8.3 State Government Analysis

8.3.1 Michigan's Experience

Given the state of Michigan's status as the only US state with a mandatory individual animal identification program in operation, Michigan provides a good model to initially evaluate in developing estimates of state expenditures associated with NAIS adoption. Furthermore, between January 1, 2000 and June 1, 2006 over 18,000 herds and 1,191,063 animals (average tested herd size of approximately 66 head) were TB tested in Michigan (MDA, 2006). Accordingly, in October 2007 members of our research team visited with personnel at the Michigan Department of Agriculture (MDA) as well as producers and auction market managers throughout Michigan. The Animal Industry Division of MDA is responsible for the state's animal identification program. The research team held discussions with key MDA personnel including Kevin Kirk (MDA Director's Special Assistant) and Roberta Bailey (MDA accountant) to obtain detailed information regarding expenditures the state has incurred in administering its animal identification program. Bailey provided the research team with detailed summaries of the Michigan Department of Agriculture Animal Identification Program expenditures for fiscal years 2006 and 2007.

These expenditures are shown in table 8.7 and segmented into five categories. Consistent with their name, the *Payroll*, *Travel*, and *Materials, Brochures, and Supplies* categories encompass all salary and benefit; travel; and materials, brochures, and supplies expenditures, respectively. The *Equipment* category includes expenditures incurred in purchasing RFID reading equipment for locations of public animal transactions including auction markets and slaughterhouses. These expenses were incurred in implementing the state-wide program, as Michigan subsidized building the state's infrastructure to expedite the implementation process. The *Grants* category is directly associated with bills the state has received from Holstein Association USA, Inc. (HAUI). The state of Michigan currently uses HAUI to process all RFID transaction reads, to obtain RFID tags (Michigan provided 100% of the tags needed in the state's tuberculosis zone (north-east region) free-of-charge, but required producers outside of this zone to purchase their own tags), and

to provide the state with weekly summary reports on the number of RFID reads made in each market. As shown in table 8.7, the majority (approximately 80%) of total funds in fiscal years 2006 and 2007 were allocated to *Payroll* and *Grants*.

Revenue used to cover these expenditures came from two sources: Federal Funds and Michigan Ag Equine Funds. As shown in table 8.7, Federal Funds covered $191,498 and $226,385 (35% - 40% of total expenditures) of MDA's expenditures in fiscal years 2006 and 2007, respectively. The remaining funds (60% - 65%) were covered by revenue allocated to MDA from the state's Ag Equine Funds, which is a resource the state obtains from horse race track revenues.

The preceding paragraphs summarized experiences incurred by Michigan in the most recent two complete fiscal years. In order to project future expenditures for the state, a number of key assumptions must be made including:

- *Payroll expenditures* will remain the same in future years as no adjustments in staff capacity are anticipated.
- *Travel expenditures* will remain the same in future years as no adjustments are anticipated.
- *Materials, supplies, phone charges, etc.* will reduce to an average of $30,000 in futures years. This reduction is based on the assumption that most advertising, promotional, informative flyers and other materials are primarily "up-front" expenditures that will be reduced in frequency and quantity in future years.
- *Equipment expenses* will be $0 in future years. This assumes that future upgrades and maintenance of RFID reading equipment will be the responsibility of owners at those facilities (an assumption consistent with the direct cost estimates for individual industry segments presented in Sections 4-7 of this report).
- *Holstein Association USA, Inc. (HAUI) expenditures* will be reduced to an estimate of $6,300 per month. Over the three-month period of March, April, and June in 2007 these expenses averaged $21,052. However, approximately 70% of these expenses were for RFID tag purchases, shipping of these products, site inspections, and tag order processing fees. All of these expenses

were initially incurred by MDA to facilitate implementation of the program. The assumption of $6,300/month is based on an estimate of future expenditures being 30% of previous values and that future RFID purchases and related HAUI expenses will be the responsibility of cattle owners, regardless of their TB-zone status (an assumption consistent with the direct cost estimates for individual industry segments presented in Sections 4-7 of this report).

Based upon these assumptions and corresponding discussions with MDA personnel, projections were made regarding future expenditures of the Michigan Department of Agriculture Animal Identification Program. Table 8.8 shows a summary of these projections. The total annual expenditure ($287,833) is forecasted to be approximately 51% - 53% of the totals realized in fiscal years 2006 and 2007. Furthermore, cost sharing of the state's expenditures with federal sources is assumed to stop in future projections. This assumption can be reversed if NAIS cooperative agreements are assumed to persist into the future; in which case, it seems the best forecast given current information would be for federal and state sources to each contribute approximately 50% of funding consistent with fiscal years 2006 and 2007.

The final analysis we conducted of MDA Animal Identification Program expenditures was to identify how these expenditures were allocated across the three core NAIS components of Premises Identification, Animal Identification Systems, and Animal Movement Data Access. These allocations are based primarily on an analysis of historical budgets (fiscal years 2006 and 2007) and consultation with MDA personnel. Table 8.9 shows a summary of these allocations based on actual fiscal year 2006 and 2007 expenditures. A general observation is that a significant portion of expenditures in each of the five budget sub-categories were occurred in efforts associated with premises registration and/or animal identification systems. To project future 2008 and onward allocations, we consulted further with MDA personnel and utilized expected future expenditures in table 8.8 allocated them across NAIS components. Table 8.10 presents a summary of these allocations (in 2007 dollars). Relative to fiscal years 2006 and 2007 (table 8.9), a notably higher proportion of expenditures are expected to be incurred in activities regarding animal

identification systems and/or animal movement data access. This anticipation is consistent with the notion that as more premises are registered, fewer resources will be needed for premises registration and may be reallocated to animal identification systems or animal movement data access activities.

Table 8.7. Michigan Dept. of Agriculture Animal Identification Program Expenditures: Fiscal Years 2006 and 2007.

Description	FY 2006			FY 2007		
	Total Expenditure	% Paid By MI Funds	% Paid By Federal Funds	Total Expenditure	% Paid By MI Funds	% Paid By Federal Funds
Payroll	$260,485	53%	47%	$231,275	38%	62%
Travel	$5,899	27%	73%	$5,407	38%	62%
Materials, Brochures, Supplies	$87,453	44%	56%	$67,263	31%	69%
Equipment	$18,472	14%	86%	$27,077	35%	65%
Grants	$168,970	100%	0%	$231,493	93%	7%
Totals	$541,279	$349,780	$191,498	$562,515	$336,129	$226,385

Table 8.8. *Projected Future* MDA Animal Identification Program Expenditures.

Description	Projected Annual Expenditures			
	Total Expenditure	% of FY 2006 & 2007 Expenditures	% Paid By MI Funds	% Paid By Federal Funds
Payroll	$245,880	100%	100%	0%
Travel	$5,653	100%	100%	0%
Materials, Brochures, Supplies	$30,000	*NA*	100%	0%
Equipment	$0	0%	100%	0%
Grants	$6,300	30%	100%	0%
Totals	$287,833			

Table 8.9. Allocation of MDA Animal Identification Program Expenditures (2006-2007) by NAIS Component.

Description	*% to Premises Registration*	*% to Animal Identification Systems*	*% to Animal Movement Data Access*
Payroll	35%	60%	5%
Travel	15%	80%	5%
Materials, Brochures, Supplies	45%	50%	5%
Equipment	5%	75%	20%
Grants	15%	75%	10%

Table 8.10. Allocation of *Future MDA* Animal Identification Program Expenditures by NAIS Component.

Description	*% to Premises Registration*	*% to Animal Identification Systems*	*% to Animal Movement Data Access*
Payroll	15%	30%	55%
Travel	0%	45%	55%
Materials, Brochures, Supplies	10%	20%	70%
Equipment	5%	50%	45%
Grants	10%	45%	45%

8.3.2 Other States

In addition to the insights provided by examining the state of Michigan, information was also gathered from other states. In particular, given time and resource constraints prohibiting a thorough evaluation of each individual state, we visited with key personnel in twelve other states (Arkansas, Colorado, Idaho, Indiana, Iowa, Kansas, Minnesota, North Carolina, Oklahoma, Tennessee, Texas, and Wisconsin). These states were identified to both cover a geographic spectrum of states while also including multiple states ranking in the top 5 regarding cattle (Texas, Oklahoma, Kansas), swine (Iowa, North Carolina, Minnesota, Indiana), and broiler/turkey (Minnesota, North Carolina, Arkansas) inventories as recorded by USDA-NASS (2008e).

Contacts at each of these states were interviewed with two main goals in mind. The first goal was to obtain budget information regarding historical expenditures incurred in each state associated with implementation of NAIS. The second goal was to assess benefits that each state may have realized by their participation in NAIS. This information was obtained by phone and email interviews with key personnel, the names and associations of individual contacts interviewed are provided in Appendix A8.1.

Notable variation was identified in the ability of individual states to provide historical expenditure information that conveyed how each year's budget was allocated across key categories such as personnel, travel, and contractual arrangement. Moreover, there was limited ability to provide budgets allocating expenditures across the three NAIS components (Premises Identification, Animal Identification Systems, and Animal Movement Data Access). This, in combination with the confirmed diversity in state-specific issues, resources, and constraints lead us to purposely avoid making any empirical assessment of the "representative state" regarding cost and benefits of NAIS. Moreover, discussions with all contacted states (with the notable exception of Wisconsin) revealed significant reliance on USDA cooperative agreements to fund state-level NAIS activities. In particular, the majority of contacted states noted that, besides those used in recent years to meet USDA cost share requirements, no additional in-state resources have historically been available to conduct NAIS-related activities. This point is especially

important for three reasons. First, future decision makers need to be aware of the dependency of state-level NAIS activities on availability of federal NAIS funds. Second, this confirms that the experience in Michigan is *not* representative of many other states.[14] Third, this point suggests that when assessing governmental cost of the national NAIS program, it is reasonable to base much of that analysis on federal government expenditures. One of the core components of past federal NAIS budgets (see tables 8.2 and 8.3 above) has been cooperative agreements. Identification of nearly complete reliance of individual states on cooperative agreement funding leads us to focus on federal governmental budgets and infer implications for states from federal budgets. In this spirit, tables 8.11-8.14 present a summary of premises registration rates (a core focus of most cooperative agreements to date), cooperative agreement amounts, and expenditures to-date for each of the 50 states.

Tables 8.11 and 8.12 provide information regarding the overall success of the NAIS program since 2004 in registering premises. Between January 2005 and August 2008, there have been a total of 453,856 premises registered, representing about 33.8% of premises. Table 8.12 reveals that, as of August 2008, 12 states have over 50% of premises registered, 10 have 25-50%, and 28 states have fewer than 25% of their premises registered. This documents the wide range in success to date of states (characterized by diverse geographic, economic, livestock inventory, and other factors) registering premises. [15]

Returning our discussion to cooperative agreement budgets, we observe in table 8.13 that federal support of efforts in individual states has varied both within and across states over the analyzed 2004-2008 period. More specifically, every year except FY 2006 is characterized by a range of $0 to over $750,000 allocations across states. Moreover, awards allocated within individual states including Colorado, Idaho, Kansas, and Texas have

[14] That is MI is less (+/- 50%) reliant on federal funding than most other states (+/-80%). This is not to suggest valuable inferences cannot be obtained by examining Michigan. Rather this suggests that caution should be exerted in generalizing Michigan's experiences to other states.

[15] We thank a reviewer for noting that more narrowly examining the array of factors leading to differential premises registrations and associated NAIS costs experienced to date was beyond the focus of this national cost-benefit study, but is worthy of future research.

varied by over $800,000 over the 2004-2008 period. This variation was noted in our discussions with key personnel in other states. Namely, multiple personnel suggested that volatility in year-to-year NAIS funding allocations to their state has resulted in ongoing adjustments in personnel that have deviated resources from their intended purpose of enhancing premises registration rates.

Forecasts of state government expenses associated with NAIS can also be developed using information in table 8 13. In particular, recall previous points that most states are heavily dependent on federal NAIS cooperative agreement funding. Given the recent requirement for 20% matching of state funds for every dollar provided federally in cooperative agreements (USDA, 2008g), we can estimate the future costs to individual state governments by assuming: a) the 20% matching requirement is sustained, b) total funding of future NAIS cooperative agreements are consistent with the three alternatives presented previously in table 8.4, and c) allocations to individual states are made consistent with those experienced over the FY 2004-2008 period as shown in table 8.13. Combined, this generates the alternative forecasts summarized in table 8.15.

Table 8.15 suggests that this forecasting procedure results in total state governmental expenditures ranging from $2.1 to $3.4 million dollars and average expenditures across the 50 states ranging from approximately $42,300 to $67,549 depending on whether $10.575 or $16.887 million dollars are made available in federal cooperative agreement funds. Moreover, table 8.15 implies notable differences across states in forecasts expenditures. For instance, while Delaware and Rhode Island are forecasted to experience no expenditures, Texas, California, Nebraska, and Oklahoma are forecasted to have expenditures consistently in excess of $100,000.

It may seem appropriate at first glance to use the information provided in tables 8.11-8.14 to answer questions such as “on average, how many premises have been registered for each additional dollar of cooperative agreement expenditures?” However, we purposely do not make such calculations as we deem them as inappropriate. That is, cooperative agreements were engaged in by both federal and state parties with more

than just premises registration enhancement goals. Given the current absence of additional, detailed budget allocation information on every single cooperative agreement (for each state and each year), one can not accurately assess things like "the national, premises weighted-average cost of each additional registration." That is, an attempt based upon the information available (mainly in tables 8.11-8.14) would only generate an "exaggerated upper-bound" estimate of premises registration results from cooperative agreement expenditures as it would over estimate appropriate costs. Moreover, we attempt to more directly assess this in a survey of state ID coordinators discussed in the next section of this report.

Table 8.11. History of Premises Registrations in Each State.

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Alabama	35,538	125	1,007	1,417	2,385	3,125	4,909	6,501	8,484
Alaska	354	0	2	2	3	41	60	86	111
Arizona	5,170	6	103	172	510	524	617	887	1,049
Arkansas	37,614	0	1,614	4,467	6,284	6,912	7,516	7,573	7,741
California	32,500	0	1,202	1,768	3,325	4,365	5,262	5,682	6,320
Colorado	22,951	46	493	920	5,355	5,569	6,511	6,769	7,583
Connecticut	2,539	0	0	0	0	16	18	19	44
Delaware	1,553	0	74	74	494	651	651	652	652
Florida	28,731	19	835	1,655	3,099	3,735	4,065	4,611	4,923
Georgia	35,431	0	533	857	2,203	2,491	3,980	4,093	4,270
Hawaii	1,391	0	9	72	214	282	291	323	358
Idaho	18,754	1,878	13,860	14,774	15,321	17,915	18,062	18,307	18,524
Illinois	30,046	318	1,108	1,922	5,093	6,213	8,325	10,742	14,355
Indiana	34,790	45	1,674	2,578	11,936	24,613	29,702	30,579	32,068
Iowa	47,273	0	1	473	6,986	11,635	19,062	20,708	23,285
Kansas	39,346	63	1,399	2,076	3,805	4,513	5,187	5,470	6,049
Kentucky	61,251	0	1,726	2,699	7,479	9,909	12,326	12,976	14,094
Louisiana	19,677	0	349	416	620	952	1,157	1,825	2,150
Maine	4,213	2	134	276	376	399	416	419	427
Maryland	7,837	1	2	918	1,178	1,301	1,340	1,355	1,429
Massachusetts	3,555	0	6	8	1,423	1,683	1,685	8,064	8,066
Michigan	29,011	1	180	9,052	14,604	16,223	18,975	19,700	20,509
Minnesota	44,193	0	6,404	8,075	9,547	11,496	11,877	12,126	12,544
Mississippi	29,312	0	0	377	833	1,197	1,472	1,582	4,682
Missouri	79,018	373	3,965	6,680	8,305	12,133	13,600	13,954	14,659
Montana	19,708	1	83	189	567	764	810	837	956
Nebraska	30,841	322	699	3,000	9,212	10,533	13,842	16,099	16,598
Nevada	2,522	0	281	869	1,044	1,132	1,241	1,281	1,385
New Hampshire	2,277	0	2	7	28	36	40	43	51
New Jersey	5,315	0	38	53	475	988	994	997	1,013
New Mexico	11,250	1	92	402	731	834	989	1,168	1,402
New York	25,559	877	9,687	11,551	13,554	13,342	16,753	19,108	20,312
North Carolina	36,142	4	1,843	2,358	3,054	4,837	9,701	10,681	12,168
North Dakota	14,085	4	627	5,878	7,613	7,909	8,313	8,391	8,520
Ohio	48,073	41	535	1,069	1,849	2,180	5,945	6,310	7,066
Oklahoma	71,420	48	1,573	2,428	3,413	4,834	7,342	8,058	9,096
Oregon	28,634	0	0	1,683	2,195	2,332	2,534	2,602	2,672

Table 8.11. History of Premises Registrations in Each State (continued).

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Pennsylvania	42,302	12,934	15,348	15,788	29,971	26,299	28,206	28,760	29,463
Rhode Island	504	0	0	0	0	5	6	6	8
South Carolina	16,120	75	750	1,090	1,636	1,861	3,734	4,370	4,651
South Dakota	22,356	16	1,086	2,515	4,218	4,694	4,976	5,058	5,134
Tennessee	68,010	0	1,256	6,295	10,557	12,354	14,299	16,253	17,782
Texas	187,118	214	2,606	4,724	18,511	23,312	28,986	29,803	31,953
Utah	12,460	20	5,530	6,538	7,578	8,090	8,671	8,945	9,388
Vermont	4,438	2	54	77	79	293	310	319	360
Virginia	37,673	10	1,278	2,112	3,152	4,001	4,680	5,116	9,100
Washington	22,155	3	722	864	1,154	1,370	1,421	1,539	1,691
West Virginia	17,670	910	6,614	7,114	7,822	8,418	8,738	8,817	9,135
Wisconsin	51,373	4,581	15,844	41,430	53,015	54,133	58,654	59,390	60,728
Wyoming	8,227	0	0	139	400	742	1,540	1,709	1,788
50 State Sum	1,438,280	22,940	103,228	179,901	293,206	343,186	409,791	440,663	476,796
Raw Average	28,766	459	2,086	3,643	5,935	6,940	8,263	8,860	9,557
Premises Weighted Average		670	2,865	5,266	9,743	11,634	14,084	14,820	16,003

Source: John Wiemers

Table 8.12. History of Premises Registrations in Each State (%).

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Alabama	35,538	0.35%	2.83%	3.99%	6.71%	8.79%	13.81%	18.29%	23.87%
Alaska	354	0.00%	0.56%	0.56%	0.85%	11.58%	16.95%	24.29%	31.36%
Arizona	5,170	0.12%	1.99%	3.33%	9.86%	10.14%	11.93%	17.16%	20.29%
Arkansas	37,614	0.00%	4.29%	11.88%	16.71%	18.38%	19.98%	20.13%	20.58%
California	32,500	0.00%	3.70%	5.44%	10.23%	13.43%	16.19%	17.48%	19.45%
Colorado	22,951	0.20%	2.15%	4.01%	23.33%	24.26%	28.37%	29.49%	33.04%
Connecticut	2,539	0.00%	0.00%	0.00%	0.00%	0.63%	0.71%	0.75%	1.73%
Delaware	1,553	0.00%	4.76%	4.76%	31.81%	41.92%	41.92%	41.98%	41.98%
Florida	28,731	0.07%	2.91%	5.76%	10.79%	13.00%	14.15%	16.05%	17.13%
Georgia	35,431	0.00%	1.50%	2.42%	6.22%	7.03%	11.23%	11.55%	12.05%
Hawaii	1,391	0.00%	0.65%	5.18%	15.38%	20.27%	20.92%	23.22%	25.74%
Idaho	18,754	10.01%	73.90%	78.78%	81.69%	95.53%	96.31%	97.62%	98.77%
Illinois	30,046	1.06%	3.69%	6.40%	16.95%	20.68%	27.71%	35.75%	47.78%
Indiana	34,790	0.13%	4.81%	7.41%	34.31%	70.75%	85.38%	87.90%	92.18%
Iowa	47,273	0.00%	0.00%	1.00%	14.78%	24.61%	40.32%	43.81%	49.26%
Kansas	39,346	0.16%	3.56%	5.28%	9.67%	11.47%	13.18%	13.90%	15.37%
Kentucky	61,251	0.00%	2.82%	4.41%	12.21%	16.18%	20.12%	21.18%	23.01%
Louisiana	19,677	0.00%	1.77%	2.11%	3.15%	4.84%	5.88%	9.27%	10.93%
Maine	4,213	0.05%	3.18%	6.55%	8.92%	9.47%	9.87%	9.95%	10.14%
Maryland	7,837	0.01%	0.03%	11.71%	15.03%	16.60%	17.10%	17.29%	18.23%
Massachusetts	3,555	0.00%	0.17%	0.23%	40.03%	47.34%	47.40%	226.84%	226.89%
Michigan	29,011	0.00%	0.62%	31.20%	50.34%	55.92%	65.41%	67.91%	70.69%
Minnesota	44,193	0.00%	14.49%	18.27%	21.60%	26.01%	26.88%	27.44%	28.38%
Mississippi	29,312	0.00%	0.00%	1.29%	2.84%	4.08%	5.02%	5.40%	15.97%
Missouri	79,018	0.47%	5.02%	8.45%	10.51%	15.35%	17.21%	17.66%	18.55%
Montana	19,708	0.01%	0.42%	0.96%	2.88%	3.88%	4.11%	4.25%	4.85%
Nebraska	30,841	1.04%	2.27%	9.73%	29.87%	34.15%	44.88%	52.20%	53.82%
Nevada	2,522	0.00%	11.14%	34.46%	41.40%	44.89%	49.21%	50.79%	54.92%
New Hampshire	2,277	0.00%	0.09%	0.31%	1.23%	1.58%	1.76%	1.89%	2.24%
New Jersey	5,315	0.00%	0.71%	1.00%	8.94%	18.59%	18.70%	18.76%	19.06%
New Mexico	11,250	0.01%	0.82%	3.57%	6.50%	7.41%	8.79%	10.38%	12.46%
New York	25,559	3.43%	37.90%	45.19%	53.03%	52.20%	65.55%	74.76%	79.47%
North Carolina	36,142	0.01%	5.10%	6.52%	8.45%	13.38%	26.84%	29.55%	33.67%
North Dakota	14,085	0.03%	4.45%	41.73%	54.05%	56.15%	59.02%	59.57%	60.49%
Ohio	48,073	0.09%	1.11%	2.22%	3.85%	4.53%	12.37%	13.13%	14.70%
Oklahoma	71,420	0.07%	2.20%	3.40%	4.78%	6.77%	10.28%	11.28%	12.74%
Oregon	28,634	0.00%	0.00%	5.88%	7.67%	8.14%	8.85%	9.09%	9.33%

Table 8.12. History of Premises Registrations in Each State (continued).

