do not lose any surplus. Between 2009 and 2018, annual domestic retail beef demand, on average, varied between an increase of 4.14% to a decrease of 4.10% from the previous. Thus, a modest increase in domestic consumer demand for beef needed to offset the costs of CattleTrace has been experienced recently.

Conclusion

This analysis is an overview of the costs and economic impacts of implementing CattleTrace, a UHF-RFID technology-based traceability program. The main objectives of this analysis was to provide an estimate of the direct cost to the industry for implementing CattleTrace, as well as estimate the economic impact of a national identification program for the beef industry. Determining the direct costs to the industry required estimating costs within each industry sector as well as taking into account economics of scale. When considering economies of scale, the cost of implementing CattleTrace ranged from $2.84 to $6.06/head for cow/calf producers. For backgrounders, the cost of implementing CattleTrace ranged from $0.41 to $0.83/head. The average cost for sale barns was $0.14/head, and the cost of implementing CattleTrace for feedlots ranged from $0.33 to $0.55/head. The average cost to packers ranged from $0.02 to $0.18/head. The overall direct cost to the beef industry estimated to be $154,087,329.

A partial equilibrium model of the U.S. livestock and meat sector was used to evaluate the impacts of adopting CattleTrace on producers. Assuming no changes in domestic and international demand for U.S. beef, producers at the wholesale, slaughter, and feeder levels lose $475 million, $1,143 million, and $1,291 million, respectively, in 10-year discounted cumulative producer surplus. If a government cost share program is implemented (i.e., 1/3 of the costs of tags and readers are borne by the producers while the other 2/3 of the costs are borne by the government), the producers losses are smaller; feeder, slaughter and wholesale levels lose $813 million, $733 million, and $304 million, respectively. With a possibility of increasing consumer demand as a result of traceability, two simulations evaluated the increase in international and domestic demand required to offset the costs of CattleTrace to U.S. cattle producers. A 17.7% and 1.9% increase in international and domestic beef demand would be required to completely offset the costs of CattleTrace, respectively.

This analysis suggests that while the direct costs to producers and the industry as a whole, can be directly offset by utilizing a government cost-share program, but also by small fluctuations in domestic and international beef demand. These results may encourage more industry support for a national traceability program, however some concerns, such as data management, cannot be addressed in this model and therefore remain as hurdles to the implementation of a national beef traceability program.

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Appendix

Table 1. Prices and Quantities used in Analysis, 2018

	Price	*Quantity*
Level	*$/lb.*	*Billion lbs.*
Retail Beef	5.923	18.759
Wholesale Beef	2.140	26.948
Imported Wholesale Beef	1.875	2.999
Exported Wholesale Beef	2.140	3.155
Slaughter Cattle	1.167	44.578
Feeder Cattle	1.469	36.403
Retail Pork	3.745	16.632
Wholesale Pork	0.752	26.315
Imported Wholesale Pork	1.605	1.042
Exported Wholesale Pork	0.752	5.870
Slaughter Hogs	0.461	35.246
Domestic Retail Lamb	8.204	0.132
Imported Retail Lamb	10.386	0.236
Wholesale Lamb	3.760	0.153
Slaughter Lamb	1.271	0.307
Feeder Lamb	1.775	0.243
Retail Poultry	1.818	35.368
Wholesale Poultry	0.957	49.016
Exported Retail Poultry	0.957	7.763

Table 2. Summary of CattleTrace Direct Costs to Industry

Sector	CattleTrace Direct Cost	% of Total Industry Cost
Cow/Calf	$129,823,537	84.3%
Backgrounder	$7,670,839	5.0%
Sale Barn	$6,439,428	4.2%
Feedlot	$9,640,589	6.3%
Packer	$512,936	0.3%
Total	$154,087,329	100%

Table 3. CattleTrace Costs and Exogenous Supply Shocks used in Partial Equilibrium Model

Industry Sector	Costs	Percent Change
Packer	$512,936	-0.0009
Slaughter Cattle	$17,311,428	-0.0333
Feeder Cattle	$136,262,965	-0.2548

Table 4. Median Percentage Changes Resulting from Adopting CattleTrace

	Price		Quantity	
Endogenous Variables	Short-Run	Long-Run	Short-Run	Long-Run
Retail Beef	0.00425	0.00003	-0.00163	-0.00002
Wholesale Beef	0.00417	0.00021	-0.00414	-0.00021
Imported Wholesale Beef	-0.00167	-0.00002	-0.00414	-0.00021
Exported Wholesale Beef	-[a]	-[a]	-0.00175	-0.00062
Slaughter Cattle	-0.00154	0.00046	-0.00339	-0.00064
Feeder Cattle	-0.00087	0.00030	-0.00263	-0.00169
Retail Pork	0.00026	0.00000	0.00059	0.00001
Wholesale Pork	0.00025	0.00000	0.00038	0.00000
Imported Wholesale Pork	0.00017	0.00000	0.00024	0.00000
Exported Wholesale Pork	-[a]	-[a]	-0.00023	0.00000
Slaughter Hog	0.00038	0.00000	0.00016	0.00000
Domestic Retail Lamb	0.00037	0.00000	0.00008	0.00000
Imported Retail Lamb	0.00005	0.00000	0.00052	0.00000
Wholesale Lamb	0.00009	0.00000	0.00002	0.00000
Slaughter Lamb	0.00004	0.00000	0.00001	0.00000
Feeder Lamb	0.00004	0.00000	0.00000	0.00000
Retail Poultry	0.00200	0.00000	0.00057	0.00001
Exported Retail Poultry	-[a]	-[a]	-0.00044	0.00000
Wholesale Poultry	0.00144	0.00000	0.00027	0.00001

Note: Percentage changes are based upon average 2018 prices and quantities for livestock and meat.