State	*Estimated Number of Premises*	*Jan. 2005*	*Aug. 2005*	*Jan. 2006*	*Aug. 2006*	*Jan. 2007*	*Aug. 2007*	*Jan. 2008*	*Aug. 2008*
Pennsylvania	42,302	30.58%	36.28%	37.32%	70.85%	62.17%	66.68%	67.99%	69.65%
Rhode Island	504	0.00%	0.00%	0.00%	0.00%	0.99%	1.19%	1.19%	1.59%
South Carolina	16,120	0.47%	4.65%	6.76%	10.15%	11.54%	23.16%	27.11%	28.85%
South Dakota	22,356	0.07%	4.86%	11.25%	18.87%	21.00%	22.26%	22.62%	22.96%
Tennessee	68,010	0.00%	1.85%	9.26%	15.52%	18.16%	21.02%	23.90%	26.15%
Texas	187,118	0.11%	1.39%	2.52%	9.89%	12.46%	15.49%	15.93%	17.08%
Utah	12,460	0.16%	44.38%	52.47%	60.82%	64.93%	69.59%	71.79%	75.35%
Vermont	4,438	0.05%	1.22%	1.74%	1.78%	6.60%	6.99%	7.19%	8.11%
Virginia	37,673	0.03%	3.39%	5.61%	8.37%	10.62%	12.42%	13.58%	24.16%
Washington	22,155	0.01%	3.26%	3.90%	5.21%	6.18%	6.41%	6.95%	7.63%
West Virginia	17,670	5.15%	37.43%	40.26%	44.27%	47.64%	49.45%	49.90%	51.70%
Wisconsin	51,373	8.92%	30.84%	80.65%	103.20%	105.37%	114.17%	115.61%	118.21%
Wyoming	8,227	0.00%	0.00%	1.69%	4.86%	9.02%	18.72%	20.77%	21.73%
50 State Raw Average	28,766	1.26%	7.50%	12.78%	20.61%	24.33%	28.24%	33.65%	36.09%
Premises Weighted Average		1.59%	7.18%	12.51%	20.39%	23.86%	28.49%	30.64%	33.15%

Source: John Wiemers

Table 8.13. History of Cooperative Agreements in Each State (Current Award Amounts).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Alabama	$115,000	$245,000	$0	$276,000	$165,630	$801,630
Alaska	$0	$34,710	$0	$60,660	$42,400	$137,770
Arizona	$0	$169,000	$84,351	$160,200	$111,650	$525,201
Arkansas	$115,000	$281,000	$203,000	$249,300	$174,500	$1,022,800
California	$670,072	$625,000	$346,909	$517,500	$361,900	$2,521,382
Colorado	$1,214,579	$255,904	$191,066	$330,087	$263,200	$2,254,836
Connecticut	$0	$0	$0	$20,000	$39,785	$59,785
Delaware	$0	$0	$0	$0	$0	$0
Florida	$531,840	$273,000	$98,721	$184,510	$176,645	$1,264,716
Georgia	$77,480	$42,173	$198,900	$197,891	$134,620	$651,064
Hawaii	$0	$98,316	$0	$61,121	$55,600	$215,036
Idaho	$1,164,000	$230,783	$60,349	$267,826	$194,600	$1,917,557
Illinois	$130,000	$245,000	$141,000	$180,000	$134,620	$830,620
Indiana	$106,493	$150,457	$80,331	$178,090	$133,872	$649,243
Iowa	$130,000	$410,878	$0	$474,000	$481,800	$1,496,678
Kansas	$805,000	$685,000	$0	$396,043	$210,000	$2,096,043
Kentucky	$269,093	$326,276	$0	$375,000	$280,459	$1,250,828
Louisiana	$12,247	$0	$0	$82,704	$78,310	$173,261
Maine	$78,343	$94,000	$21,500	$80,000	$41,250	$315,093
Maryland	$105,000	$85,952	$0	$81,000	$53,915	$325,867
Massachusetts	$0	$95,348	$0	$80,000	$59,831	$235,179
Michigan	$120,000	$206,953	$0	$179,000	$183,872	$689,825
Minnesota	$434,578	$339,140	$202,957	$278,914	$193,814	$1,449,403
Mississippi	$153,327	$170,129	$43,294	$171,883	$133,872	$672,504
Missouri	$484,875	$496,973	$72,931	$0	$0	$1,054,779
Montana	$431,928	$349,000	$0	$251,100	$176,000	$1,208,028
Nebraska	$125,401	$672,000	$448,000	$672,000	$470,400	$2,387,801
Nevada	$97,939	$128,241	$80,000	$76,903	$57,400	$440,483
New Hampshire	$0	$17,547	$0	$35,000	$2,100	$54,647
New Jersey	$100,000	$92,000	$72,108	$80,000	$59,831	$403,939
New Mexico	$0	$244,000	$203,000	$248,400	$246,350	$941,750
New York	$93,000	$204,152	$178,791	$275,980	$183,400	$935,323
North Carolina	$111,630	$196,989	$0	$179,000	$133,872	$621,490
North Dakota	$515,000	$176,225	$0	$160,856	$193,900	$1,045,982
Ohio	$117,135	$192,560	$112,786	$275,283	$206,418	$904,181
Oklahoma	$675,000	$629,000	$166,860	$517,500	$362,200	$2,350,560
Oregon	$0	$169,322	$0	$75,815	$192,194	$437,331

Table 8.13. History of Cooperative Agreements in Each State, (Current Award Amounts) (continued).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Pennsylvania	$614,147	$257,000	$142,238	$199,009	$139,087	$1,351,481
Rhode Island	$0	$0	$0	$0	$0	$0
South Carolina	$186,727	$139,000	$141,000	$177,000	$132,377	$776,104
South Dakota	$505,240	$334,277	$0	$426,000	$298,200	$1,563,717
Tennessee	$130,000	$264,611	$82,678	$251,100	$209,000	$937,389
Texas	$1,000,000	$1,038,975	$201,065	$1,069,302	$756,000	$4,065,342
Utah	$149,586	$194,000	$0	$179,000	$125,300	$647,886
Vermont	$84,059	$104,125	$0	$0	$60,579	$248,763
Virginia	$112,636	$237,831	$0	$249,300	$207,126	$806,893
Washington	$104,313	$206,000	$60,854	$179,000	$240,800	$790,967
West Virginia	$95,090	$108,862	$58,942	$155,488	$132,377	$550,758
Wisconsin	$100,000	$243,605	$0	$378,000	$265,468	$987,073
Wyoming	$361,929	$235,000	$141,000	$248,000	$173,600	$1,159,529
50 State Sum	$12,427,687	$11,995,314	$3,834,630	$11,240,764	$8,730,124	$48,228,520
Raw Average	$248,554	$239,906	$76,693	$224,815	$174,602	$964,570
Premises Weighted Average	$390,894	$400,881	$105,369	$371,957	$277,491	$1,546,592

Source: Neil Hammerschmidt

Table 8.14. History of Cooperative Agreements in Each State (Current Expenditures).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Alabama	$115,000	$245,000	$0	$276,000		$636,000
Alaska	$0	$34,710	$0	$30,225	$0	$64,935
Arizona	$0	$169,000	$84,351	$160,200	$47,801	$461,352
Arkansas	$115,000	$281,000	$203,000	$249,300	$130,875	$979,175
California	$670,072	$492,090	$346,909	$517,500		$2,026,572
Colorado	$1,157,140	$255,904	$191,066	$330,087	$105,848	$2,040,045
Connecticut	$0	$0	$0	$20,000		$20,000
Delaware	$0	$0	$0	$0		$0
Florida	$531,840	$273,000	$98,721	$184,510	$67,446	$1,155,517
Georgia	$77,480	$42,173	$198,900	$191,262		$509,816
Hawaii	$0	$98,316	$0	$61,121	$13,900	$173,336
Idaho	$960,553	$230,783	$60,349	$267,826	$25,095	$1,544,605
Illinois	$130,000	$245,000	$141,000	$134,272	$67,418	$717,690
Indiana	$106,493	$150,457	$80,331	$109,936		$447,218
Iowa	$130,000	$410,878	$0	$474,000	$290,669	$1,305,547
Kansas	$523,531	$527,500	$0	$285,056	$52,500	$1,388,587
Kentucky	$246,002	$326,276	$0	$375,000	$35,160	$982,438
Louisiana	$12,247	$0	$0	$82,704		$94,951
Maine	$78,343	$94,000	$21,500	$64,000	$12,000	$269,843
Maryland	$105,000	$85,952	$0	$81,000		$271,952
Massachusetts	$0	$95,348	$0	$80,000		$175,348
Michigan	$120,000	$206,953	$0	$179,000		$505,953
Minnesota	$430,372	$339,140	$202,957	$278,914	$21,513	$1,272,896
Mississippi	$124,806	$170,129	$43,294	$171,883	$21,809	$531,920
Missouri	$484,874	$496,973	$72,931	$0		$1,054,779
Montana	$431,928	$349,000	$0	$150,000		$930,928
Nebraska	$125,401	$672,000	$448,000	$672,000	$92,885	$2,010,287
Nevada	$97,939	$128,241	$80,000	$76,903		$383,083
New Hampshire	$0	$17,547	$0	$1,395	$0	$18,942
New Jersey	$75,000	$92,000	$72,108	$80,000	$14,958	$334,066
New Mexico	$0	$244,000	$203,000	$248,400		$695,400
New York	$93,000	$204,152	$178,791	$275,980	$28,490	$780,413
North Carolina	$111,630	$196,989	$0	$178,536	$25,698	$512,852
North Dakota	$468,631	$176,225	$0	$160,856	$30,160	$835,873
Ohio	$117,135	$192,560	$112,786	$275,283	$52,435	$750,198
Oklahoma	$548,532	$629,000	$166,860	$517,500	$103,067	$1,964,959
Oregon	$0	$169,322	$0	$75,815	$0	$245,137

Table 8.14. History of Cooperative Agreements in Each State, (Current Expenditures) (continued).

State	CCC (FY 2004)	FY 2005	FY 2006	FY 2007	FY 2008	Total 2004 - 2008
Pennsylvania	$614,147	$257,000	$142,238	$166,856	$12,426	$1,192,667
Rhode Island	$0	$0	$0	$0		$0
South Carolina	$186,727	$139,000	$141,000	$177,000	$7,953	$651,681
South Dakota	$481,032	$334,277	$0	$257,605	$78,223	$1,151,137
Tennessee	$130,000	$264,611	$82,678	$251,100	$99,627	$828,016
Texas	$1,000,000	$1,038,975	$201,065	$1,069,302	$257,261	$3,566,603
Utah	$149,586	$194,000	$0	$179,000		$522,586
Vermont	$84,059	$104,125	$0	$0		$188,184
Virginia	$115,000	$237,831	$0	$249,300	$80,789	$682,920
Washington	$104,313	$206,000	$60,854	$0		$371,167
West Virginia	$95,090	$108,862	$58,942	$155,488	$33,777	$452,157
Wisconsin	$100,000	$243,605	$0	$160,950	$80,027	$584,583
Wyoming	$361,929	$235,000	$141,000	$248,000	$15,549	$1,001,478
50 State Sum	$11,609,832	$11,704,905	$3,834,630	$10,231,065	$1,905,360	$39,285,791
Raw Average	$232,197	$234,098	$76,693	$204,621	$59,542	$785,716
Premises Weighted Average	$370,790	$393,569	$105,369	$350,576	$77,702	$1,298,006

Source: Neil Hammerschmidt

Table 8.15. Future State Governmental Costs Estimates (Dollars in thousands).

State	Estimate 1: $10.575 million in USDA Cooperative Agreements	Estimate 2: $16.887 million in USDA Cooperative Agreements	Estimate 3: $13.036 million in USDA Cooperative Agreements
Alabama	$35.15	$56.14	$43.34
Alaska	$6.04	$9.65	$7.45
Arizona	$23.03	$36.78	$28.39
Arkansas	$44.85	$71.63	$55.29
California	$110.57	$176.57	$136.30
Colorado	$98.88	$157.91	$121.89
Connecticut	$2.62	$4.19	$3.23
Delaware	$0.00	$0.00	$0.00
Florida	$55.46	$88.57	$68.37
Georgia	$28.55	$45.59	$35.20
Hawaii	$9.43	$15.06	$11.62
Idaho	$84.09	$134.29	$103.66
Illinois	$36.43	$58.17	$44.90
Indiana	$28.47	$45.47	$35.10
Iowa	$65.63	$104.81	$80.91
Kansas	$91.92	$146.79	$113.31
Kentucky	$54.85	$87.60	$67.62
Louisiana	$7.60	$12.13	$9.37
Maine	$13.82	$22.07	$17.03
Maryland	$14.29	$22.82	$17.62
Massachusetts	$10.31	$16.47	$12.71
Michigan	$30.25	$48.31	$37.29
Minnesota	$63.56	$101.50	$78.35
Mississippi	$29.49	$47.10	$36.36
Missouri	$46.26	$73.87	$57.02
Montana	$52.98	$84.60	$65.31
Nebraska	$104.71	$167.22	$129.08
Nevada	$19.32	$30.85	$23.81
New Hampshire	$2.40	$3.83	$2.95
New Jersey	$17.71	$28.29	$21.84
New Mexico	$41.30	$65.95	$50.91
New York	$41.02	$65.50	$50.56
North Carolina	$27.25	$43.52	$33.60
North Dakota	$45.87	$73.25	$56.55
Ohio	$39.65	$63.32	$48.88
Oklahoma	$103.08	$164.61	$127.07
Oregon	$19.18	$30.63	$23.64

Table 8.15. Future State Governmental Costs Estimates (Dollars in thousands), continued.

State	Estimate 1: $10.575 million in USDA Cooperative Agreements	Estimate 2: $16.887 million in USDA Cooperative Agreements	Estimate 3: $13.036 million in USDA Cooperative Agreements
Pennsylvania	$59.27	$94.64	$73.06
Rhode Island	$0.00	$0.00	$0.00
South Carolina	$34.04	$54.35	$41.96
South Dakota	$68.57	$109.51	$84.53
Tennessee	$41.11	$65.65	$50.67
Texas	$178.28	$284.70	$219.77
Utah	$28.41	$45.37	$35.02
Vermont	$10.91	$17.42	$13.45
Virginia	$35.39	$56.51	$43.62
Washington	$34.69	$55.39	$42.76
West Virginia	$24.15	$38.57	$29.77
Wisconsin	$43.29	$69.13	$53.36
Wyoming	$50.85	$81.20	$62.68
Sum	$2,115.00	$3,377.47	$2,607.20
Raw Average	$42.30	$67.55	$52.14
Minimum	$0.00	$0.00	$0.00
Maximum	$178.28	$284.70	$219.77

Notes: These cost forecasts assume a) mandated 20% matching of funds by each state and b) individual state allocations are made consistent with allocations of awards during the FY 2004-2008 period (table 8.13).

8.3.3 Survey of Animal ID Coordinators

To supplement the above information, and obtain answers to standardized questions not ascertained in the initial interviews, we also asked key personnel in 14 states (the 12 noted above with the addition of California and Michigan) to complete a short survey (that is included in Appendix A8.2). Summary statistics of answers from 13 respondents (92.9% response rate) are provided in table 8.16.

The first set of questions asked in this survey focused on premises registration details. Responses suggest approximately 19 new applications can be processed per hour by one employee. Assuming a rate of $13.75/hour for a data entry clerk wages (consistent with Darnell (2008) analysis previously discussed), this suggests that the governmental cost of processing new premises registration applications is approximately $0.72/application. WLIC (2006) suggest that 100-125 premises registrations can be processed per work day. Assuming an 8-hour work day and the $13.75/hour wage rate, this provides a higher processing cost estimate of $0.88 - $1.10/application.

The surveyed respondents also suggest that hard-copy applications, relative to internet-based applications, are characterized by a higher need for follow-up activities necessary to complete new applications and maintain data integrity. In particular, the weighted-average error/omission frequency rates are 8.04% (n=13) and 3.65% (n=8), respectively, for hard-copy and internet-based applications. Five of the 13 respondents indicated their state does not currently accept internet-based applications. [16] This appears to be due to requirements in those states for physical, hard-copy signatures to accompany all premises registration applications. Moreover, WLIC (2006) suggest that processing applications with exceptions (application with missing or invalid information) takes approximately four times as long as complete applications to process.

[16] If only the states accepting both hard-copy and internet-based applications are considered, weighted average frequencies are 9.06% and 3.65%, respectively. This suggests that the difference in error rates between hard-copy and internet submissions may be higher than suggested in table 8.16.

To gain additional insight on the total cost of establishing new premises registrations, the survey included the question: *What do you believe is the cost (including all costs of efforts related to soliciting new applications, processing applications, addressing application errors/omissions, etc.) of currently establishing new premises in your state?* Responses to this question varied notably from *$0-$15/premise* to *Over $90/premise*. Without disclosing individual responses, it is important to note that the three respondents indicating cost estimates of over $90 operate in states ranking high in terms of NASS estimated cattle inventories. This finding supports USDA's decision to increase its focus on cattle premises registrations and its planned "*840 Start Up*" campaign for FY 2009 (USDA, 2008g). Conversely, three of the four respondents suggesting cost estimates in the $0-$30 range were from states that have mandatory premises registration. This divergence in responses is consistent with the notion (and corresponding phone interviews) that states with mandatory premises registration have, at least in relation to the magnitude of premises located in their state, superior alignment of resources with premises registration. The weighted-average cost estimate for registering new premises in the 13 states is $45.17 per registration. Valuable information for comparison is also provided by WLIC (2006) suggesting premises registration costs of $128 and $17 per premises, respectively, during the 2004 and 2005 periods. The stark difference in cost estimates is primarily reflective of a surge in registration volume in 2005 as premises registration became mandatory in Wisconsin on January 1, 2006. Overall, the average cost of premises registrations by WLIC between January 2004 and December 2005 is estimated to be $26/premises.

Penny Page (Animal ID Coordinator in North Carolina) provided detailed statistics on a December 2006 mass mailing effort she initiated to enhance premises registrations in North Carolina. This effort targeted 27,332 producers, cost a total of $65,788.60, and resulted in 3,933 premises registrations. This implies a 14.4% registration success rate at an average cost of $16.73 pre premises, not including state processing (Page, 2008). To assess the representativeness of these figures, we included a corresponding question in our survey. The weighted-average response suggests a forecasted 12.9% "success rate" would be

experienced by similar mass mailing efforts in other states. That is, if resources were allocated in the surveyed states using similar mass mailing procedures, we would anticipate about 13% of recipients to register their premises. It should be noted that this reflects a wide range of prior mass mailing histories across these states (i.e., this would be at least the 2nd mass mailing in North Carolina). Furthermore, resulting premise registrations would likely diminish over subsequent mailings as each additional effort would inherently be targeting producers previously revealing an unwillingness to register.

Our survey also included questions to further assess the current NAIS infrastructure development and current ability to respond to animal diseases in individual states. When asked *"If tomorrow a livestock disease was identified in your state, to what extent would you use information available to you through your state's current participation in the national NAIS system?"* Two-thirds responded that they *would use NAIS information, but less than other in-state resources* and one-third responded that they *would use NAIS information more than other in-state resources*. Accordingly, we followed this question up to assess perceived abilities to currently respond to animal diseases. As shown in table 8.16, the weighted-average response time to notify all livestock producers within 15 and 30 miles of an outbreak is estimated to be 70.5 and 97.5 hours (approximately 3 and 4 days), respectively. While this weighted-average response time estimate is useful, the range in responses is arguably more telling. For instance, response times for a 15-mile notification circle ranged from less than 5 hours to over 1 week. This finding is consistent with previous comments regarding the diversity in individual state situations (e.g., range in perceived costs of establishing new premises registrations).

Table 8.16 Summary Statistics of Key State Personnel Survey

Questions	Multiple-Choice Options	Frequency of Responses	Weighted Average[a]
# 1: How many new applications for NAIS premises registration can your office typically process in one hour?	0-20	61.54%	19.23
	21-40	30.77%	
	41-60	7.69%	
	61-80	0.00%	
	81-100	0.00%	
	101-120	0.00%	
	Over 120	0.00%	
#2: What is the frequency of premises registration applications that contain some sort of error or omission requiring follow-up investigations?	For hard-copy applications		
	0%-5% frequency	53.85%	8.04%
	6%-10% frequency	7.69%	
	11-15% frequency	23.08%	
	16-20% frequency	7.69%	
	Over 20 %	7.69%	
	For internet-based applications		
	0%-5% frequency	23.08%	3.65%
	6%-10% frequency	38.46%	
	11-15% frequency	0.00%	
	16-20% frequency	0.00%	
	Over 20 %	0.00%	
	Not applicable[b]	38.46%	
#3: What do you believe is the cost (including all costs of efforts related to soliciting new applications, processing applications, addressing application errors/omissions, etc.) of currently establishing new premises in your state?	$0/ - $15/premise	16.67%	$45.17
	$16/ - $30/premise	16.67%	
	$31/ - $45/premise	41.67%	
	$46/ - $60/premise	0.00%	
	$61/ - $75/premise	0.00%	
	$76/ - $90/premise	0.00%	
	Over $90/premise	25.00%	
#4: Assume tomorrow you were provided the necessary funds, with the intent of enhancing premises registration rates in your state, to conduct an extensive mass mailing effort to all known individuals within your state that have not yet registered their premises (but are suspected to have premises that ideally would be registered with NAIS). What do you believe would be the overall response?	0-10% of those contacted would register their premises	46.15%	12.88%
	11-20% of those contacted would register their premises	46.15%	
	21-30% of those contacted would register their premises	0.00%	
	31-40% of those contacted would register their premises	0.00%	
	Over 40% of those contacted would register their premises	7.69%	

Table 8.16 Summary Statistics of Key State Personnel Survey (continued)

Questions	Multiple-Choice Options	Frequency of Responses	Weighted Average[a]
#5: Approximately what portion of the funds received in the USDA cooperative agreements your state has received to date were used primarily for premises registration activities?	0-20%	7.69%	68.46%
	21%-40%	15.38%	
	41%-60%	0.00%	
	61%-80%	30.77%	
	81%-100%	46.15%	
#6: Looking forward over the next three years, what portion of your state's NAIS related activities do you expect to be focused on premises registration?	0-20%	15.38%	54.62%
	21%-40%	23.08%	
	41%-60%	15.38%	
	61%-80%	15.38%	
	81%-100%	30.77%	
#7: If tomorrow a livestock disease was identified in your state, to what extent would you use information available to you through your state's current participation in the national NAIS system?	Not at all, I would not use NAIS information	0.00%	*N/A*
	I would use NAIS information, but less than other in-state resources	66.67%	
	I would use NAIS information more than other in-state resources	33.33%	
	I would rely almost exclusively on NAIS information	0.00%	
#8: Continuing with the prior question, if a livestock disease was identified in your state, how long do you believe it would currently take to notify all livestock producers operating within the following distances of the outbreak?	WITHIN 15 miles:		
	less than 1 hour	0.00%	70.46 (hours)
	1-5 hours	8.33%	
	6-12 hours	0.00%	
	13-24 hours	16.67%	
	25-48 hours	25.00%	
	49-96 hours	25.00%	
	5-7 days	16.67%	
	Over 1 week	8.33%	
	WITHIN 30 miles:		
	less than 1 hour	0.00%	97.45 (hours)
	1-5 hours	0.00%	
	6-12 hours	9.09%	
	13-24 hours	9.09%	
	25-48 hours	27.27%	
	49-96 hours	9.09%	
	5-7 days	18.18%	
	Over 1 week	27.27%	

Notes: See Appendix 8.2 for a copy of the full survey.
[a] The presented averages are weighted using mid-points of the multiple-choice ranges. For open-ended responses to questions 1, 2, 3, 4, and 8, values of 130, 22%, $97, 44.5%, and 8 days, respectively were used in calculations.
[b] The survey did not include a *Not Applicable* option in question #2. This is included in this table to reflect the fact that multiple respondents noted their state does not accept or utilize internet application procedures. These "Not applicable" responses are not included in the mid-point weighted average calculations.

8.4 Conclusions

THE PURPOSE OF THIS CHAPTER was to examine government benefits and costs of NAIS adoption. This chapter provided a summary of past and forecasted future governmental NAIS budgets. Alternative future federal NAIS budgets are presented that range from $23.8 to $33.0 million annually. Moreover, forecasts of future state governmental NAIS expenditures are made with annual combined totals ranging from $2.1 to $3.4 million.

This chapter also provides estimates on the cost savings that NAIS may provide federal and state governments in conducting animal disease surveillance activities. A preliminary estimate of approximately $300,000 is provided of the annual herd level bovine tuberculosis testing cost reductions that NAIS may provide. We also note the need of future work, enabled by improved data and epidemiological modeling abilities, to estimate the impacts of NAIS on animal disease response, rather than surveillance, activities. Moreover, we note that our analysis under-estimates the government benefits, in the form of cost savings, provided by NAIS.

Finally, this chapter provides a summary of results obtained in a small survey of individual state animal ID coordinators and leaders. Results suggest that governmental processing cost of new premises registration applications are approximately $0.72/premises. Moreover, total costs of obtaining new premises registrations are estimated at $45.17/premises. These and other estimates presented throughout this chapter are provided to aid in future NAIS resource allocation decisions.

9. Economic Model Benefit-cost Welfare Impacts: Modeling Market Effects of Animal Identification

Chapter Overview

The previous sections presented cost estimates for a variety of animal identification/tracking scenarios. These species-specific costs were also dependent upon the degree of program adoption. A variety of effects are caused by adding costs to a marketing system. In general, added costs are dispersed throughout a vertically-related marketing chain and prices and quantity exchanged in the market are detrimentally impacted. Furthermore, changes in prices for one commodity meat product influences the demand for substitute meat products.

It is also possible that the adoption of an animal identification/tracking program could positively influence the domestic and/or export demand for meat products. However, the extent of these potential changes is difficult to forecast.

This chapter addresses various combinations of these issues. We develop an equilibrium displacement model (EDM) to simulate the effects of non-governmental costs of animal identification/tracking programs on meat/livestock prices, quantities exchanged, and producer/consumer surplus. Various adoption rates of premises identification, bookend identification, and full animal identification/tracking systems are considered. Changes in producer and consumer surplus are estimated because these metrics measure changes in producer/consumer well-being. We focus on the beef, pork, lamb, and poultry industries.

In addition, we simulate the size of export and domestic demand increases that would be necessary to offset increased costs of animal identification/tracking programs. Because we are unable to forecast domestic and foreign consumer responses to such programs, we evaluate the sizes of these potential changes that would be required to cause those in the meat sectors to be indifferent with respect to the

implementation of an animal identification/tracking program. It is important to note that we evaluate these impacts in an aggregate environment. That is, while an entire livestock sector may be indifferent (in terms of producer surplus generation) to such programs, it may be the case that individual producers within a sector may not be indifferent. We also evaluate various combinations of domestic and export demand increases on prices, quantities, and producer/consumer surplus.

Finally, an epidemiological disease spread model is used to evaluate a hypothetical foot-and-mouth disease (FMD) outbreak in southwest Kansas under alternative animal tracing strategies. The equilibrium displacement model is used in conjunction with the disease spread model to simulate the economic impacts on the livestock industry.

Equilibrium Displacement Models

An equilibrium displacement model is used to estimate the impacts on meat and livestock prices, quantities, and producer and consumer surplus resulting from the adoption of an animal identification program. The model accounts for interrelationships along the meat marketing chain and the substitutability of meats at the consumer level. This type of modeling technique has been well developed and is widely used in the economics literature to assess net impacts on society of a variety of private technology adoption and/or public policy regulations and initiatives. We estimate cumulative changes in consumer surplus at the retail level and producer surplus at each level of the meat marketing chain associated with an animal identification and tracking program.

Estimates of changes in consumer and producer surplus are useful for evaluating the impacts of policy changes on markets. Consumer surplus is a measure of the difference between what consumers are *willing* to pay for a product and the price that they *actually* pay for a product. That is, at any given product price, some consumers are just willing to pay that price for a product. However, many other consumers are willing to pay more for the product than the current market price. This concept is clearly illustrated by increases in the price of any food product. Suppose

the price of a food product increases because poor weather has reduced the supply of an important ingredient. The resulting price increase certainly reduces the quantity sold, but some consumers will continue to purchase the product in spite of the price increase. Clearly, these consumers were willing to pay more for the product prior to its price increase. This difference between willingness to pay for a product and the amount actually paid is a measure of a consumer's gain from a voluntary transaction with a producer. Increases in consumer surplus represent improvements in the collective well-being of consumers in general. This does not mean that every consumer benefits when consumer surplus increases. Rather, consumers in aggregate are better-off when consumer surplus increases.

Producer surplus represents an analog to consumer surplus. That is, at any given market price, some (but not all) producers would be *willing* to produce a product even if prices were lower than that being currently offered by the market. Essentially, aggregate producer surplus is the difference between an industry's total revenue and the total variable costs of producing a product. Note that this is not synonymous with profit because measures of profit must include costs which do not vary with output (i.e., fixed costs). Increases in producer surplus represent an aggregate improvement in the economic well-being of producers within a sector of an industry.

Estimates of total consumer and producer surplus are not heavily relied upon themselves as they contain measurement and methodological error. However, an equilibrium displacement model can be used to effectively measure *changes* in consumer and producer surplus associated with changing economic conditions. The model measures these changes in response to changes in demand for products, supply of products, or both. Consumer demand changes occur for a variety of reasons (e.g., changes in income, prices of substitute goods, tastes and preferences, product attributes, trade policies, etc.). The supply of products may also change for a variety of reasons (e.g., changes in input costs, technology, regulations, etc.). The equilibrium displacement model is used to simulate a number of these impacts caused by the potential implementation of an animal identification and tracking program. By adopting such a program producers will certainly incur direct costs, but

adoption could also have a positive effect on international and domestic consumer demand if consumers value this attribute.

Equilibrium displacement models are based on estimates of supply and demand elasticities. Consequently, the model's results are dependent upon those estimates. Our methodology includes a process in which distributions of supply and demand elasticities are used to estimate changes in prices, quantities, and consumer and producer surplus resulting from the implementation of a variety of animal identification program scenarios. Monte Carlo simulations are conducted in which 1,000 sampled sets of related elasticity estimates are drawn from the distributions and used to estimate potential changes in the variables of interest for each scenario.

9.1 Model Development

THIS SECTION DESCRIBES THE MODELING STRATEGY for estimating changes in consumer and producer surplus resulting from the implementation of a variety of animal identification programs. An equilibrium displacement model is presented and used as the primary approach to estimating changes in welfare effects. Later sections describe parameterization of the model and simulation results.

9.1.1 Modeling Strategy

We develop an EDM to estimate the distribution of net societal benefits and costs of an animal identification program among producers, processors, and consumers. For example, the adoption of an animal identification program will impose differential costs on suppliers at each market level. Conceptually, such costs shift relevant supply functions upward and to the left in each affected sector. A reduction in supply at the retail level causes a reduction in quantity demanded at that level. Concurrently, this change causes reductions in derived demand at each upstream level in the marketing chain. In a competitive market, the impacts and distribution of added marketing costs on prices and

quantities at each market level are determined by the size of cost impacts and relative supply and demand elasticities at each level.

Figure 9.1 illustrates the relevant market linkages for a simplified case in which, for example, the beef industry marketing chain is separated into a retail and farm sector. To simplify the illustration, fixed input proportions between the farm input (feeder cattle) and marketing services are assumed. Retail demand (D_r) and farm (feeder) supply (S_f) are considered the "primary" relations, while the demand for feeder cattle (D_f) and the retail supply of beef (S_r) are considered "derived" relations (Tomek and Robinson, 1990). The intersection of demand and supply at each level determines relative market-clearing prices (P_r) and (P_f) and market-clearing quantity (Q_0). In this case, the farm-level market-clearing quantity is represented graphically on a retail weight equivalent basis. The difference in equilibrium prices ($P_r - P_f$) represents the farm–retail price spread or marketing margin.

If an animal identification program increased costs only at the retail level, retail supply would shift from S_r to $S_r^{'}$ and the farm-level derived demand for feeder cattle would decline to $D_f^{'}$ (figure 9.1). Retail price would increase to $P_r^{'}$ and farm price would decline to $P_f^{'}$. Marketing cost increases would be reflected by a larger marketing margin ($P_r^{'} - P_f^{'}$), and a new equilibrium quantity would be established at Q_1 . If retail demand were relatively inelastic, consumer expenditures would increase, but farm revenues and producer surplus would decline along with farm price and quantity.

FIGURE 9.1. EFFECTS ON THE BEEF SECTOR OF INCREASED COSTS FROM AN IDENTIFICATION PROGRAM ON THE RETAIL LEVEL

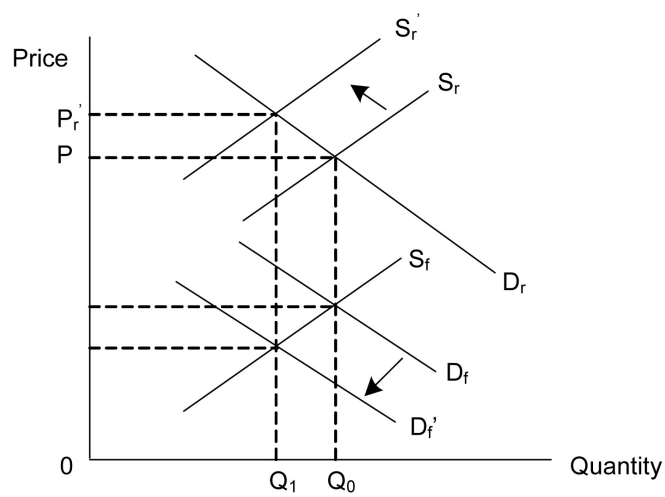


Figure 9.2 extends this simplified case by illustrating a situation in which procurement costs increase at both the retail and farm levels. The initial equilibrium occurs at P_r , P_f , and Q_0 . Increased costs associated with an animal identification program are reflected in reductions in both derived retail supply ($S_r^{"}$) and primary farm supply ($S_f^{"}$). The derived demand for cattle declines to $D_f^{"}$. The new equilibrium prices are at $P_r^{"}$ and $P_f^{"}$, and the new equilibrium quantity is Q_2 . Whether $P_f^{"}$ is higher or lower than P_f depends on relative supply and demand shifts and elasticities at each level. However, Q_2 is unambiguously less than Q_0 . That is, the quantity of cattle traded decreases because of increased marketing costs.

In figure 9.2, the new equilibrium farm price $P_f^{''}$ is higher than the original farm price of P_f. Nonetheless, the higher farm price does not mean that producers are better off because of associated declines in farm output. Producer welfare effects can be measured by the change in producer surplus that results from moving from the original equilibrium (P_f, Q_0) to the new equilibrium ($P_f^{''}$, Q_2). In figure 9.3, shaded area A represents farm-level producer surplus at the original equilibrium price and quantity, and shaded area B represents farm-level producer surplus as a result of increased marketing costs that affect the retail and farm levels. Assuming linear supply and demand functions, elasticity estimates and equilibrium prices and quantities can be used to calculate the sizes of the shaded areas. Absent a consumer demand increase, the change in producer surplus illustrated in figure 9.3 must be negative and is expressed as

$$\Delta PS = B - A = [1/2(P_f^{''} - \alpha_1)Q_2] - [1/2(P_f - \alpha_0)Q_0] \qquad (9.1)$$

where ΔPS represents the change in producer surplus.

FIGURE 9.2. EFFECTS ON THE BEEF SECTOR OF INCREASED RETAIL AND FARM LEVEL COSTS CAUSED BY AN ANIMAL IDENTIFICATION PROGRAM

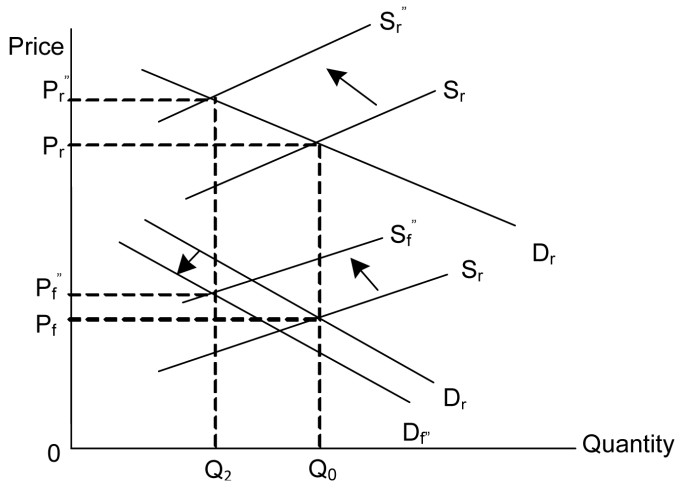
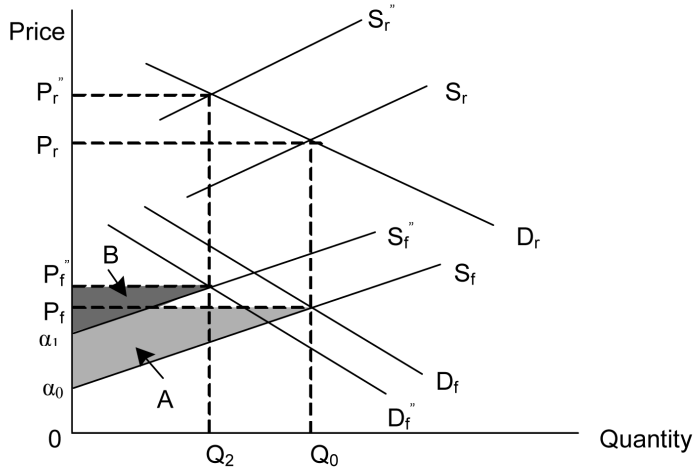


FIGURE 9.3. CHANGES IN FARM-LEVEL PRODUCER SURPLUS RESULTING FROM INCREASED RETAIL AND FARM COSTS CAUSED BY AN ANIMAL IDENTIFICATION PROGRAM



9.1.2 An Equilibrium Displacement Model of the US Meat Industry

An equilibrium displacement model is a linear approximation to a set of underlying and unknown demand and supply functions. The model's accuracy depends on the degree of nonlinearity of the true demand and supply functions and the magnitude of deviations from equilibrium being considered. If these deviations are relatively small, then a linear approximation of the true demand and supply functions should be relatively accurate (Brester, Marsh, and Atwood, 2004; Brester and Wohlgenant, 1997; Wohlgenant, 1993). Although total producer surplus measurements obtained from linear supply functions may or may not reflect actual values, changes in producer surplus caused by shifts in linear supply or demand functions should approximate actual changes provided that such shifts are relatively small.

A general structural model of supply and demand relationships in the US meat industry provides the framework for an equilibrium displacement model. The meat industry is modeled as a series of primary and derived demand and supply relations for the beef, pork, lamb, and poultry industries. The model uses quantity transmission elasticities between the supply and demand sectors to reflect variable input proportions among live animals and marketing service inputs (Brester, Marsh, and Atwood, 2004; Tomek and Robinson, 1990; Wohlgenant, 1993). The transmission elasticities incorporate variable input proportion technologies by allowing production quantities to vary across market levels as input substitution occurs in response to changing output and input prices (Wohlgenant, 1989).

We model the beef and lamb marketing chains by considering four distinct sectors: retail (consumer), wholesale (processor), slaughter (feedlot), and farm (feeder and cow/calf). The pork industry includes three sectors: retail, wholesale, and slaughter. The poultry industry consists of only the retail and wholesale sectors. The pork and poultry industries are modeled with fewer market levels than the beef and lamb industries because of higher degrees of vertical market integration. International trade is included for each industry at various sectors depending upon market structures. For example, beef and pork imports and exports are considered at the wholesale level. Likewise, poultry

exports are considered at the wholesale level while poultry imports are not modeled because they are virtually nonexistent. Lamb imports are considered at the retail level because most imported lamb retains its country-of-origin branding. Consequently, domestic lamb and imported lamb are considered distinctly different products at the retail level. However, imported beef and imported pork are generally indistinguishable at the retail level from their domestic counterparts though enactment of country of origin labeling could alter this somewhat in the future. Hence, imports of beef and pork are additions to US wholesale supplies of each. Beef, pork, imported lamb, domestic lamb, and poultry are considered meat substitutes in the primary demand functions.