[a] Export prices are assumed to be equal to domestic prices.

Table 5. Changes in Producer and Consumer Surplus Resulting from Adopting CattleTrace (million $)

Surplus Measure	Short-Run	Long-Run	Cumulative Present Value
Producer Surplus			
Retail Beef	116.32	-0.43	11.76
Wholesale Beef	-55.96	-3.54	-475.12
Slaughter Cattle	-271.74	-11.37	-1,143.13
Feeder Cattle	-238.04	-41.70	-1,291.02
Retail Pork	33.90	0.05	75.53
Wholesale Pork	11.06	0.03	27.65
Slaughter Hog	6.32	0.03	17.28
Retail Domestic Lamb	0.45	0.00	0.95
Wholesale Lamb	0.06	0.00	0.16
Slaughter Lamb	0.02	0.00	0.09
Feeder Lamb	0.02	0.00	0.09
Retail Poultry	167.33	0.02	294.30
Wholesale Poultry	73.57	0.02	151.19
Consumer Surplus			
Retail Beef	-445.01	-3.38	-1,305.12
Retail Pork	14.21	0.15	48.60
Retail Domestic Lamb	-0.11	0.00	-0.12
Retail Imported Lamb	1.09	0.00	2.37
Retail Poultry	119.39	0.51	371.78

Note: Surplus is calculated using average 2018 prices and quantities for livestock and meat.
[a] Totals are not identical to sums of individual surpluses because they are medians of simulations.
[b] Short-run is year 1 and long-run is year 10.

Table 6. Median Percentage Changes Resulting from a Government Cost Share of CattleTrace Costs

	Price		Quantity	
Endogenous Variables	Short-Run	Long-Run	Short-Run	Long-Run
Retail Beef	0.00270	0.00002	-0.00104	-0.00001
Wholesale Beef	0.00265	0.00014	-0.00264	-0.00014
Imported Wholesale Beef	-0.00106	-0.00001	-0.00194	-0.00012
Exported Wholesale Beef	-[a]	-[a]	-0.00111	-0.00040
Slaughter Cattle	-0.00099	0.00030	-0.00215	-0.00041
Feeder Cattle	-0.00068	0.00018	-0.00160	-0.00103
Retail Pork	0.00017	0.00000	0.00038	0.00000
Wholesale Pork	0.00016	0.00000	0.00024	0.00000
Imported Wholesale Pork	0.00011	0.00000	0.00016	0.00000
Exported Wholesale Pork	-[a]	-[a]	-0.00014	0.00000
Slaughter Hog	0.00025	0.00000	0.00010	0.00000
Domestic Retail Lamb	0.00024	0.00000	0.00005	0.00000
Imported Retail Lamb	0.00003	0.00000	0.00033	0.00000
Wholesale Lamb	0.00006	0.00000	0.00001	0.00000
Slaughter Lamb	0.00003	0.00000	0.00001	0.00000
Feeder Lamb	0.00002	0.00000	0.00000	0.00000
Retail Poultry	0.00127	0.00000	0.00036	0.00000
Exported Retail Poultry	-[a]	-[a]	-0.00044	0.00000
Wholesale Poultry	0.00092	0.00000	0.00017	0.00000

Note: Percentage changes are based upon average 2018 prices and quantities for livestock and meat.

[a] Export prices are assumed to be equal to domestic prices.

Table 7. Changes in Producer and Consumer Surplus Resulting from a Government Cost Share of CattleTrace Costs (million $)

Surplus Measure	Short-Run	Long-Run	Cumulative Present Value
Producer Surplus			
Retail Beef	74.56	-0.28	7.44
Wholesale Beef	-35.46	-2.32	-304.39
Slaughter Cattle	-173.61	-7.40	-732.50
Feeder Cattle	-154.10	-25.46	-813.39
Retail Pork	21.59	0.03	48.33
Wholesale Pork	7.06	0.02	17.59
Slaughter Hog	4.03	0.02	11.05
Retail Domestic Lamb	0.28	0.00	0.60
Wholesale Lamb	0.04	0.00	0.10
Slaughter Lamb	0.02	0.00	0.05
Feeder Lamb	0.01	0.00	0.06
Retail Poultry	106.47	0.01	187.71
Wholesale Poultry	46.84	0.01	96.14
Consumer Surplus			
Retail Beef	-283.25	-2.21	-835.56
Retail Pork	9.13	0.10	31.23
Retail Domestic Lamb	-0.07	0.00	-0.08
Retail Imported Lamb	0.70	0.00	1.51
Retail Poultry	76.31	0.34	237.42

Note: Surplus is calculated using average 2018 prices and quantities for livestock and meat.
[a] Totals are not identical to sums of individual surpluses because they are medians of simulations.
[b] Short-run is year 1 and long-run is year 10.