In general terms, the structural supply and demand model is given by the following equations (error terms have been omitted):

BEEF SECTOR:

Retail Beef Sector:

Retail beef primary demand:

$$Q_B^{rd} = f_1\left(P_B^{rd}, P_K^{rd}, P_{Ld}^{rd}, P_{Li}^{rd}, P_Y^{rd}, \boldsymbol{Z}_B^{rd}\right) \tag{9.2}$$

Retail beef derived supply:

$$Q_B^{rs} = f_2\left(P_B^{rs}, Q_B^{ws}, \boldsymbol{W}_B^{rs}\right) \tag{9.3}$$

Wholesale Beef Sector:

Wholesale beef derived demand:

$$Q_B^{wd} = f_3\left(P_B^{wd}, Q_B^{rd}, \boldsymbol{Z}_B^{wd}\right) \tag{9.4}$$

Wholesale beef derived supply:

$$Q_B^{ws} = f_4\left(P_B^{ws}, Q_B^{ss}, Q_{Bi}^{ws}, Q_{Be}^{wd}, \boldsymbol{W}_B^{ws}\right) \tag{9.5}$$

Imported wholesale beef derived demand:

$$Q_{Bi}^{wd} = f_5\left(P_{Bi}^{wd}, Q_B^{wd}, \boldsymbol{Z}_{Bi}^{wd}\right) \tag{9.6}$$

Imported wholesale beef derived supply:

$$Q_{Bi}^{ws} = f_6\left(P_{Bi}^{ws}, \boldsymbol{W}_{Bi}^{ws}\right) \tag{9.7}$$

Exported wholesale beef derived demand:

$$Q_{Be}^{wd} = f_7\left(P_B^{wd}, \boldsymbol{Z}_{Be}^{wd}\right) \tag{9.8}$$

Slaughter Cattle Sector:

Slaughter cattle derived demand:

$$Q_B^{sd} = f_8\left(P_B^{sd}, Q_B^{wd}, \boldsymbol{Z}_B^{sd}\right) \tag{9.9}$$

Slaughter cattle derived supply:

$$Q_B^{ss} = f_9\left(P_B^{ss}, Q_B^{fs}, \boldsymbol{W}_B^{ss}\right) \tag{9.10}$$

Feeder Cattle Sector:

Feeder cattle derived demand:

$$Q_B^{fd} = f_{10}\left(P_B^{fd}, Q_B^{sd}, \boldsymbol{Z}_B^{fd}\right) \tag{9.11}$$

Feeder cattle primary supply:

$$Q_B^{fs} = f_{11}\left(P_B^{fs}, \boldsymbol{W}_B^{fs}\right) \tag{9.12}$$

PORK SECTOR:

Retail Pork Sector:

Retail pork primary demand:

$$Q_K^{rd} = f_{12}\left(P_K^{rd}, P_B^{rd}, P_{Ld}^{rd}, P_{Li}^{rd}, P_Y^{rd}, \boldsymbol{Z}_K^{rd}\right) \tag{9.13}$$

Retail pork derived supply:

$$Q_K^{rs} = f_{13}\left(P_K^{rs}, Q_K^{ws}, \boldsymbol{W}_K^{rs}\right) \tag{9.14}$$

Wholesale Pork Sector:

Wholesale pork derived demand:

$$Q_K^{wd} = f_{14}\left(P_K^{wd}, Q_K^{rd}, \boldsymbol{Z}_K^{wd}\right) \tag{9.15}$$

Wholesale pork derived supply:

$$Q_K^{ws} = f_{15}\left(P_K^{ws}, Q_K^{ss}, Q_{Ki}^{ws}, Q_{Ke}^{wd}, \boldsymbol{W}_K^{ws}\right) \tag{9.16}$$

Imported wholesale pork derived demand:

$$Q_{Ki}^{wd} = f_{16}\left(P_{Ki}^{wd}, Q_K^{wd}, \boldsymbol{Z}_{Ki}^{wd}\right) \tag{9.17}$$

Imported wholesale pork derived supply:

$$Q_{Ki}^{ws} = f_{17}\left(P_{Ki}^{ws}, \boldsymbol{W}_{Ki}^{ws}\right) \tag{9.18}$$

Exported wholesale pork derived demand:

$$Q_{Ke}^{wd} = f_{18}\left(P_K^{wd}, \boldsymbol{Z}_{Ke}^{wd}\right) \tag{9.19}$$

Slaughter Hog Sector:

Slaughter hog derived demand:

$$Q_K^{sd} = f_{19}\left(P_K^{sd}, Q_K^{wd}, \boldsymbol{Z}_k^{sd}\right) \tag{9.20}$$

Slaughter hog primary supply:

$$Q_K^{ss} = f_{20}\left(P_K^{ss}, \boldsymbol{W}_K^{ss}\right) \tag{9.21}$$

LAMB SECTOR:

Retail Lamb Sector:

Domestic retail lamb primary demand:

$$Q_{Ld}^{rd} = f_{21}\left(P_{Ld}^{rd}, P_{Li}^{rd}, P_{B}^{rd}, P_{K}^{rd}, P_{Y}^{rd}, \boldsymbol{Z}_{Ld}^{rd}\right) \tag{9.22}$$

Domestic retail lamb derived supply:

$$Q_{Ld}^{rs} = f_{22}\left(P_{Ld}^{rd}, Q_{L}^{ws}, \boldsymbol{W}_{Ld}^{rs}\right) \tag{9.23}$$

Imported retail lamb primary demand:

$$Q_{Li}^{rd} = f_{23}\left(P_{Li}^{rd}, P_{Ld}^{rd}, P_{B}^{rd}, P_{K}^{rd}, P_{Y}^{rd}, \boldsymbol{Z}_{Li}^{rd}\right) \tag{9.24}$$

Imported retail lamb derived supply:

$$Q_{Li}^{rs} = f_{24}\left(P_{Li}^{rs}, \boldsymbol{W}_{Li}^{rs}\right) \tag{9.25}$$

Wholesale Lamb Sector:

Wholesale lamb derived demand:

$$Q_{L}^{wd} = f_{25}\left(P_{L}^{wd}, Q_{Ld}^{rd}, \boldsymbol{Z}_{L}^{wd}\right) \tag{9.26}$$

Wholesale lamb derived supply:

$$Q_{L}^{ws} = f_{26}\left(P_{L}^{ws}, Q_{L}^{ss}, \boldsymbol{W}_{L}^{ws}\right) \tag{9.27}$$

Slaughter Lamb Sector:

Domestic slaughter lamb derived demand:

$$Q_{L}^{sd} = f_{27}\left(P_{L}^{sd}, Q_{L}^{wd}, \boldsymbol{Z}_{L}^{sd}\right) \tag{9.28}$$

Domestic slaughter lamb derived supply:

$$Q_{L}^{ss} = f_{28}\left(P_{L}^{ss}, Q_{L}^{fs}, \boldsymbol{W}_{L}^{ss}\right) \tag{9.29}$$

Feeder Lamb Sector:

Domestic feeder lamb derived demand:

$$Q_{L}^{fd} = f_{29}\left(P_{L}^{fd}, Q_{L}^{sd}, \boldsymbol{Z}_{L}^{fd}\right) \tag{9.30}$$

Domestic feeder lamb primary supply:

$$Q_L^{fs} = f_{30}\left(P_L^{fs}, \boldsymbol{W}_L^{fs}\right) \tag{9.31}$$

POULTRY SECTOR:

Retail Poultry Sector:

Retail poultry primary demand:

$$Q_Y^{rd} = f_{31}\left(P_Y^{rd}, P_B^{rd}, P_K^{rd}, P_{Ld}^{rd}, P_{Li}^{rd}, \boldsymbol{Z}_Y^{rd}\right) \tag{9.32}$$

Retail poultry derived supply:

$$Q_Y^{rs} = f_{32}\left(P_Y^{rs}, Q_Y^{ws}, Q_{Ye}^{rd}, \boldsymbol{W}_Y^{rs}\right) \tag{9.33}$$

Exported retail poultry derived demand:

$$Q_{Ye}^{rd} = f_{33}\left(P_Y^{rd}, \boldsymbol{Z}_{Ye}^{rd}\right) \tag{9.34}$$

Wholesale Poultry Sector:

Wholesale poultry derived demand:

$$Q_Y^{wd} = f_{34}\left(P_Y^{wd}, Q_Y^{rd}, \boldsymbol{Z}_Y^{wd}\right) \tag{9.35}$$

Wholesale poultry primary supply:

$$Q_Y^{ws} = f_{35}\left(P_Y^{ws}, \boldsymbol{W}_Y^{ws}\right) \tag{9.36}$$

Each of the endogenous price and quantity variables, as well as the exogenous vectors, are presented in the form of X_{kl}^{ij} for which *i* represents a market level (i.e., *r* = retail, *w* = wholesale/processor, *s* = slaughter/feedlot, and *f* = feeder/farm level). In each case, the superscript *j* indicates either a demand function (*d*) or a supply function (*s*). The subscript *k* represents the species being considered (i.e., *B* = beef, *K* = pork, *L* = lamb, and *Y* = poultry). Finally, the subscript *l* represents either an import (*i*) or export (*e*) function where appropriate. This subscript is omitted for domestic market variables. Within each

species, market levels are linked by downstream quantity variables among the demand equations and upstream quantity variables among the supply equations (Wohlgenant, 1993). The vectors Z_{kl}^{i} and W_{kl}^{i} represent demand and supply shifters, respectively.

Variable definitions and estimates are presented in table 9.1. It is assumed that market clearing conditions hold for each pair of demand and supply functions. Hence, the superscript *j* is omitted for each price and quantity endogenous variable in table 9.1 and the equilibrium displacement model.

The equilibrium displacement model is developed by totally differentiating equations (9.2) – (9.36). The results were then converted to log differentials so that each relation can be expressed in terms of elasticities. Table 9.2 presents the variable definitions and table 9.3 presents the elasticity definitions and estimates used in the log differential model. Finally, table 9.4 presents the quantity transmission elasticity definitions and estimates.

Table 9.1. Variable Definitions and Estimates for the Structural and Equilibrium Displacement Models, 2007.

Symbol	Definition	Mean[a]
Q_B^r	Quantity (consumption) of retail beef, billions pounds (retail weight)	19.81
P_B^r	Price of Choice retail beef, cents per pound	415.80
P_K^r	Price of retail pork, cents per pound	287.10
P_{Ld}^r	Price of retail domestic lamb, cents per pound	547.92
P_{Li}^r	Price of retail imported lamb, cents per pound	657.67
P_Y^r	Price of retail poultry, cents per pound	165.11
Q_B^w	Quantity of wholesale beef, billions pounds (carcass weight)	26.56
P_B^w	Price of wholesale Choice beef, cents per pound	149.83
Q_B^s	Quantity of beef obtained from slaughter cattle, billions pounds (live weight)	43.64
Q_{Bi}^w	Quantity of wholesale beef imports, billions pounds (carcass weight)	3.05
Q_{Be}^w	Quantity of wholesale beef exports, billions pounds (carcass weight)	1.43
P_{Bi}^w	Price of wholesale beef imports, cents per pound	149.92
P_B^s	Price of slaughter cattle, $/cwt (live weight)	91.82
Q_B^f	Quantity of beef obtained from feeder cattle, billions pounds (live weight)	28.02
P_B^f	Price of feeder cattle, $/cwt	108.23
Q_K^r	Quantity (consumption) of retail pork, billions pounds (retail weight)	15.31
Q_K^w	Quantity of wholesale pork, billions pounds (carcass weight)	21.94
P_K^w	Price of wholesale pork, cents per pound	67.55
Q_K^s	Quantity of pork obtained from slaughter hogs, billions pounds (live weight)	29.32

Table 9.1. Variable Definitions and Estimates for the Structural and Equilibrium Displacement Models, 2007, Continued.

Symbol	Definition	Mean
Q^w_{Ki}	Quantity of wholesale pork imports, billions pounds (carcass weight)	0.97
Q^w_{Ke}	Quantity of wholesale pork exports, billions pounds (carcass weight)	3.14
P^w_{Ki}	Price of wholesale pork imports, cents per pound	42.47
P^s_K	Price of slaughter hogs, $/cwt (live weight)	47.26
Q^r_{Ld}	Quantity (consumption) of retail domestic lamb, billions pounds (retail weight)	0.16
Q^w_L	Quantity of wholesale lamb, billions pounds (carcass weight)	0.18
Q^r_{Li}	Quantity (consumption) of retail imported lamb, billions pounds (retail weight)	0.17
P^w_L	Price of wholesale lamb, cents per pound	194.31
Q^s_L	Quantity of lamb obtained from slaughter lamb, billions pounds (live weight)	0.37
P^s_L	Price of slaughter lamb, $/cwt (live weight)	84.94
Q^f_L	Quantity of lamb obtained from feeder lamb, billions pounds (live weight)	0.30
P^f_L	Price of feeder lamb, $/cwt	103.84
Q^r_Y	Quantity (consumption) of retail poultry, billions pounds (retail weight)	31.07
Q^w_Y	Quantity of wholesale poultry, billions pounds (RTC)	57.35
Q^w_{Ye}	Quantity of retail poultry exports, billions pounds (retail weight)	4.68[b]
P^w_Y	Price of wholesale poultry, cents per pound	77.14
$\boldsymbol{z}^i_{kl}$	Demand shifters at the *i*th market level for the *k*th commodity and *l*th market (domestic/import)	-[c]
$\boldsymbol{w}^i_{kl}$	Supply shifters at the *i*th market level for the *k*th commodity and *l*th market (domestic/import)	-[c]

[a] Source: Livestock Marketing Information Center
[b] We converted wholesale poultry export to retail poultry export by multiplying the wholesale poultry export by 0.74.
[c] Variables without means are inputs to the model and thus do not have data values.

Table 9.2. Variable Definitions for the Log Differential Equilibrium Displacement Model.

z_B^r	Change in consumer demand for retail beef consumption caused by an animal identification program
z_B^w	Change in demand for wholesale beef caused by an animal identification program
z_{Bi}^w	Change in demand for wholesale beef imports caused by an animal identification program
z_{Be}^r	Change in export consumer demand for wholesale beef consumption caused by an animal identification program
z_B^s	Change in demand for slaughter cattle caused by an animal identification program
z_B^f	Change in demand for feeder cattle caused by an animal identification program
z_K^r	Change in consumer demand for retail pork caused by an animal identification program
z_K^w	Change in demand for wholesale pork caused by an animal identification program
z_{Ki}^w	Change in demand for imported wholesale pork caused by an animal identification program
z_{Ke}^w	Change in export consumer demand for wholesale pork caused by an animal identification program
z_K^s	Change in demand for slaughter hogs caused by an animal identification program
z_{Ld}^r	Change in consumer demand for retail domestic lamb consumption caused by an animal identification program
z_{Li}^r	Change in consumer demand for retail imported consumption caused by an animal identification program
z_L^w	Change in demand for wholesale domestic lamb caused by an animal identification program
z_L^s	Change in demand for slaughter lamb caused by an animal identification program
z_L^f	Change in demand for feeder lamb caused by an animal identification program
z_Y^r	Change in consumer demand for retail poultry consumption caused by an animal identification program
z_Y^w	Change in demand for wholesale poultry caused by an animal identification program

Table 9.2. Variable Definitions for the Log Differential Equilibrium Displacement Model, Continued.

z_{Ye}^{w}	Change in export consumer demand for wholesale poultry caused by an animal identification program
w_{B}^{r}	Changes in costs of supplying retail beef caused by an animal identification program
w_{B}^{w}	Changes in costs of supplying wholesale beef caused by an animal identification program
w_{Bi}^{w}	Changes in costs of supplying wholesale beef imports caused by an animal identification program
w_{B}^{s}	Changes in costs of supplying slaughter cattle caused by an animal identification program
w_{B}^{f}	Changes in costs of supplying feeder cattle caused by an animal identification program
w_{K}^{r}	Changes in costs of supplying retail pork caused by an animal identification program
w_{K}^{w}	Changes in costs of supplying wholesale pork caused by an animal identification program
w_{Ki}^{w}	Changes in costs of supplying wholesale pork imports caused by an animal identification program
w_{K}^{s}	Changes in costs of supplying slaughter hogs caused by an animal identification program
w_{Ld}^{r}	Changes in costs of supplying retail domestic lamb caused by an animal identification program
w_{Li}^{r}	Changes in costs of supplying retail imported lamb caused by an animal identification program
w_{L}^{w}	Changes in costs of supplying wholesale lamb caused by an animal identification program
w_{L}^{s}	Changes in costs of supplying slaughter lamb caused by an animal identification program
w_{L}^{f}	Changes in costs of supplying feeder lamb caused by an animal identification program
w_{Y}^{r}	Changes in costs of supplying retail poultry caused by an animal identification program
w_{Y}^{w}	Changes in costs of supplying wholesale poultry caused by an animal identification program

Table 9.3. Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model.

		Estimate	
Symbol	Definition	Short Run	Long Run
η_B^r	Own-price elasticity of demand for retail beef	-0.86[b]	-1.17[b]
η_{BK}^r	Cross-price elasticity of demand for retail beef with respect to the price of retail pork	0.10[a]	
η_{BLd}^r	Cross-price elasticity of demand for retail beef with respect to the price of domestic retail lamb	0.05[c]	
η_{BLi}^r	Cross-price elasticity of demand for retail beef with respect to the price of imported retail lamb	0.05[c]	
η_{BY}^r	Cross-price elasticity of demand for retail beef with respect to the price of retail poultry	0.05[a]	
ε_B^r	Own-price elasticity of supply for retail beef	0.36[d]	4.62[d]
η_B^w	Own-price elasticity of demand for wholesale beef	-0.58[b]	-0.94[b]
ε_B^w	Own-price elasticity of supply for wholesale beef	0.28[d]	3.43[b]
η_{Bi}^w	Own-price elasticity of demand for wholesale beef imports	-0.58[c]	-0.94[c]
ε_{Bi}^w	Own-price elasticity of supply for wholesale beef imports	1.83[e]	10.00[c]
η_{Be}^w	Own-price elasticity of demand for wholesale beef exports	-0.42[f]	-3.00[f]
η_B^s	Own-price elasticity of demand for slaughter cattle	-0.40[b]	-0.53[b]
ε_B^s	Own-price elasticity of supply for slaughter cattle	0.26[g]	3.24[g]
η_B^f	Own-price elasticity of demand for feeder cattle	-0.14[b]	-0.75[b]
ε_B^f	Own-price elasticity of supply for feeder cattle	0.22[h]	2.82[h]
η_K^r	Own-price elasticity of demand for retail pork	-0.69[a]	-1.00[c]
η_{KB}^r	Cross-price elasticity of demand for retail pork with respect to the price of retail beef	0.18[i]	
η_{KLd}^r	Cross-price elasticity of demand for retail pork with respect to the price of domestic retail lamb	0.02[c]	
η_{KLi}^r	Cross-price elasticity of demand for retail pork with respect to the price of imported retail lamb	0.02[c]	
η_{KY}^r	Cross-price elasticity of demand for retail pork with respect to the price of retail poultry	0.02[i]	
ε_K^r	Own-price elasticity of supply for retail pork	0.73[d]	3.87[d]
η_K^w	Own-price elasticity of demand for wholesale pork	-0.71[d]	-1.00[c]
ε_K^w	Own-price elasticity of supply for wholesale pork	0.44[d]	1.94[d]

Table 9.3. Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model, Continued.

Symbol	Definition	Estimate	
		Short Run	Long Run
η^{w}_{Ki}	Own-price elasticity of demand for wholesale pork imports	-0.71[c]	-1.00[c]
ε^{w}_{Ki}	Own-price elasticity of supply for wholesale pork imports	1.41[e]	10.00[c]
η^{w}_{Ke}	Own-price elasticity of demand for wholesale pork exports	-0.89[j]	-1.00[c]
η^{s}_{K}	Own-price elasticity of demand for slaughter hogs	-0.51[k]	-1.00[c]
ε^{s}_{K}	Own-price elasticity of supply for slaughter hogs	0.41[l]	1.80[l]
η^{r}_{Ld}	Own-price elasticity of demand for domestic retail lamb	-0.52[b]	-1.11[b]
η^{r}_{LdLi}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of imported retail lamb	0.29[b]	
η^{r}_{LdB}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of retail beef	0.05[c]	
η^{r}_{LdK}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of retail pork	0.02[c]	
η^{r}_{LdY}	Cross-price elasticity of demand for domestic retail lamb with respect to the price of retail poultry	0.02[c]	
ε^{r}_{Ld}	Own-price elasticity of supply for domestic retail lamb	0.15[b]	3.96[b]
η^{r}_{Li}	Own-price elasticity of demand for imported retail lamb	-0.41[b]	-0.63[b]
η^{r}_{LiLd}	Cross-price elasticity of demand for imported retail lamb with respect to the price of domestic retail lamb	0.78[b]	
η^{r}_{LiB}	Cross-price elasticity of demand for imported retail lamb with respect to the price of retail beef	0.05[c]	
η^{r}_{LiK}	Cross-price elasticity of demand for imported retail lamb with respect to the price of retail pork	0.02[c]	
η^{r}_{LiY}	Cross-price elasticity of demand for imported retail lamb with respect to the price of retail poultry	0.02[c]	
ε^{r}_{Li}	Own-price elasticity of supply for imported retail lamb	10.00[b]	10.00[b]
η^{w}_{L}	Own-price elasticity of demand for wholesale lamb	-0.35[b]	-1.03[b]
ε^{w}_{L}	Own-price elasticity of supply for wholesale lamb	0.16[b]	3.85[b]
η^{s}_{L}	Own-price elasticity of demand for slaughter lamb	-0.33[b]	-0.87[b]
ε^{s}_{L}	Own-price elasticity of supply for slaughter lamb	0.12[b]	2.95[b]
η^{f}_{L}	Own-price elasticity of demand for feeder lamb	-0.11[b]	-0.29[b]
ε^{f}_{L}	Own-price elasticity of supply for feeder lamb	0.09[b]	2.26[b]

Table 9.3. Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model, Continued.

Symbol	Definition	Estimate	
		Short Run	Long Run
η_Y^r	Own-price elasticity of demand for retail poultry	-0.29[i]	-1.00[c]
η_{YB}^r	Cross-price elasticity of demand for retail poultry with respect to the price of retail beef	0.18[i]	
η_{YK}^r	Cross-price elasticity of demand for retail poultry with respect to the price of retail pork	0.04[i]	
η_{YLd}^r	Cross-price elasticity of demand for retail poultry with respect to the price of domestic retail lamb	0.02[c]	
η_{YLi}^r	Cross-price elasticity of demand for retail poultry with respect to the price of imported retail lamb	0.02[c]	
ε_Y^r	Own-price elasticity of supply for retail poultry	0.18[d]	13.10[d]
	Own-price elasticity of demand for retail poultry exports	-0.31[e]	-1.00[c]
η_Y^w	Own-price elasticity of demand for wholesale poultry	-0.22[d]	-1.00[d]
ε_Y^w	Own-price elasticity of supply for wholesale poultry	0.14[d]	14.00[d]

[a]Brester and Schroeder (1995); [b]GIPSA RTI Meat Marketing Study (2007); [c]Authors best estimate; [d]Brester, Marsh, and Atwood (2004); [e]Estimated by authors; [f]Zaho, Wahl, and Marsh (2006); [g]Marsh (1994); [h]Marsh (2003); [i]Brester (1996); [j]Paarlberg et al. (2008); [k]Wohlgenant (2005); [l]Lemieux and Wohlgenant (1989).

Table 9.4. Quantity Transmission Elasticity Definitions and Estimates for the Log Differential Equilibrium Displacement Model.

Symbol	Definition	Estimate[a]	Standard Deviation[a]
γ_B^{wr}	Percentage change in retail beef supply given a 1% change in wholesale beef supply	0.771	0.072
τ_B^{rw}	Percentage change in wholesale beef demand given a 1% change in retail beef demand	0.995	0.095
γ_B^{sw}	Percentage change in wholesale beef supply given a 1% change in slaughter cattle supply	0.909	0.024
τ_B^{ws}	Percentage change in slaughter cattle demand given a 1% change in wholesale beef demand	1.09	0.024
γ_B^{fs}	Percentage change in slaughter cattle supply given a 1% change in feeder cattle supply	1.07	0.351
τ_B^{sf}	Percentage change in feeder cattle demand given a 1% change in slaughter cattle demand	0.957	0.036
γ_K^{wr}	Percentage change in retail pork supply given a 1% change in wholesale pork supply	0.962	0.038
τ_K^{rw}	Percentage change in wholesale pork demand given a 1% change in retail pork demand	0.983	0.037
γ_K^{sw}	Percentage change in wholesale pork supply given a 1% change in slaughter hog supply	0.963	0.039
τ_K^{ws}	Percentage change in slaughter hog demand given a 1% change in wholesale pork demand	0.961	0.037
γ_L^{wr}	Percentage change in retail domestic lamb supply given a 1% change in wholesale lamb supply	0.908	0.103
τ_L^{rw}	Percentage change in wholesale lamb demand given a 1% change in retail domestic lamb demand	0.731	0.058
γ_L^{sw}	Percentage change in wholesale lamb supply given a 1% change in slaughter lamb supply	1.007	0.002
τ_L^{ws}	Percentage change in slaughter lamb demand given a 1% change in wholesale lamb demand	0.993	0.002
γ_L^{fs}	Percentage change in slaughter lamb supply given a 1% change in feeder lamb supply	0.864	0.142
τ_L^{sf}	Percentage change in feeder lamb demand given a 1% change in slaughter lamb demand	0.962	0.025
γ_Y^{wr}	Percentage change in retail poultry supply given a 1% change in wholesale poultry supply	0.806	0.022
τ_Y^{rw}	Percentage change in wholesale poultry demand given a 1% change in retail poultry demand	1.035	0.103

[a]These estimates are obtained from the structural model that is presented later in the report.

BEEF SECTOR:

$$EQ_B^r = \eta_B^r EP_B^r + \eta_{BK}^r EP_K^r + \eta_{BLd}^r EP_{Ld}^r + \eta_{BLi}^r EP_{Li}^r + \eta_{BY}^r EP_Y^r + Ez_B^r \quad (9.37)$$

$$EQ_B^r = \varepsilon_B^r EP_B^r + \gamma_B^{wr} EQ_B^w + Ew_B^r \quad (9.38)$$

$$EQ_B^w = \eta_B^w EP_B^w + \tau_B^{rw} EQ_B^r + Ez_B^w \quad (9.39)$$

$$EQ_B^w = \varepsilon_B^w EP_B^w + \gamma_B^{sw} (Q_B^s / Q_B^w) EQ_B^s + (Q_{Bi}^w / Q_B^w) EQ_{Bi}^w - (Q_{Be}^w / Q_B^w) EQ_{Be}^w + Ew_B^w \quad (9.40)$$

$$EQ_{Bi}^w = \eta_{Bi}^w EP_{Bi}^w + \tau_B^{rw} EQ_B^w + (Q_{Bi}^w / Q_B^w) Ez_{Be}^w + Ez_{Bi}^w \quad (9.41)$$

$$EQ_{Bi}^w = \varepsilon_{Bi}^w EP_{Bi}^w + Ew_{Bi}^w \quad (9.42)$$

$$EQ_{Be}^w = \eta_{Be}^w EP_B^w + Ez_{Be}^w \quad (9.43)$$

$$EQ_B^s = \eta_B^s EP_B^s + \tau_B^{ws} EQ_B^w + (Q_{Be}^w / Q_B^w) Ez_{Be}^w + Ez_B^s \quad (9.44)$$

$$EQ_B^s = \varepsilon_B^s EP_B^s + \gamma_B^{fs} EQ_B^f + Ew_B^s \quad (9.45)$$

$$EQ_B^f = \eta_B^f EP_B^f + \tau_B^{sf} EQ_B^s + Ez_B^f \quad (9.46)$$

$$EQ_B^f = \varepsilon_B^f EP_B^f + Ew_B^f \quad (9.47)$$

PORK SECTOR:

$$EQ_K^r = \eta_K^r EP_K^r + \eta_{KB}^r EP_B^r + \eta_{KLd}^r EP_{Ld}^r + \eta_{KLi}^r EP_{Li}^r + \eta_{KY}^r EP_Y^r + Ez_K^r \quad (9.48)$$

$$EQ_K^r = \varepsilon_K^r EP_K^r + \gamma_K^{wr} EQ_K^w + Ew_K^r \quad (9.49)$$

$$EQ_K^w = \eta_K^w EP_K^w + \tau_K^{rw} EQ_K^r + Ez_K^w \quad (9.50)$$

$$EQ_K^w = \varepsilon_K^w EP_K^w + \gamma_K^{sw} (Q_K^s / Q_K^w) EQ_K^s + (Q_{Ki}^w / Q_K^w) EQ_{Ki}^w - (Q_{Ke}^w / Q_K^w) EQ_{Ke}^w + Ew_K^w \quad (9.51)$$

$$EQ_{Ki}^w = \eta_{Ki}^w EP_{Ki}^w + \tau_K^{rw} EQ_K^w + (Q_{Ki}^w / Q_K^w) Ez_{Ke}^w + Ez_{Ki}^w \quad (9.52)$$

$$EQ_{Ki}^w = \varepsilon_{Ki}^w EP_{Ki}^w + Ew_{Ki}^w \quad (9.53)$$

$$EQ_{Ke}^w = \eta_{Ke}^w EP_K^w + Ez_{Ke}^w \quad (9.54)$$

$$EQ_K^s = \eta_K^s EP_K^s + \tau_K^{ws} EQ_K^w + (Q_{Ke}^w / Q_K^w) Ez_{Ke}^w + Ez_K^s \quad (9.55)$$

$$EQ_K^s = \varepsilon_K^s EP_K^s + Ew_k^s \quad (9.56)$$

LAMB SECTOR:

$$EQ^r_{Ld} = \eta^r_{Ld}EP^r_{Ld} + \eta^r_{LdLi}EP^r_{Li} + \eta^r_{LdB}EP^r_B + \eta^r_{LdK}EP^r_K + \eta^r_{LdY}EP^r_Y + Ez^r_{Ld} \quad (9.57)$$

$$EQ^r_{Ld} = \varepsilon^r_{Ld}EP^r_{Ld} + \gamma^{wr}_L EQ^w_L + Ew^r_{Ld} \quad (9.58)$$

$$EQ^r_{Li} = \eta^r_{Li}EP^r_{Li} + \eta^r_{LiLd}EP^r_{Ld} + \eta^r_{LiB}EP^r_B + \eta^r_{LiK}EP^r_K + \eta^r_{LiY}EP^r_Y + Ez^r_{Li} \quad (9.59)$$

$$EQ^r_{Li} = \varepsilon^r_{Li}EP^r_{Li} + Ew^r_{Li} \quad (9.60)$$

$$EQ^w_L = \eta^w_L EP^w_L + \tau^{rw}_L EQ^r_{Ld} + Ez^w_L \quad (9.61)$$

$$EQ^w_L = \varepsilon^w_L EP^w_L + \gamma^{sw}_L EQ^s_L + Ew^w_L \quad (9.62)$$

$$EQ^s_L = \eta^s_L EP^s_L + \tau^{ws}_L EQ^w_L + Ez^s_L \quad (9.63)$$

$$EQ^s_L = \varepsilon^s_L EP^s_L + \gamma^{fs}_L EQ^f_L + Ew^s_L \quad (9.64)$$

$$EQ^f_L = \eta^f_L EP^f_L + \tau^{sf}_L EQ^s_L + Ez^f_L \quad (9.65)$$

$$EQ^f_L = \varepsilon^f_L EP^f_L + Ew^f_L \quad (9.66)$$

POULTRY SECTOR:

$$EQ^r_Y = \eta^r_Y EP^r_Y + \eta^r_{YB}EP^r_B + \eta^r_{YK}EP^r_K + \eta^r_{YLd}EP^r_{Ld} + \eta^r_{YLi}EP^r_{Li} + Ez^r_Y \quad (9.67)$$

$$EQ^r_Y = \varepsilon^r_Y EP^r_Y + \gamma^{wr}_Y EQ^w_Y - (Q^r_{Ye} / Q^r_Y)EQ^r_{Ye} + Ew^r_Y \quad (9.68)$$

$$EQ^r_{Ye} = \eta^r_{Ye}EP^r_Y + Ez^r_{Ye} \quad (9.69)$$

$$EQ^w_Y = \eta^w_Y EP^w_Y + \tau^{rw}_Y EQ^r_Y + (Q^r_{Ye} / Q^r_Y)\, Ez^r_{Ye} + Ew^w_Y \quad (9.70)$$

$$EQ^w_Y = \varepsilon^w_Y EP^w_Y + Ew^w_Y \quad (9.71)$$

The term *E* represents a relative change operator (e.g., $EQ^r_B = \partial Q^r_B / Q^r_B = \partial \ln^r_B$). Table 9-2 provides definitions for all parameters. In addition, each z^i_B and w^i_B represent single elements of the demand (Z^i_k) and supply (W^i_k) shifters, respectively. Specifically, these elements represent percentage supply or demand changes from initial equilibria caused by an animal identification program. That is, z^i_k

represents potential changes in demand for meat products resulting from an animal identification program. Similarly, w_k^i represents costs that shift supply which may result from an animal identification program. All other elements of (Z_k^i) and (W_k^i) are assumed to be unchanged by implementation of an animal identification program.

The equilibrium displacement model was implemented by placing all of the endogenous variables in equations (9.37) through (9.71) onto the left-hand side of each equation:

BEEF SECTOR:

$$EQ_B^r - \eta_B^r EP_B^r - \eta_{BK}^r EP_K^r - \eta_{BLd}^r EP_{Ld}^r - \eta_{BLi}^r EP_{Li}^r - \eta_{BY}^r EP_Y^r = Ez_B^r \quad (9.72)$$

$$EQ_B^r - \varepsilon_B^r EP_B^r - \gamma_B^{wr} EQ_B^w = Ew_B^r \quad (9.73)$$

$$EQ_B^w - \eta_B^w EP_B^w - \tau_B^{rw} EQ_B^r = Ez_B^w \quad (9.74)$$

$$EQ_B^w - \varepsilon_B^w EP_B^w - \gamma_B^{sw}(Q_B^s / Q_B^w)EQ_B^s - (Q_{Bi}^w / Q_B^w)EQ_{Bi}^w + (Q_{Be}^w / Q_B^w)EQ_{Be}^w = Ew_B^w \quad (9.75)$$

$$EQ_{Bi}^w - \eta_{Bi}^w EP_{Bi}^w - \tau_B^{rw} EQ_B^w = (Q_{Bi}^w / Q_B^w)Ez_{Be}^w + Ez_{Bi}^w \quad (9.76)$$

$$EQ_{Bi}^w - \varepsilon_{Bi}^w EP_{Bi}^w = Ew_{Bi}^w \quad (9.77)$$

$$EQ_{Be}^w - \eta_{Be}^w EP_B^w = Ez_{Be}^w \quad (9.78)$$

$$EQ_B^s - \eta_B^s EP_B^s - \tau_B^{ws} EQ_B^w = (Q_{Be}^w / Q_B^w)Ez_{Be}^w + Ez_B^s \quad (9.79)$$

$$EQ_B^s - \varepsilon_B^s EP_B^s - \gamma_B^{fs} EQ_B^f = Ew_B^s \quad (9.80)$$

$$EQ_B^f - \eta_B^f EP_B^f - \tau_B^{sf} EQ_B^s = Ez_B^f \quad (9.81)$$

$$EQ_B^f - \varepsilon_B^f EP_B^f = Ew_B^f \quad (9.82)$$

PORK SECTOR:

$$EQ_K^r - \eta_K^r EP_K^r - \eta_{KB}^r EP_B^r - \eta_{KLd}^r EP_{Ld}^r - \eta_{KLi}^r EP_{Li}^r - \eta_{KY}^r EP_Y^r = Ez_K^r \quad (9.83)$$

$$EQ_K^r - \varepsilon_K^r EP_K^r - \gamma_K^{wr} EQ_K^w = Ew_K^r \quad (9.84)$$

$$EQ_K^w - \eta_K^w EP_K^w - \tau_K^{rw} EQ_K^r = Ez_K^w \quad (9.85)$$

$$EQ_K^w - \varepsilon_K^w EP_K^w - \gamma_K^{sw}(Q_K^s / Q_K^w)EQ_K^s - (Q_{Ki}^w / Q_K^w)EQ_{Ki}^w + (Q_{Ke}^w / Q_K^w)EQ_{Ke}^w = Ew_K^w \quad (9.86)$$

$$EQ_{Ki}^w - \eta_{Ki}^w EP_{Ki}^w - \tau_K^{rw} EQ_K^w = (Q_{Ki}^w / Q_K^w)Ez_{Ke}^w + Ez_{Ki}^w \quad (9.87)$$

$$EQ_{Ki}^w - \varepsilon_{Ki}^w EP_{Ki}^w = Ew_{Ki}^w \quad (9.88)$$

$$EQ_{Ke}^w - \eta_{Ke}^w EP_K^w = Ez_{Ke}^w \quad (9.89)$$

$$EQ_K^s - \eta_K^s EP_K^s - \tau_K^{ws} EQ_K^w = (Q_{Ke}^w / Q_K^w)Ez_{Ke}^w + Ez_K^s \quad (9.90)$$

$$EQ_K^s - \varepsilon_K^s EP_K^s = Ew_k^s \quad (9.91)$$

LAMB SECTOR:

$$EQ_{Ld}^r - \eta_{Ld}^r EP_{Ld}^r - \eta_{LdLi}^r EP_{Li}^r - \eta_{LdB}^r EP_B^r - \eta_{LdK}^r EP_K^r - \eta_{LdY}^r EP_Y^r = Ez_{Ld}^r \quad (9.92)$$

$$EQ_{Ld}^r - \varepsilon_{Ld}^r EP_{Ld}^r - \gamma_L^{wr} EQ_L^w = Ew_{Ld}^r \quad (9.93)$$

$$EQ_{Li}^r - \eta_{Li}^r EP_{Li}^r - \eta_{LiLd}^r EP_{Ld}^r - \eta_{LiB}^r EP_B^r - \eta_{LiK}^r EP_K^r - \eta_{LiY}^r EP_Y^r = Ez_{Li}^r \quad (9.94)$$

$$EQ_{Li}^r - \varepsilon_{Li}^r EP_{Li}^r = Ew_{Li}^r \quad (9.95)$$

$$EQ_L^w - \eta_L^w EP_L^w - \tau_L^{rw} EQ_{Ld}^r = Ez_L^w \quad (9.96)$$

$$EQ_L^w - \varepsilon_L^w EP_L^w - \gamma_L^{sw} EQ_L^s = Ew_L^w \quad (9.97)$$

$$EQ_L^s - \eta_L^s EP_L^s - \tau_L^{ws} EQ_L^w = Ez_L^s \quad (9.98)$$

$$EQ_L^s - \varepsilon_L^s EP_L^s - \gamma_L^{fs} EQ_L^f = Ew_L^s \quad (9.99)$$

$$EQ_L^f - \eta_L^f EP_L^f - \tau_L^{sf} EQ_L^s = Ez_L^f \quad (9.100)$$

$$EQ_L^f - \varepsilon_L^f EP_L^f = Ew_L^f \quad (9.101)$$

POULTRY SECTOR:

$$EQ_Y^r - \eta_Y^r EP_Y^r - \eta_{YB}^r EP_B^r - \eta_{YK}^r EP_K^r - \eta_{YLd}^r EP_{Ld}^r - \eta_{YLi}^r EP_{Li}^r = Ez_Y^r \quad (9.102)$$

$$EQ_Y^r - \varepsilon_Y^r EP_Y^r - \gamma_Y^{wr} EQ_Y^w + (Q_{Ye}^r / Q_Y^r)EQ_{Ye}^r = Ew_Y^r \quad (9.103)$$

$$EQ_{Ye}^r - \eta_{Ye}^r EP_Y^r = Ez_{Ye}^r \quad (9.104)$$

$$EQ_Y^w - \eta_Y^w EP_Y^w - \tau_Y^{rw} EQ_Y^r = (Q_{Ye}^r / Q_Y^r) Ez_{Ye}^r + Ew_Y^w \quad (9.105)$$

$$EQ_Y^w - \varepsilon_Y^w EP_Y^w = Ew_Y^w \quad (9.106)$$

For any given set of elasticity estimates, equations (9.72) through (9.106) can be used to determine the relative changes in endogenous quantities and prices for any given exogenous changes in costs and/or consumer demand. In matrix notation, equations (9.72) through (9.106) can be written as:

$$\mathbf{A} \times \mathbf{Y} = \mathbf{B} \times \mathbf{X} \quad (9.107)$$

where A is a 35x35 nonsingular matrix of elasticities; **Y** is a 35x1 vector of changes in the endogenous price and quantity variables; **B** is a 35x35 matrix of parameters associated with the exogenous variables; and **X** is a 35x1 vector of percentage changes in the exogenous supply and demand variables. Relative changes in the endogenous variables (**Y**) caused by relative changes in animal identification costs and benefits (**X**) are calculated by solving equation (9.107) as

$$\mathbf{Y} = \mathbf{A}^{-1} \times \mathbf{B} \times \mathbf{X} \quad (9.108)$$

9.2 DATA

COMPLETE PRICE AND QUANTITY DATA for 2007 were available for all variables included in the model. All price and quantity data were obtained from the Livestock Marketing Information Center.

9.3 Elasticity Estimates

Elasticity estimates are required to implement the EDM model. When possible, estimates are obtained from the extant literature. In addition, the demand and supply quantity transmission elasticities were estimated from publically-available data. In all cases, Monte Carlo simulations are conducted using random sampling from a range of these elasticities. The Monte Carlo simulations allow the construction of empirical probability distributions for changes in endogenous variables and surplus measures. The Monte Carlo simulations are conducted assuming that elasticity estimates are correlated among vertical demand and supply sectors within each species. Discussion on the Monte Carlo simulations can be found in Appendix A9.1.

9.3.1 Elasticities Obtained From The Literature

The elasticities reported in table 9.3 were generally selected from previously published studies. When several estimates were available, we selected "mid-range" estimates. In other cases, elasticity estimates were unavailable. In these cases, we selected elasticity estimates that were similar to others in the model. For example, the derived demand for imported wholesale beef and imported wholesale pork were assumed to be the same as the derived demand elasticity for domestic wholesale beef and pork, respectively.

Estimates of cross-price elasticities with respect to lamb at the retail level were particularly sparse in the literature. Consequently, the cross-price elasticities of demand for beef with respect to the price of domestic lamb and imported lamb were assumed to be the same as the cross-price elasticity of demand for beef with respect to the price of poultry (0.05). Likewise, the cross-price elasticities of demand for pork with respect to the price of domestic lamb and imported lamb were assumed to be the same as the cross-price elasticity of demand for pork with respect to the price of poultry (0.02).

The cross-price elasticities of domestic lamb to beef, pork, and poultry are assumed to be the same as the cross-price elasticity of beef, pork, and poultry to domestic lamb, respectively (0.05). Similarly, the cross-price elasticities of imported lamb to beef, pork, and poultry are assumed to be the same as the cross-price elasticity of beef, pork, and poultry to imported lamb.

9.3.2 Estimated Demand Quantity Transmission Elasticities

Estimates of demand quantity transmission elasticities are used in the equilibrium displacement model to provide linkages between vertically connected demand sectors. These estimates are obtained from Seemingly Unrelated Regression (SUR) estimation of three equations for both beef and lamb. Because the pork and poultry industries are more vertically integrated compared to the beef and lamb industries, the demand quantity transmission elasticities for pork are obtained from the SUR estimation of two equations while the poultry demand quantity transmission elasticities are obtained from a single ordinary least squares equation. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities. All demand quantity transmission equations are corrected for first-order autocorrelation. Demand quantity transmission elasticity estimates are summarized in table 9.4.

Tables 9.5 through 9.8 present the regression results for the demand quantity transmission regressions. Annual data for the years 1970 through 2007 were used to estimate the transmission elasticities. The quantity data were obtained from the Livestock Marketing Information Center.

Table 9.5. SUR (Double Log) Demand Quantity Transmission Elasticities for Beef.

	Dependent Variables		
Regressors	Wholesale Beef Quantity (Q_B^w)	Slaughter Cattle Quantity (Q_B^s)	Feeder Cattle Quantity (Q_B^f)
Constant	0.34 (0.36)	-0.85 (-3.40)	11.565 (14.2291)
Retail Beef Quantity (Q_B^r)	0.99 (10.44)		
Wholesale Beef Quantity (Q_B^w)		1.09 (44.99)	
Slaughter Cattle Quantity (Q_B^s)			0.96 (26.29)
Regression Statistics:			
Adjusted R^2	0.909	0.992	0.944
Log mean of the dependent variable	10.10	10.18	12.65

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.6. SUR (Double Log) Demand Quantity Transmission Elasticities for Pork.

	Dependent Variables	
Regressors	Wholesale Pork Quantity (Q_K^w)	Slaughter Hogs Quantity (Q_K^s)
Constant	5.39 (18.52)	0.27 (0.74)
Retail Pork Quantity (Q_K^r)	0.98 (26.47)	
Wholesale Pork Quantity (Q_K^w)		0.97 (26.12)
Regression Statistics:		
Adjusted R^2	0.992	0.991
Log mean of the dependent variable	9.70	9.72

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.7. SUR (Double Log) Demand Quantity Transmission Elasticities for Lamb.

	Dependent Variables		
Regressors	Wholesale Lamb Quantity (Q_L^w)	Slaughter Lamb Quantity (Q_L^s)	Feeder Lamb Quantity (Q_L^f)
Constant	4.9 (89.75)	0.05 (5.36)	3.03 (5.76)
Domestic Retail Lamb Quantity (Q_L^r)	0.73 (12.69)		
Wholesale Lamb Quantity (Q_L^w)		0.99 (580.73)	
Slaughter Lamb Quantity (Q_L^s)			0.96 (38.86)
Regression Statistics:			
Adjusted R^2	0.987	0.999	0.991
Log mean of the dependent variable	5.69	5.73	6.23

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.8. OLS (Double Log) Demand Quantity Transmission Elasticity for Poultry.

	Dependent Variable
Regressors	Wholesale Poultry Quantity (Q_Y^w)
Constant	-5.85 (-0.05)
Retail Poultry Quantity (Q_Y^r)	1.035 (10.05)
Regression Statistics:	
Adjusted R^2	0.999
Log mean of the dependent variable	10.28

[a]These estimates are obtained from the structural model presented later in the report.

9.3.3 Estimated Supply Quantity Transmission Elasticities

Estimates of supply quantity transmission elasticities are used in the equilibrium displacement model to provide linkages between vertically connected supply sectors. These estimates are obtained from the SUR estimation of three equations for both beef and lamb. Because the pork and poultry industries are more vertically integrated compared to the beef and lamb industries, the supply quantity transmission elasticities for pork are obtained from the SUR estimation of two equations while the poultry supply quantity transmission elasticities are obtained from a single ordinary least squares equation. Double log specifications are used so that resulting parameter estimates are interpreted as transmission elasticities. All supply quantity transmission equations are corrected for first-order autocorrelation. Supply quantity transmission elasticity estimates are summarized in table 9.4.

Tables 9.9 through 9.12 provide the estimation results for the supply quantity transmission models. Annual data for the years 1970 through 2007 were used to estimate the transmission elasticities. The quantity data were obtained from the Livestock Marketing Information Center

Table 9.9. SUR (Double Log) Supply Quantity Transmission Elasticities for Beef.

	Dependent Variables		
Regressors	Retail Beef Quantity (Q_B^r)	Wholesale Beef Quantity (Q_B^w)	Slaughter Cattle Quantity (Q_B^s)
Constant	2.03	0.84	-3.23
	(2.79)	(3.38)	(-0.73)
Wholesale Beef Quantity (Q_B^w)	0.771		
	(10.77)		
Slaughter Cattle Quantity (Q_B^s)		0.91	
		(37.35)	
Feeder Cattle Quantity (Q_B^f)			1.07
			(3.05)
Regression Statistics:			
Adjusted R^2	0.898	0.991	0.638
Log mean of the dependent variable	9.83	10.10	10.18

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.10. SUR (Double Log) Supply Quantity Transmission Elasticities for Pork.

	Dependent Variables	
Regressors	Retail Pork Quantity (Q_K^r)	Wholesale Hogs Quantity (Q_K^w)
Constant	-4.99 (-10.71)	0.23 (0.58)
Wholesale Pork Quantity (Q_K^w)	0.97 (25.32)	
Slaughter Hogs Quantity (Q_K^s)		0.98 (24.85)
Regression Statistics:		
Adjusted R^2	0.938	0.992
Log mean of the dependent variable	3.93	9.7

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.11. SUR (Double Log) Supply Quantity Transmission Elasticities for Lamb.

	Dependent Variables		
Regressors	Domestic Retail Lamb Quantity (Q_L^r)	Wholesale Lamb Quantity (Q_L^w)	Slaughter Lamb Quantity (Q_L^s)
Constant	-5.99 (-2.87)	-0.05 (-5.24)	0.34 (0.40)
Wholesale Retail Lamb Quantity (Q_L^w)	0.91 (8.82)		
Slaughter Lamb Quantity (Q_L^s)		1.01 (571.09)	
Feeder Lamb Quantity (Q_L^f)			0.86 (6.10)
Regression Statistics:			
Adjusted R^2	0.993	0.999	0.979
Log mean of the dependent variable	0.086	5.72	5.73

[a]These estimates are obtained from the structural model presented later in the report.

Table 9.12. OLS (Double Log) Supply Quantity Transmission Elasticity for Poultry.

	Dependent Variable
Regressors	Retail Poultry Quantity (Q_Y^r)
Constant	1.5 (6.49)
Wholesale Poultry Quantity (Q_Y^w)	0.81 (36.62)
Regression Statistics:	
Adjusted R^2	0.999
Log mean of the dependent variable	9.78

[a]These estimates are obtained from the structural model presented later in the report.

9.3.4 Simulated Elasticities

Whether obtained from the literature or estimated, Monte Carlo simulations are conducted after selecting prior distributions for each of the elasticities used in the model. We use Beta (4,4) distributions as priors in all cases. The Beta distribution is used because it allows for truncation while the alpha and beta parameters approximates a normal distribution across the two truncation points. In addition, demand elasticities are constrained to always be negative and supply elasticities to always be positive.

After reviewing the literature, ranges for each short run demand, supply, cross-price, and transmission elasticity were established by multiplying each estimate by 0.50 to establish the lower bound (in absolute value) and by 1.50 to establish the upper bound (in absolute value).

For each Monte Carlo replication, each randomly selected elasticity was allowed to multiplicatively approach its long run elasticity estimate reported above. The approach allows for supply and demand adjustments to occur as both consumers and producers respond to exogenous shocks.

Each simulation includes 1,000 iterations. Empirical probability distributions are generated for each endogenous variable and for all estimates of changes in consumer and producer surplus. We use these empirical distributions to develop reported means (Brester, Marsh, and Atwood, 2004).

9.3.5 Correlations

A sensitivity analysis of an equilibrium displacement model should consider both variations of elasticity estimates and correlations among these estimates (Davis and Espinoza, 1998). We assume that demand elasticities are uncorrelated with supply elasticities. Furthermore, we assume that supply and demand elasticities are uncorrelated across species. Because we obtained supply and demand elasticity estimates from the literature, estimated correlation among supply and demand elasticities are not available. However, estimated correlations among the demand and supply quantity transmissions indicated that vertical

correlations averaged about 0.20. In addition, correlation estimates for both the beef sector and lamb sector also indicated correlations of about 0.20 (GIPSA RTI Meat Marketing Study, 2007). Consequently, we selected 0.20 as the correlation coefficient to be used among vertically related supply and demand elasticities.

9.4 Simulation Scenarios

Various simulation scenarios are presented below to illustrate the impact of combinations of animal identification policies, adoption rates, and potential export and domestic beef demand responses. The costs on the beef industry are proportionally larger than for the other meat species. Consequently, export and domestic beef demand shocks dominate all others. Thus, the various scenarios focus on shocks to beef demand rather than the potential impacts on demand for other species. Scenarios estimate producer and consumer surplus under 30, 50, 70, and 90% NAIS adoption rates (with few noted exceptions) to illustrate how different adoption rates cause different impacts. The scenarios are separated into five general areas:

1. Effects of Various Adoption Rates of Full Animal Identification/Tracing

The impacts of increased costs of full animal identification/tracing are simulated assuming 30, 50, 70, and 90% adoption rates. This set of simulations are conducted assuming that both export and domestic demand for meat are unaffected by the adoption of a full animal identification/tracing program. In essence these scenarios reflect where costs of NAIS adoption accrue in the short and long run if there are no benefits at all from adoption.

2. Effects of a 50% Adoption Rate for Premises Registration, Bookend, and Full Animal Identification/Tracing

The impacts of a 50% adoption rate of three animal identification programs, 1) premises registration, 2) bookend, and 3) full animal identification/tracing, are simulated. The simulations are conducted assuming that both export and domestic demand for meat are unaffected by the 50% adoption of these three programs. This set of scenarios enables us to compare how additional costs of bookend and full animal tracing alone without any changes in demand would affect producers and consumers. These scenarios again reflect only costs of adoption assuming no benefits.

3. Increases in Export Beef Demand Needed to Offset Various Adoption Rates of Full Animal Identification/Tracing

Regardless of adoption rates, the implementation of a full animal identification/tracing program increases costs. However, it is possible that such systems may increase foreign consumer confidence in the US meat system. Hence, the size of an increase in beef export demand needed to just offset adoption costs is simulated assuming 30, 50, 70, and 90% adoption rates. The focus is on beef exports rather than exports of other meats because the beef sector dominates the simulation model. That is, since costs of adoption are by far largest in the beef sector, it is the sector that is most affected. The simulation involves adjusting the size of the increase in beef export demand to the point where none of the wholesale, slaughter cattle, nor feeder cattle (which includes cow/calf producers) sectors lose any (10-year discounted present value) producer surplus. These sectors were selected because they are the sectors in the beef industry that incur direct costs of an individual animal ID and tracing system with NAIS adoption. In essence, these scenarios measure how much of a beef export demand enhancement would be needed (assuming constant domestic demand) to encourage beef producer adoption of NAIS for each adoption rate.

4. Increases in Domestic Beef Demand Needed to Offset Various Adoption Rates of Full Animal Identification/Tracing

Adoption of an animal identification/tracing program could increase consumer confidence in the US meat system. Hence, the size of an increase in domestic beef demand needed to just offset the costs of such a program is simulated assuming 30, 50, 70, and 90% adoption rates. In these scenarios, the focus is on domestic beef demand rather than the domestic demand for other meats because the beef sector dominates the simulation model. The simulation involves adjusting the size of an increase in domestic beef demand to the point where neither the wholesale beef, slaughter cattle, nor feeder cattle sectors lose any (10-year discounted) producer surplus. In essence, these scenarios measure how much of a domestic beef demand enhancement would be needed (assuming constant domestic demand) to encourage beef producer adoption of NAIS for each adoption rate.

5. Loss of Export Beef Demand if Animal Identification/Tracing is Not Implemented

Animal identification systems are rapidly developing through the world (see Table 12.1 for a summary comparing global cattle identification and traceability systems). World Trade Organization guidelines allow members to maintain higher sanitary and phytosanitary standards than internationally accepted if there is scientific justification to impose such standards. Furthermore, as international adoption of animal identification and tracing systems are adopted, they raise internationally accepted standards. The United States could begin to lose access to international beef export markets if the United States falls behind world standards on adoption of an animal identification/tracing system.

According to USDA-APHIS (2007), the U.S. needs to develop and implement an animal identification system that can “protect U.S. exports and meet the growing international market demand for systems that provide timely animal identification capabilities...” (page 2). Furthermore, Murphy et al. (2008) states that animal identification systems “are becoming prerequisites to international trade” (page 284).

As a result, status quo of doing nothing going forward to increase adoption of NAIS is likely to reduce US access to specific international markets. Exactly how much access and at what timing is not certain, but reduced access is probable. To estimate how such reduced export market access, all else constant, we estimate a set of scenarios where loss of the beef export markets are evaluated at 10%, 25%, and 50% losses assuming the United States does not implement an animal identification/tracing system. These scenarios demonstrate potential losses of not having NAIS as animal identification and tracing becomes an international norm.

9.5 Animal Identification Program Cost Estimates

Exogenous (percentage) changes in an animal identification program at the wholesale, slaughter, and farm levels of the beef, pork, lamb, and poultry industries were estimated (see Sections 4-7 for discussion on the animal identification program cost estimates). There are no changes in costs at the retail levels. The annual operation costs estimates resulting from a 90% adoption of an animal identification program for beef, pork, lamb, and poultry would increase by $175.87 million, $5.67 million, $2.71 million, and $7.98 million, respectively.

Of the $192.22 million annual increase in operating costs, the beef industry will bear the largest portion of this with a $175.87 million annual increase in operating costs. Costs associated with several sectors within the beef industry are aggregated for use in the simulation model. For example, Beef cow/calf and Auction yard costs are combined into the feeder cattle sector. Dairy, Background, and Feedlot costs are aggregated into the slaughter cattle sector. Packer costs are referred to as wholesale costs in the simulation model. Thus, beef industry costs are estimated to be distributed as: $126.69 million to the feeder cattle sector, $46.48 million to the slaughter cattle sector, and $2.69 million to the wholesale sector. Using 2007 prices and quantities for each market level, these costs estimates represent the following percentage increases in costs relative to total value: 0.42% at the farm level, 0.12% at the slaughter cattle level, and 0.007% at the wholesale beef level (see column 5, table 9.13). Each of these percentage increases in costs represent upward shifts (reductions in supply) of the respective supply functions [equations (9.47), (9.45), and (9.40)].

Costs associated with the pork industry are aggregated into specific sectors within the simulation model. Identification costs associated with Farrow-to-Wean, Farrow-to-Feeder, Farrow-to-Finish, Wean-to-Feeder, and Feeder-to-Finish are aggregated into the slaughter hog sector. Packer costs are represented in the simulation model by the wholesale level. These costs will be distributed throughout the pork industry as follows: $5.54 million to the slaughter hog sector and $0.13 million to the

wholesale pork (packer) sector. These translate to the following percentage increases in costs relative to total value: 0.04% at the slaughter hog level, and 0.0009% at the wholesale pork level (column 5, table 9.13). Each of these percentage increases in costs represents upward shifts of the respective supply functions [equations (9.56) and (9.51)].

One-half of the costs associated with All Operations in the lamb industry are allocated to the feeder lamb level, while the other one-half of All Operations costs are allocated to the slaughter lamb sector. Packer costs are included in the wholesale level in the simulation model. The $2.71 million annual increase in lamb industry costs will be distributed as: $1.34 million, $1.34 million, and $0.029 million to the feeder lamb, slaughter lamb, and wholesale marketing levels, respectively. These costs increases represent the following percentage increases relative to total value at the feeder, slaughter, and wholesale levels: 0.43%, 0.43%, and 0.008%, respectively (column 5, table 9.13). Each of these percentage increases in costs represents upward shifts of the respective supply functions [equations (9.66), (9.64), and (9.62)].

All of the costs incurred by the poultry industry are assigned to the wholesale level in the simulation model. Increased costs to the poultry sector are attributed to the wholesale level and represent a 0.02% increase in wholesale costs relative to total value. This percentage increase represents an upward shift in the respective supply function [equation (9.71)].

The percentage changes in animal identification costs for the alternate scenarios (e.g., 30% adoption for Full Identification/Tracing, 50% adoption for Full Identification/Tracing, etc.) at each market level are estimated in a similar manner. These percentage increases in costs are presented in table 9.13.

Table 9.13. Exogenous Supply Changes Used in the Equilibrium Displacement Model. (%)

	No Change in Demand						
	30% adoption	50% adoption	70% adoption	90% adoption	50% adoption	50% adoption	50% adoption
	Full ID & Tracing	Full ID & Tracing	Full ID & Tracing	Full ID & Tracing	Prem. Registration	Bookend	Full ID & Tracing
Beef Sector:							
Wholesale	0.0019%	0.0032%	0.0046%	0.0068%	0.0000%	0.0032%	0.0032%
Slaughter	0.0303%	0.0538%	0.0815%	0.1160%	0.0001%	0.0319%	0.0538%
Farm	0.0997%	0.1755%	0.2905%	0.4178%	0.0011%	0.1558%	0.1755%
Pork Sector:							
Wholesale	0.0003%	0.0005%	0.0007%	0.0009%	0.0000%	0.0005%	0.0005%
Slaughter	0.0121%	0.0206%	0.0299%	0.0399%	0.0008%	0.0046%	0.0206%
Lamb Sector:							
Wholesale	0.0027%	0.0045%	0.0063%	0.0081%	0.0045%	0.0045%	0.0045%
Slaughter	0.1371%	0.2286%	0.3200%	0.4318%	0.0221%	0.1308%	0.2286%
Farm	0.1350%	0.2249%	0.3149%	0.4250%	0.0217%	0.1287%	0.2249%
Poultry Sector:							
Wholesale	0.0046%	0.0084%	0.0129%	0.0180%	0.0003%	NA*	0.0084%

*There are no costs in the bookend approach for poultry.

9.6 Animal Disease Management

An epidemiological disease spread model is used to evaluate a hypothetical foot-and-mouth disease (FMD) outbreak in southwest Kansas under alternative animal tracing strategies. The disease spread in this exercise is confined to the southwest Kansas region and is not allowed to jump outside of the region, though in all likelihood FMD would spread beyond this region if it occurred. The main reason for confining the disease to this area is that it is the only region for which we have well-calibrated reliable animal location and movement data which are critical inputs into the disease spread model. Restricting the model to this geographic area likely underestimates both the disease spread and its duration. However, the equilibrium displacement model results presented below resulting from a highly contagious FMD outbreak are driven more off of export market losses than animal losses associated with disease outbreak.

The tracing strategies used in the disease spread model are 30, 50, 70, and 90% successful one-step forward traces which we use as a proxy for ID and tracing adoption rates used in other scenarios. However, successful one-step forward traces are not the same as industry animal ID and tracing adoption rates. The specific epidemiological model used is the *North American Animal Disease Spread Model* (NAADSM). NAADSM is a stochastic, spatial, state-transition simulation model that is designed to simulate the spread and control of highly contagious diseases in a population of susceptible animals (Harvey, et al.). Results from the disease spread model are then incorporated into the equilibrium displacement model.

The disease spread model used in this study was developed by the US Department of Agriculture's Animal and Plant Health Inspection Service (USDA/APHIS) in collaboration with Colorado State University, University of Guelph, Canadian Food Inspection Agency, and Ontario Ministry of Agriculture, Food, and Rural Affairs. Several recent studies including Paarlberg et al. (2008), Pendell et al. (2007), Pendell (2006), and Reeves et al. (2006) have used the NAADSM to analyze impacts of FMD outbreaks.

9.6.1 Impacts of Foot-and-Mouth Disease Outbreak with Various Decreases in Export Beef Demand Given Various Adoption Rates of Full Animal Identification/Tracing.

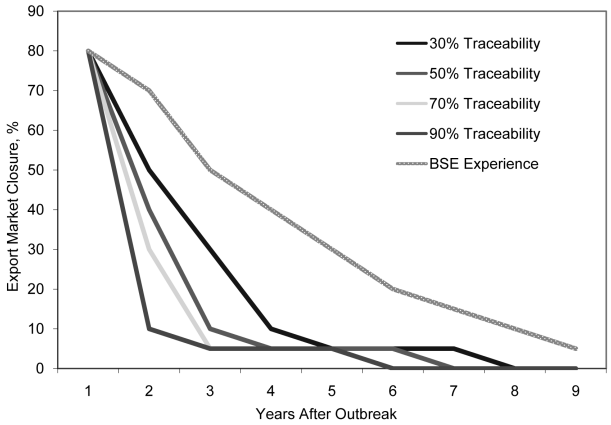
This set of simulations considers increased levels of animal tracing at 30, 50, 70, and 90% tracing adoption rates simultaneously with various changes in export beef demand. In each scenario a first-year reduction in exports of 80% was assumed following an FMD outbreak. The rationale for this is that major export markets would immediately completely close in similar fashion to what the US experienced with the BSE event that resulted in an 80% first-year export market reduction. FMD is a much more well understood and common disease in the world than BSE and is not considered a food safety threat. As such, resumption of trade with an FMD outbreak is assumed to occur faster than the US experienced with BSE. Furthermore, as animal tracing adoption increases, it is assumed that regionalization would enable for more rapid export market re-opening so the export market is assumed to be re-opened more quickly with higher levels of animal tracing adoption.

With 30% tracing adoption, it is assumed that an FMD outbreak would result in an 80% decrease in export beef demand in the first year, a 50% decrease in export beef demand in the second year, a 30% decrease in export beef demand in the third year, 10% decrease in export beef demand in the fourth year, a 5% decrease in export beef demand in years five, six, and seven, and by year eight, the markets would be back to pre-FMD export beef demand levels. A second simulation considers a 50% tracing adoption rate assuming an 80, 40, 10, 5, 5, and 5% loss in export beef demand in years one through six, respectively, with the last four years at pre-FMD beef export levels following the FMD outbreak. A third model simulates a 70% adoption rate tracing adoption rate assuming a 80, 30, 5, 5, and 5% loss in export beef demand in years one through five, respectively, following the FMD outbreak with the last five years at pre-FMD beef export levels. A fourth model considers a 90% adoption rate, and losses of 80, 10, 5, 5, and 5% in export beef demand in years one through five, respectively, with the last five years at pre-FMD beef export levels.

Figure 9.4 presents the alternate tracing adoption rates and the associated export market losses by year following a FMD outbreak and for comparison illustrates the export market losses by year as a result of the BSE event in the US. The BSE event occurred in late 2003, so we have only realized just under

five years of export market access since that time. Export market forecasts from the Livestock Marketing Information Center were used for years five, six, seven, eight, and nine, after the BSE event in figure 9.4.

FIGURE 9.4. ASSUMED EXPORT MARKET LOSS BY YEAR FOLLOWING A FOOT-AND-MOUTH DISEASE OUTBREAK WITH DIFFERENT BOVINE AND SWINE TRACEABILITY LEVELS AND ACTUAL AND FORECASTED BSE EXPERIENCED EXPORT MARKET LOSS



9.6 SIMULATION RESULTS

IN THIS SECTION, WE PRESENT EDM SIMULATION RESULTS for a variety of scenarios that evaluate the cost impacts of implementing an animal identification program on the meat industry. In each case, percentage changes in prices and quantities for livestock and meat prices are presented for both short run (1 year) and long run (10 year) time horizons. Each percentage change is relative to 2007 average prices and quantities. In addition, changes in producer surplus at each market level and for each species are presented as are changes in consumer surplus at the retail level.

Changes in producer and consumer surplus are presented for short run and long run time horizons as well as cumulative effects over a ten-year period. Changes in producer and consumer surplus for the various simulations can be found in the tables in Appendix A.9.2.

9.6.1 Simulated Effects of Various Adoption Rates of Full Animal Identification/Tracing

Table 9.14 presents median percentage changes in prices and quantities for all endogenous variables resulting from a 90% adoption of a full animal identification/tracing program. The first column shows the short run (first year) results. Retail and wholesale beef prices increase by 0.73% and 0.87%, respectively, while quantities decrease by 0.52% and 1.03%. Prices and quantities for imported wholesale beef, slaughter cattle, and feeder cattle all decline. Exported wholesale beef quantities also decline.

Retail, wholesale, and imported pork prices and quantities all increase slightly (but by less than 0.11%). This occurs because the demand for pork increases as the retail price of beef increases. This demand increase is large enough to offset additional costs imposed on the pork sector by the 90% adoption of full animal identification/tracing program. Slaughter hog prices increase by 0.09%, but quantities decline slightly as do quantities of pork exports. Higher domestic pork prices encourages imports which displaces some domestic and export production.

The retail price of domestic lamb increases by 1.1%, while quantity declines by about 0.5%. Thus, retail demand (as a result of higher beef and pork prices) for lamb does not increase enough to offset higher costs of full animal identification/tracing. However, the retail demand for imported lamb increases. The prices of wholesale and slaughter lamb increase while quantities decline. Feeder lamb prices and quantities both decline. Retail and wholesale poultry prices and quantities increase, while poultry exports decline slightly.

In the long run, most of these relationships are similar. However, all of the long run estimates are quite small indicating that the meat industry adjusts to the animal identification/tracing program over time.

Table 9.14. Median Changes from 90% Adoption of a Full Animal Identification/Tracing Program

Endogenous Variables	Short Run	Long Run
Retail Beef Quantity	-0.522%	-0.003%
Retail Beef Price	0.729%	0.003%
Wholesale Beef Quantity	-1.029%	-0.021%
Wholesale Beef Price	0.866%	0.020%
Imported Wholesale Beef Quantity	-0.766%	-0.019%
Imported Wholesale Beef Price	-0.418%	-0.002%
Exported Wholesale Beef Quantity	-0.359%	-0.059%
Slaughter Cattle Quantity	-0.812%	-0.055%
Slaughter Cattle Price	-0.711%	0.061%
Feeder Cattle Quantity	-0.562%	-0.130%
Feeder Cattle Price	-1.469%	0.102%
Retail Pork Quantity	0.104%	-0.001%
Retail Pork Price	0.082%	0.002%
Wholesale Pork Quantity	0.043%	-0.010%
Wholesale Pork Price	0.080%	0.008%
Imported Wholesale Pork Quantity	0.027%	-0.009%
Imported Wholesale Pork Price	0.020%	-0.001%
Exported Wholesale Pork Quantity	-0.073%	-0.008%
Slaughter Hog Quantity	-0.005%	-0.020%
Slaughter Hog Price	0.086%	0.011%
Domestic Retail Lamb Quantity	-0.505%	-0.008%
Domestic Retail Lamb Price	1.126%	0.008%
Imported Retail Lamb Quantity	0.907%	0.006%
Imported Retail Lamb Price	0.090%	0.001%
Wholesale Lamb Quantity	-0.747%	-0.042%
Wholesale Lamb Price	1.057%	0.035%
Slaughter Lamb Quantity	-0.900%	-0.166%
Slaughter Lamb Price	0.511%	0.145%
Feeder Lamb Quantity	-0.609%	-0.191%
Feeder Lamb Price	-2.245%	0.103%
Retail Poultry Quantity	0.080%	0.001%
Retail Poultry Price	0.280%	0.000%
Exported Retail Poultry Quantity	-0.085%	0.000%
Wholesale Poultry Quantity	0.021%	-0.001%
Wholesale Poultry Price	0.276%	0.002%

Table 9.15 presents changes in producer and consumer surplus that occur because of the 90% adoption of a full animal identification/tracing program. As expected, the short run impacts are larger than the long run effects. In the short run, the slaughter and feeder cattle sectors each lose about $570 million. The costs of a full animal identification/tracing program with 90% adoption are approximately $173 million for the slaughter and feeder cattle sectors. These costs cause the supply of both slaughter and feeder cattle to be reduced, thus increasing the price of cattle. However, the increase in price of slaughter and feeder cattle will ultimately raise the price at the retail level causing consumers to substitute away from beef to pork, poultry and/or lamb. This reduction in demand for beef results in a decrease in the derived demand for slaughter and feeder cattle, thus lowering the price and quantity. In year 10, the entire beef industry loses $24 million of producer surplus. Over the entire 10-year period, the discounted present value of producer surplus losses for the beef industry totals $4.52 billion or about 1% of the discounted present value of the 10-year total surplus for the industry.

The pork industry realizes a small gain in producer surplus of $76 million in year 1 as higher beef prices caused by relatively higher animal identification costs causes pork to be a more attractive consumption substitute for beef. Over the entire 10-year period, the pork industry gains only about 0.06% of discounted total producer surplus.

The entire lamb industry loses about $5.3 million of producer surplus in year 1, and a discounted present value of $31.5 million over the entire 10 years. The latter amount represents a 0.35% decline.

The poultry industry gains producer surplus as a result of the implementation of an animal identification program because relatively lower costs are being added to the poultry sector. Thus, as prices for substitute meats increase, the demand for poultry increases. The poultry sector gains $274 million of producer surplus (0.16%) in terms of the discounted present value over the 10-year period.

Assuming that no changes in the domestic or export demand for meats occur as a result of the implementation of an animal identification program, beef consumer surplus declines by 0.45%, pork consumer surplus increases by 0.01%, and domestic lamb consumer surplus declines by 0.55%. Imported lamb consumer surplus increases by 0.35% and poultry consumer surplus

increases by 0.01%. In terms of all US meat consumers, consumer surplus declines by $1.33 billion over the 10-year period which represents a 0.11% decline.

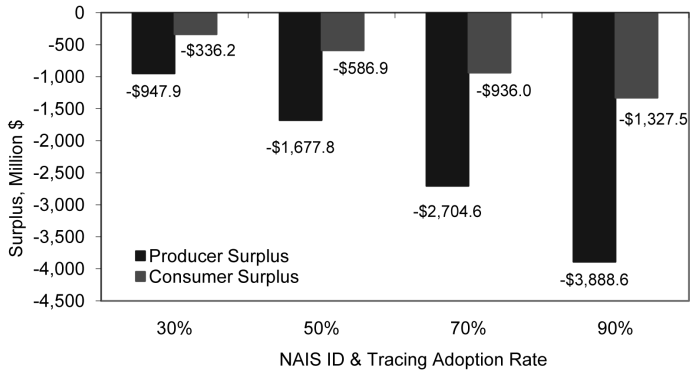
Figure 9.5 presents changes in the total discounted present value of producer and consumer surplus assuming 30, 50, 70, and 90% adoption rates of a full animal identification/tracing program. The losses increase with adoption rates. Of course, each of these scenarios assumes that neither export nor domestic demand for meat are affected by such programs. As such, these scenarios estimate societal impacts of NAIS adoption assuming no benefits accrued.

Table 9.15. Producer and Consumer Surplus Changes from 90% Adoption of a Full Animal Identification/Tracing Program.[a]

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	-55.57	-0.50	-613.13	-534.79	-0.177%
Wholesale Beef	-152.95	-2.46	-919.68	-786.85	-0.474%
Slaughter Cattle	-568.31	-6.84	-1,946.61	-1,693.05	-0.862%
Feeder Cattle	-570.12	-13.93	-1,869.94	-1,628.31	-1.038%
Total Beef Producer Surplus	-1,354.51	-23.66	-5,260.73	-4,520.48	-0.991%
Retail Pork	56.29	-0.15	142.13	127.27	0.107%
Wholesale Pork	13.02	-0.75	26.96	25.34	0.041%
Slaughter Hog	6.41	-1.55	-0.78	2.04	0.003%
Total Pork Producer Surplus	76.18	-2.45	167.57	155.70	0.064%
Retail Domestic Lamb	3.84	-0.02	3.99	4.18	0.105%
Wholesale Lamb	0.55	-0.04	-2.50	-1.78	-0.108%
Slaughter Lamb	-1.32	-0.17	-9.45	-7.62	-0.485%
Feeder Lamb	-8.39	-0.27	-30.79	-26.57	-1.539%
Total Lamb Producer Surplus	-5.31	-0.50	-38.41	-31.51	-0.352%
Retail Poultry	160.29	0.03	347.86	314.21	0.171%
Wholesale Poultry	114.25	-0.04	270.96	245.33	0.138%
Total Poultry Producer Surplus	274.28	-0.02	614.87	560.83	0.156%
Total Meat Producer Surplus	-1,018.66	-26.78	-4,537.21	-3,888.63	-0.489%
Consumer Surplus					
Retail Beef	-550.31	-2.19	-1,642.31	-1,448.50	-0.446%
Retail Pork	14.40	-0.74	44.28	39.88	0.019%
Retail Domestic Lamb	-9.00	-0.06	-29.08	-25.66	-0.554%
Retail Imported Lamb	12.29	0.05	34.87	30.89	0.346%
Retail Poultry	-2.16	0.14	69.85	57.70	0.014%
Total Meat Consumer Surplus	-522.82	-2.87	-1,503.37	-1,327.48	-0.109%

[a] Totals are not identical to sums of individual surpluses because they are averages of simulations.

FIGURE 9.5. CUMULATIVE PRESENT VALUE OF 10-YEAR TOTAL PRODUCER AND CONSUMER SURPLUS CHANGES, FULL TRACING, WITH VARYING ADOPTION RATES, WITH NO DOMESTIC OR EXPORT DEMAND CHANGES*

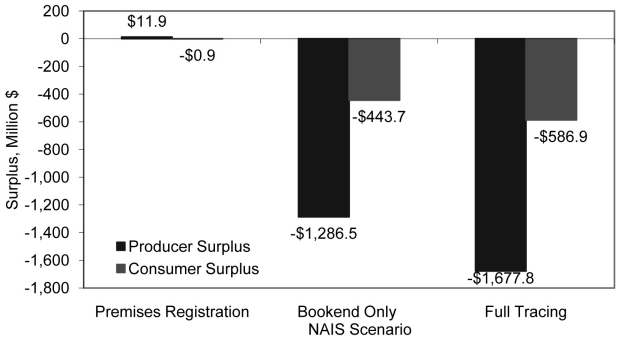


*Information for figure 9.5 can be found in table 9.15 and A9.2.1 – A9.2.3.

9.6.2 SIMULATED EFFECTS OF A 50% ADOPTION RATE FOR PREMISES REGISTRATION, BOOKEND, AND FULL ANIMAL IDENTIFICATION/TRACING

Simulations were conducted based upon a 50% adoption rate of premises registration, bookend, and full animal identification/tracing programs. Once again, the simulations are conducted assuming that both export and domestic demand for meat are unaffected by a 50% adoption of these three programs. In other words, they assume no direct benefits of adoption. Figure 9.6 illustrates the results in terms of 10-year cumulative total discounted present value of producer and consumer surplus. The impacts on producer and consumer surplus are negligible in the case of premises registration because associated costs are relatively small. However, the costs for bookend and full animal identification/tracing are relatively larger, and cause large changes in total producer and consumer surplus. For the bookend program and full animal identification/traceability program with a 50% adoption rate, total meat producer surplus declines by $1.3 and $1.7 billion, respectively. Of course, each of these scenarios assumes that neither export nor domestic demand for meat are affected by such programs.

FIGURE 9.6. CUMULATIVE PRESENT VALUE OF 10-YEAR TOTAL PRODUCER AND CONSUMER SURPLUS CHANGES, PREMISES REGISTRATION, BOOKEND, FULL TRACING, 50% ADOPTION RATES, NO DEMAND CHANGES*



*Information for figure 9.6 can be found in tables A9.2.4 – A9.2.6.

9.6.3 INCREASES IN BEEF EXPORT DEMAND NEEDED TO OFFSET VARIOUS ADOPTION RATES OF FULL ANIMAL IDENTIFICATION/TRACING

A large and growing body of research suggests that US consumers, as well as those in many other countries, value animal traceability or attributes made available through traceability of food products. Many consumers demand and demonstrate willingness-to-pay for food products that are traceable to the farm or ranch. "The improved food safety from increased traceability increases consumers' willingness to pay for the (safer) product. This creates an additional incentive to improve the food safety reputation of the industry" (Pouliot and Sumner, 2008, p. 25).

International consumers have demonstrated demand for traceability and/or product attributes (e.g., Buhr, 2003; Cuthbertson and Marks, 2007; Gracia and Zeballos, 2005; Hobbs, 1996; Hobbs et al., 2005; Schroeder et al., 2006;

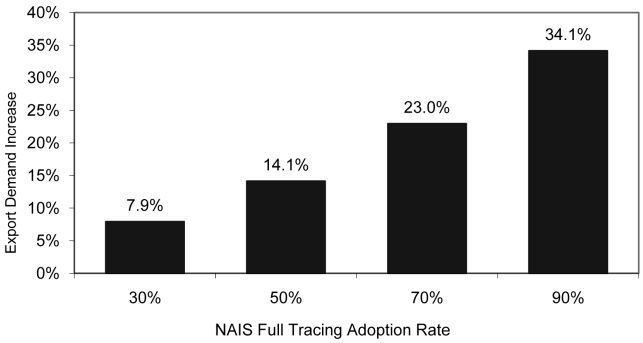
Tonsor et al., 2005). Dickinson and Bailey (2005) concluded that consumers in Japan, Canada, US, and the UK were willing to pay on average from 7% to 25% more for beef and pork sandwiches containing traceable meat. Japanese consumers, a very important market for US beef and pork, was the highest at 25%. Results from this body of literature reveals that the United States livestock industries lagging behind other major producing regions in animal ID and traceability (as documented in an earlier section of this report), reduces its competitiveness and demand for its product relative to other major exporters in the global market.

Regardless of adoption rates, the advent of full animal identification/tracing increases costs. However, it is possible that such systems may increase foreign consumer confidence in the US meat system. Hence, the size of an increase in beef export demand needed to just offset these costs are simulated assuming 30, 50, 70, and 90% adoption rates. The focus is on beef exports rather than exports of other meats because the beef sector dominates the simulation model. The simulation involves adjusting the size of the increase in beef export demand to the point where none of the wholesale, slaughter cattle, nor feeder cattle (which includes cow/calf producers) sector lose any (10-year discounted) producer surplus.

Figure 9.7 illustrates the simulation results. Assuming a 30% adoption rate of a full animal identification/tracing program, an 7.9% increase in beef export demand over 2007 levels would be required so that the wholesale beef, slaughter cattle, and feeder cattle sectors do not lose producer surplus because of the implementation of an animal identification program. With an 7.9% increase in beef export demand, slaughter and feeder cattle sectors gain $1,037 and $549 million, respectively, while the wholesale sector is virtually no worse off (table A.9.2.7). Given that industry costs increase with adoption rates, a 34.1% increase in beef export demand would be required under a 90% adoption rate to so that none of these three sectors of the beef industry would lose any producer surplus. A 34.1% increase in beef export demand leads to an increase producer surplus in the slaughter and feeder cattle sectors by $4,621 and $2,549 million, respectively (table A.9.2.10). To put such an increase into perspective, South Korea's beef export market share prior to the 2003 US BSE discovery was 23%. Since that time, South Korea's beef market has generally been closed to US beef exports. South Korea's trade negotiators have, at least indirectly, hinted that a lack of a US

animal identification system is one of the barriers to the normalization of beef trade between the two countries. Finally, it is likely that adoption rates and export demand increases are likely to be positively correlated.

FIGURE 9.7. CHANGE IN BEEF EXPORT DEMAND NEEDED SO THAT WHOLESALE BEEF, SLAUGHTER CATTLE, AND FEEDER CATTLE SECTORS DO NOT LOSE ANY CUMULATIVE PRESENT VALUE 10-YEAR SURPLUS OF FULL TRACING BY ADOPTION RATES *



*Information for figure 9.7 can be found in tables A9.2.7 – A9.2.10.

9.6.4 Increases in Domestic Beef Demand Needed to Offset Various Adoption Rates of Full Animal Identification/Tracing

Based on the large body of literature demonstrating consumer demand for meat traceability and associated credence and food safety enhancements that are associated with tracing, likely domestic consumer demand would be greater for meat produced under a viable animal tracing system. Exactly how much demand might increase as a result of animal tracking is difficult to determine. However, past research includes willingness to pay premiums for traceability alone of more than 7% (Dickinson and Bailey, 2002).

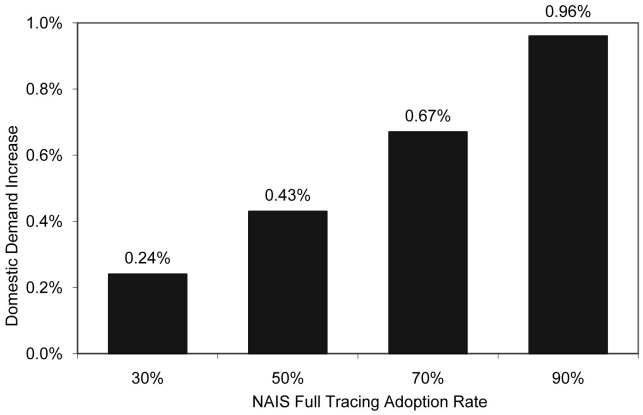
Dickinson and Bailey (2002) conducted binding experiments using beef and pork sandwiches with base prices of $3.00 and actual dollar exchange to determine consumer willingness-to-pay for traceability. Participants were willing-to-pay on average $0.23 more for traceability to the farm for beef and $0.50 for pork. Umberger et al. (2003) concluded that on average consumers in Chicago and Denver were willing to pay from 10% (steak) to 23% (ground beef) more for beef with a US country to origin guarantee. Loureiro and Umberger (2003) determined that consumers were willing to pay $1.53/lb more for steak and $0.70/lb more for ground beef that was "US Certified Beef". Other studies find similar support of US consumers demanding animal and meat traceability (e.g., Loureiro and Umberger, 2004; Ward, Bailey, and Jensen, 2005). Traceability alone appears to be less valuable than what traceability better enables the food supply chain to deliver in regards to food safety assurances, enhanced product quality, origin labeling, and related product credence characteristics (Hobbs et al., 2005; Schroeder et al., 2006; Verbeke and Ward, 2006).

Mennecke et al. (2007) conducted a national survey of 1,171 consumers in addition to surveys of 76 business and animal science students and 221 other students about beef steak attribute preferences. Region of origin was overall the highest ranked important product attribute followed by growth promoters, cost, tenderness, traceability, organic certification, animal breed, steak cut, and animal feed. They concluded "Our results clearly indicate that information about the region of origin, the use or nonuse of growth promoters, guaranteed tenderness, and traceability could all be critical elements of consumer decision making" (p. 2653).

Simulations were conducted to evaluate the potential impacts of increases in domestic consumer demand as a result of various adoption rates of a full animal identification/tracing program. Because the beef industry faces the largest costs, we focus on that sector. The model was used to determine the size of an increase in domestic beef demand that would be required so that none of the wholesale beef, slaughter cattle, nor feeder cattle sectors lose any producer surplus (i.e., 10-year discounted present value) associated with animal identification. Figure 9.8 presents these results, and indicates that a permanent 0.24% increase in domestic beef demand would just offset these costs for the entire industry if a 30% adoption occurred. Under a 90% adoption rate, a permanent domestic demand increase of 0.96% would be required so that no sector of the beef industry would incur any loss of producer surplus based upon the present discounted values occurring over a 10-year time period.

Since 2000, annual beef demand has varied from an increase of 8.9% to a decline of 3.7%. Hence, a 1% increase is certainly within the range of recent demand changes.

FIGURE 9.8. CHANGE IN DOMESTIC BEEF DEMAND NEEDED SO THAT WHOLESALE BEEF, SLAUGHTER CATTLE, AND FEEDER CATTLE SECTORS DO NOT LOSE ANY CUMULATIVE PRESENT VALUE 10-YEAR SURPLUS OF FULL TRACING BY ADOPTION RATES*



*Information for figure 9.8 can be found in tables A9.2.11 – A9.2.14.

9.6.5 IMPACTS OF DECREASES IN EXPORT BEEF DEMAND IF ANIMAL IDENTIFICATION/TRACING IS NOT IMPLEMENTED

This set of simulations considers decreases in export beef demand of 10, 25, and 50% if the US loses access to beef export markets because it does not implement an animal identification/tracing system.

Table 9.16 presents median percentage changes in prices and quantities that would result from a permanent 50% decrease in export demand. The first column shows the short run (first year) results. Retail and wholesale beef prices decrease by 0.79% and 1.03%, respectively, while quantities increase by 0.66% and 1.32%. Imported wholesale beef prices and both import and export quantities decrease. Both slaughter and feeder cattle quantities (0.45% and 0.18%) and prices (2.06% and 1.78%) decline.

With the exception of export pork and poultry quantities, all other pork, lamb and poultry prices and quantities decrease. Because there is a larger supply of beef in the US (because of the decrease in export beef demand), the price at the retail level for beef falls, thus reducing the retail demand for pork, lamb, and poultry.

The long run results are slightly different from the short run results. Specifically, most of the long run results are positive. However, the long run results are much smaller than the short run results.

Table 9.16. Median Changes in the Absence of an Animal Identification/Tracing Program and a 50% Permanent Loss of Beef Export Markets.

Endogenous Variables	Short Run	Long Run
Retail Beef Quantity	0.662%	-0.108%
Retail Beef Price	-0.786%	0.092%
Wholesale Beef Quantity	1.317%	-0.700%
Wholesale Beef Price	-1.025%	0.640%
Imported Wholesale Beef Quantity	-3.383%	-5.879%
Imported Wholesale Beef Price	-1.869%	-0.588%
Exported Wholesale Beef Quantity	-49.581%	-51.920%
Slaughter Cattle Quantity	-0.452%	-3.339%
Slaughter Cattle Price	-2.062%	-0.212%
Feeder Cattle Quantity	-0.180%	-2.511%
Feeder Cattle Price	-1.781%	-0.890%
Retail Pork Quantity	-0.111%	0.016%
Retail Pork Price	-0.051%	0.000%
Wholesale Pork Quantity	-0.068%	0.014%
Wholesale Pork Price	-0.047%	0.001%
Imported Wholesale Pork Quantity0.359%	-0.043%	0.012%
Imported Wholesale Pork Price	-0.031%	0.001%
Exported Wholesale Pork Quantity	0.041%	-0.001%
Slaughter Hog Quantity	-0.028%	0.009%
Slaughter Hog Price	-0.069%	0.005%
Domestic Retail Lamb Quantity	-0.013%	0.004%
Domestic Retail Lamb Price	-0.064%	0.000%
Imported Retail Lamb Quantity	-0.092%	0.005%
Imported Retail Lamb Price	-0.009%	0.000%
Wholesale Lamb Quantity	-0.004%	0.003%
Wholesale Lamb Price	-0.016%	0.000%
Slaughter Lamb Quantity	-0.001%	0.003%
Slaughter Lamb Price	-0.007%	0.000%
Feeder Lamb Quantity	-0.001%	0.002%
Feeder Lamb Price	-0.006%	0.001%
Retail Poultry Quantity	-0.076%	0.016%
Retail Poultry Price	-0.229%	0.000%
Exported Retail Poultry Quantity	0.068%	0.000%
Wholesale Poultry Quantity	-0.029%	0.015%
Wholesale Poultry Price	-0.213%	0.002%

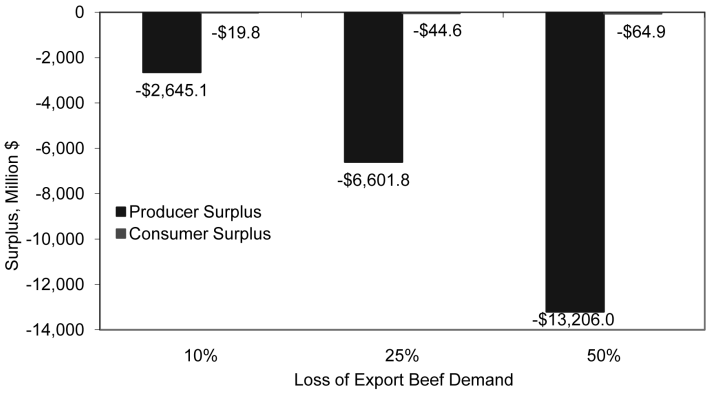
Table 9.17 presents changes in producer and consumer surplus that occur because of a permanent 50% decrease in export demand. The cumulative discounted present value of producer surplus decreases for all sectors. Total beef producer surplus decreases by 2.8%, pork producer surplus by 0.02%, poultry producer surplus by 0.07%, while lamb producer surplus declines by 0.005%. Overall, total meat producer surplus decreases by 1.7%.

Figure 9.9 presents changes in the total discounted present value of producer and consumer surplus assuming 10, 25, and 50% losses in the beef export markets. Given the beef export demand decreases assumed above, producer surplus decreases by $2.6, $6.6, and $13.2 billion for a 10, 25, and 50% loss of demand in beef exports, respectively. Consumer surplus decreases by a much smaller amount, $19.8, $44.6, and $64.9 million for export demand decreases of 10, 25, and 50%, respectively.

Table 9.17. Producer and Consumer Surplus Changes in the Absence of an Animal Identification/Tracing Program and a 50% Permanent loss of Beef Export Markets.

Surplus Measure	Short Run	Long Run	Cumulative	Cumulative Present Value	Cumulative As A Percent Of Total
	million dollars				
Producer Surplus					
Retail Beef	404.48	28.21	706.35	610.00	0.211%
Wholesale Beef	681.50	85.42	962.24	833.61	0.535%
Slaughter Cattle	-1,123.01	-246.75	-10,583.12	-8,579.86	-4.533%
Feeder Cattle	-539.41	-266.60	-7,282.04	-5,774.09	-3.801%
Total Beef Producer Surplus	-556.29	-400.03	-16,056.28	-12,770.44	-2.834%
Retail Pork	-44.81	0.98	-22.82	-29.75	-0.025%
Wholesale Pork	-15.31	0.63	-2.07	-5.66	-0.009%
Slaughter Hog	-9.53	0.67	2.58	-0.72	-0.001%
Total Pork Producer Surplus	-71.25	2.33	-23.37	-36.73	-0.015%
Retail Domestic Lamb	-0.66	0.01	-0.50	-0.54	-0.013%
Wholesale Lamb	-0.07	0.00	-0.02	-0.03	-0.002%
Slaughter Lamb	-0.03	0.00	0.04	0.02	0.001%
Feeder Lamb	-0.02	0.00	0.08	0.05	0.003%
Total Lamb Producer Surplus	-0.79	0.01	-0.40	-0.49	-0.005%
Retail Poultry	-168.46	0.39	-170.41	-166.58	-0.092%
Wholesale Poultry	-94.25	0.67	-67.80	-75.00	-0.042%
Total Poultry Producer Surplus	-264.87	1.10	-247.88	-248.81	-0.070%
Total Meat Producer Surplus	-911.67	-396.57	-16,383.05	-13,206.04	-1.694%
Consumer Surplus					
Retail Beef	640.52	-75.61	-427.37	-112.74	-0.034%
Retail Pork	-20.81	3.41	28.91	15.36	0.007%
Retail Domestic Lamb	0.16	0.02	0.43	0.36	0.008%
Retail Imported Lamb	-1.22	0.04	-0.64	-0.79	-0.009%
Retail Poultry	-6.61	4.10	83.27	57.66	0.014%
Total Meat Consumer Surplus	607.12	-68.01	-324.94	-64.89	-0.005%

FIGURE 9.9 CUMULATIVE 10-YEAR PRESENT VALUE OF TOTAL PRODUCER AND CONSUMER SURPLUS CHANGES, IN THE ABSENCE OF AN ANIMAL IDENTIFICATION/TRACING PROGRAM, WITH PERMANENT LOSS OF ACCESS TO BEEF EXPORT MARKETS *

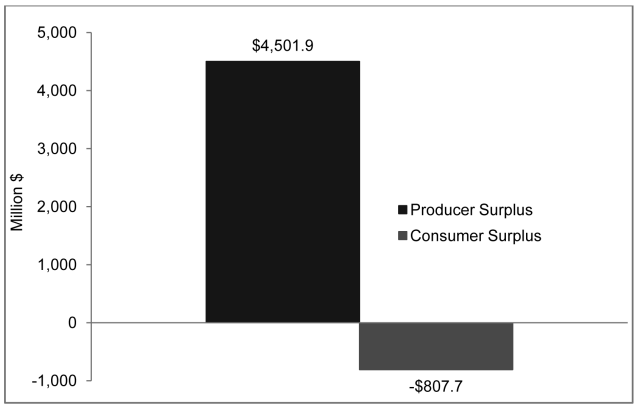


*Information for figure 9.9 can be found in tables 9.17 and A9.2.15 – A9.2.16.

9.6.6 Impacts of Foot-and-Mouth Disease Outbreak with Various Decreases in Export Beef Demand Given Various Adoption Rates of Full Animal Identification/Tracing.

Simulations were conducted to evaluate the potential impacts of closures in the export markets with various animal tracing rates as a result of a FMD outbreak. Figure 9.10 presents the difference in the total discounted present value of producer and consumer surplus between 90 and 30% ID and tracing adoption rates with an FMD. That is, the scenarios presented illustrate potential gains in the event of a FMD (or similar highly contagious disease) at different levels of animal ID. Producer surplus losses for a 90% animal identification/tracing program are $4,501.9 million less than a 30% animal identification/tracing program in the FMD outbreak scenarios with changes in the beef export markets (figure 9.10). Consumer surplus decreases as animal tracing adoption rates rise. The difference between the 90 and 30% animal identification/tracing program is a consumer loss of $807.7 million. The loss in consumer surplus is a result of increased demand in the beef export markets, thus less quantity of beef supplied at the retail level. Combined the societal gain (producer gain less consumer loss) from having 90% vs. 30% tracing is $3,694.2 million.

FIGURE 9.10. DIFFERENCE IN THE 10-YEAR CUMULATIVE PRESENT VALUE OF TOTAL PRODUCER AND CONSUMER SURPLUS BETWEEN 90% AND 30% ID AND TRACING ADOPTION RATES WITH A FOOT-AND-MOUTH DISEASE OUTBREAK



9.7 Conclusions

An equilibrium displacement model of the beef, pork, lamb, and poultry sectors was developed to evaluate the impacts on producers and consumers from costs incurred as a result of implementing animal identification/tracking programs. Several programs were evaluated including various adoption rates of premises identification, bookend identification, and full animal identification.

Assuming no changes in either domestic or export demand, the 90% adoption of a full animal identification/tracing program causes a 10-year discounted present value loss of beef industry producer surplus of $4.52 billion (about 1%). Over the entire 10-year period, the pork industry gains about 0.06% of discounted total producer surplus. The gain occurs because the beef industry's relatively larger increase in costs makes pork a more attractive consumption substitute. Conversely, the domestic lamb industry loses about $32 million over the entire 10 years (a 0.4% decline). The poultry industry gains a small amount of producer surplus ($561 million or 0.2%) as a result of the implementation of an animal identification program because relatively lower costs are being added to the poultry sector. Thus, as prices for substitute meats increase, the demand for poultry increases.

Assuming that no changes in the domestic or export demand for meats occur as a result of the implementation of an animal identification program, beef consumer surplus declines by 0.45%, pork consumer surplus increases by 0.02%, and domestic lamb consumer surplus declines by 0.55%. Imported lamb consumer surplus increases by 0.35% and poultry consumer surplus increases by 0.01%. In terms of all US meat consumers, consumer surplus declines by $1.33 billion over the 10 year period which represents a 0.11% decline.

It is possible that export demand for US meat could increase as a result of adopting some type of animal identification system. Because the costs of each of these programs are relatively larger on the beef sector, export demand is the crucial factor that determines changes in producer surplus across all species. Consequently, the simulation model determined the magnitude of an increase in beef export demand increase necessary so that the wholesale beef, slaughter cattle, and feeder cattle sectors would lose no producer surplus for 30, 50, 70, and 90% industry adoption rates. A 23% increase in beef export demand would completely pay for 70% adoption of full animal ID and tracing in the US beef herd over a 10-year period. Parenthetically, South Korea's beef export market share prior to the 2003 US BSE discovery was 23%. No other benefits beyond these would be necessary to make the investment in NAIS economically viable.

Research indicates that domestic beef demand is likely to be greater for products having animal ID and traceability. Small increases in domestic beef demand, with all else constant, would also completely pay for full animal ID and tracing in the beef industry. This scenario was evaluated for a full animal ID and tracing program with 30, 50, 70 and 90% adoption rates. A 0.67% increase in domestic beef demand would be enough to fully pay for 70% adoption of cattle ID and tracing even if no other benefits (i.e., increased export demand) occurred over a 10-year period. This is a relatively modest increase in beef demand relative to changes that have occurred (for a variety of reasons) over the past decade. The overall societal gain under this scenario (producer plus consumer surplus) is a 10-year cumulative net present value of $7.2 billion. In other words, NAIS adoption results in large positive net returns to producers and consumers with even a very small increase in domestic beef demand resulting from NAIS adoption.

If nothing were done in regards to animal identification/tracing, it is possible that we could begin to lose access to export markets as countries around the

world adopt animal identification/tracing systems. If the US experiences a 25% permanent loss of the beef export markets, slaughter cattle, feeder cattle, domestic retail lamb, wholesale lamb, all producer sectors of pork and poultry lose economic surplus while retail and wholesale beef and slaughter and feeder lambs gain economic surplus. Consumers of pork, lamb, and poultry gain a small amount of economic surplus while beef consumer surplus declines. The overall societal loss under this scenario (producer plus consumer surplus) is a 10-year cumulative net present value of $6.65 billion.

Finally, simulations were conducted to evaluate the potential impacts of closures in the export markets with various animal tracing rates as a result of an FMD outbreak given 30, 50, 70, and 90% adoption rates of a full animal identification/tracking program. The scenarios illustrate potential gains in the event of a FMD (or similar highly contagious disease) if the different levels of animal ID tracing were already present. Producer surplus losses for a 90% animal identification/tracing program are $4.5 billion less than a 30% animal identification/tracing program. In addition, losses of consumer surplus decline as animal tracing adoption rates rise. Consumers lose $807.7 million more if adoption rates are only 30% adoption relative to 90%. The combined societal gain (producer gain less consumer loss) from a 90% versus 30% adoption rate is $3.7 billion over the 10-year period.

10. Equine

10.1 The Equine Industry

The Equine Industry, both in the United States and world-wide, is one that is unique in many aspects and characteristics, making it difficult to describe, classify, and research. The equine industry combines the world of companion animals with the livestock industry – many owners consider their horses to be their pets, while others use them for business. Two main sources of information were used to define the state of the United States equine industry for this project – the NAHMS Equine 2005 project, published in three sections over 2006-2007, and the American Horse Council (AHC) Deloitte Survey, for the calendar year 2003 and published in 2005. In addition to these two major sources, several other sources are noted as discussed. The two primary information sources used greatly differing methods of data collection, with varying results. This is especially apparent in the estimated number of equids in the United States. However, a great deal of important information can still be obtained from these sources.

The actual number of equids in the United States is difficult to ascertain, due to the fact that the USDA Census, conducted every five years, only applies to "on-farm" livestock. As stated in the Equine 2005 project, Part II (p. 18), "The US equine population is difficult to enumerate because of the diversity of the equine industry, the geographic breadth of the equine population, and the suburban areas not included in the traditional livestock enumeration." Horses are different from other livestock because of their companion animal status. Therefore, many horses are not located on "farms," as defined by the USDA as a property that can or has produced more than $1,000 of agricultural goods on an annual basis, and/or (as of 1987) has five or more equids owned by the same owner, not including boarding stables (where horses are owned by multiple individuals) or commercial enterprises such as racetracks. The Equine 2005 Part II Booklet states (p. 7), "There is no accurate estimate of the current total number of equids in the United States because the number of equids on nonfarm operations does not exist." This same source

suggests that the on-farm estimation may only constitute 50-60% of the total equine population.

The only USDA estimates for the total number of equids in the United States come from the NASS Surveys in 1998-1999. The January 1, 1998 estimate for horse numbers by USDA was 5.25 million head, with 3.20 million on farms and 2.05 million on non-farms. On January 1, 1999 the estimate was 5.32 million head. The 1997 Census suggested there were 3.02 million head on farms, compared to the 3.20 million head the next year, and the 2002 Census states that there were 3.64 million head. At the very least, we can see an upward trend in on-farm horse numbers, which likely represents an upward trend in total horse numbers, though they are not documented by USDA. If we assume the same percentage of horses are on or off farms in 2002 as in 1998, then we can take the estimated 3.64 million head of horses on farms as 60.95% of the total, and come up with a total number of horses in the US in 2002 as 5.97 million head (which would mean there were approximately 2.33 million off-farm horses in 2002). The USDA-APHIS *Business Plan to Advance Animal Disease Traceability* quotes June 2007 equine population estimate as 5.8 million horses in approximately 570,000 locations.

Another organization which has conducted numerous surveys on the horse population is the American Horse Council (AHC). In 1986, an AHC commissioned study estimated 5.25 million equids in the United States. In 1996, another AHC survey estimated 6.9 million horses and other equine, and the most recent AHC commissioned Deloitte survey for the calendar year of 2003, published in 2005, suggested there were 9.2 million horses. A 2007 Oklahoma State University Extension Publication also lists the American Veterinarian Medical Association (AVMA) estimates since 1986. The AVMA estimates horses that are specifically owned by “households” which do not include those owned by ranches, farms, or other operations – they specifically estimated horses that are treated by their owners more as “pets.” The 1986 AVMA estimate was 6.6 million horses, the 1991 estimate was 4.9 million head and the 1996 estimate was only 4 million head. However, the most recent AVMA study mentioned in the publication, from 2001, estimates 5.1 million horses owned as “pets” in the US. The conclusion of this publication states that all the sources seem to agree that the United States horse population has

had an annual growth rate of between 3 and 5% over the last decade. The most common breed of horses in the United States is the American Quarter Horse, with the leading registry of these horses being the American Quarter Horse Association (AQHA). The AQHA 2007 annual report states that there were 2.9 million Quarter Horses in the United States. This total is down by just over 28,000, and new registrations were also down by over 26,000. This is the first time in recent history that AQHA registration numbers declined. Most people familiar with the equine industry agree that the market for horses is down currently, and this may be an explanation for the downturn in AQHA numbers. AQHA also keeps track of transfer numbers, and had a total of 188,907 ownership transfers in 2007, some being within the United States and some internationally. There are 902,453 registered owners of AQHA Quarter Horses in the United States. A summary of all equine population estimates obtained can be seen in table 10.1.

Table 10.1. Equine Population Estimates.

Year	Group	Estimate (million head)	Notes
1986	AHC	5.25	All equids
1986	AVMA	6.60	"Pet" equids only
1991	AVMA	4.90	"Pet" equids only
1996	AHC	6.90	All equids
1996	AVMA	4.00	"Pet" equids only
1997	USDA Census	3.02	On farms only
1998	USDA-NASS	5.25	All equids
1999	USDA-NASS	5.35	All equids
2001	AVMA	5.10	"Pet" equids only
2002	USDA Census	3.64	On farms only
2003	AHC	9.20	All equids, published 2005
2007	AQHA	2.90	AQHA Registered Horses
2007	APHIS Business Plan	5.80	All equids

The 2007 AHC Horse Industry Directory listed 125 Breed Organizations in the United States. These are organizations that register horses and usually assign horses a registration number and some sort of certificate of identification. AHC also found 31 educational organizations involved in the equine industry, 29 equine welfare organizations, 23 general interest organizations, 18 health and research organizations, 28 equine veterinary schools, 19 libraries and museums, 70 racing organizations, 6 rodeo associations, 66 show and sport organizations (some of which were the same as breed organizations), 48 state horse councils, and 20 trail organizations. In addition, they listed 40 National Steeplechase Association Meetings, and 177 Pari-Mutuel Racetracks in their directory, which should constitute the majority of race meetings in the United States. All of these organizations have some involvement in the equine industry and could be sources of education and information for studying the equine industry.

The Deloitte survey utilized 13 different show organizations, the Equibase and Project Steering Committee databases for racetracks, and a total of 80 horse related organizations to construct a survey list of horse owners. The survey was sent out in 2004 and respondents were asked to complete it for the year 2003. Deloitte found 4,865 organizations that managed or held horse shows and they identified 122 primary racing tracks in the United States for the survey.

To breakdown the numbers of horses in the United States, the most recent AHC survey had a total population estimate of 9.2 million horses, with 844,531 of those in racing, 2.7 million in showing, 3,9 million in recreation, and 1.8 million horses used for other purposes. A 95% confidence interval on this estimate is + or – 352,989 horses (American Horse Council, 2005b). As mentioned above, Quarter Horses are the most common breed of horses, with 3.3 million in this survey, and the only other breed broken out was Thoroughbreds, with 1.3 million horses. Other horses included other breed's registered horses and grade (non-registered, non-pedigreed) horses (American Horse Council, 2005a).

Equine 2005 reports horses in different (and more numerous) categories than the AHC survey. These reports only looked at farm operations with five or more equids (as meets the definition of "farm" for the USDA

Census). Small operations (5-9 head) had 36.1% of all equids, medium operations (10-19 head) had 34.2%, and large operations with 20 or more equids housed 29.7% of all equids in this survey. The percentage of equids on the property by primary purpose of the operation were as follows: boarding/training, 5.9%; breeding farm, 14.4%; farm/ranch, 40.3%; residence with equids for personal use 37.0%; and other, (including carriage services, guest ranches, and riding stables) was 2.4%. Small operations were most likely to state their primary purpose was having equids for personal use, at 46.0%, while large operations only said this was their primary function 10.4% of the time. Large operations were boarding/training facilities or breeding farms more often than medium and small operations. Broken down by primary use of equids, the percentages were: pleasure, 45.7%; lessons/school, 1.4%; show/competition, 9.6%; breeding, 15.9%; racing, 1.4%; farm/ranch work, 24.8%; and other (such as horse trader, carriage or pony rides, etc.), 1.2%. The comparison of Equine 1998 to Equine 2005 indicates that more horses are on smaller operations than before; the percentage of large operations has decreased while medium and small operations have increased, and 10% less horses are on the large operations in 2005 as compared to 1998. Some of this information is summarized in table 10.2.

Table 10.2. Equine Industry Premises Size and Use.

	Operation Size		
	Small (5-9 head)	Medium (10-19 head)	Large (20+ head)
Premises (%)	66.1	26.1	7.8
Total Equids (%)	36.1	34.2	29.7
Residence w/ Equids for personal use (%)	46.0	22.2	10.4
Boarding/Training Facilities (%)	2.8	10.4	17.2
Breeding Operations (%)	9.2	21.8	34.1

Source: NAHMS Equine 2005 Part I.

Equine age is another unique point for the industry, as horses tend to live much longer than other livestock species. The 2005 NAHMS survey reported that 35.6% of operations overall had a foal under 6 months of age when they received the survey, and 33.6% of operations had an equine birth within the 12-month period the survey queried. More of the large operations (72.7%) had births than small operations (20.4%). From 1998-2005, the percentage of operations having foals on their property decreased from 42.2% to 33.6%. Approximately 0.8% of the equine population is in the age range from birth to 30 days. Foals have a 4.9% mortality rate within 30 days after birth for various reasons. The overall equid death percentage for horses over 30 days of age was 1.8% in the year this study covered. The highest mortality rate by age group was horses over 30 years of age, followed by horses 20-30 years old. In 2005, 10.2% of equids over 20 years of age died.

The 2002 Census of Agriculture reported that the number of horses and ponies sold from farms in their surveys was 470,423, in addition to 17,385 mules, burros, and donkeys. Of the total of 487,808 horses, ponies, mules, burros, and donkeys sold, the value was approximately $1,328,733,000. Using these numbers, we can obtain an average value for the horses sold as approximately $2,724. In the 1998-1999 equine reports, the total equine sales were approximately 539,600 head in 1997 for a value of $1,641,196,000 with an average of $3,042, and in 1998 the equine sales numbers were approximately 557,600 head for $1,753,996,000 with an average sale amount of $3,146. These values are summarized in table 10.3. The Deloitte Survey reported the equine industry generates an estimated $39 billion in direct economic impacts and $102 billion in annual impacts when indirect and induced spending is included. The recreational segment generates most of this total, with $32.0 billion attributed to this branch of the industry. Showing, racing, and other segments generated approximately $28.8, $26.1, and $14.7 billion each, respectively. One important point from a financial standpoint is that of US live animal exports, the equine industry consistently exports several times greater value than any other livestock industry. In 2005, the last estimate conducted showed that live equid exports were approximately $461,541,000, with the closest number to that being live poultry exports at $95,522,000 (USDA, 2006e).

Further information from the most recent AHC survey is also of financial interest. The majority of horse owners (56%) earn under $75,000 per year in household income, with 16% earning between $75,000 and $100,000, 15% between $100,000 and $150,000, $9% over $150,000, and 4% not reporting that information in their survey. The "average" horse in the industry earns $1,172 annually, and costs the owner $2,882 annually – notably, however, the recreational industry only makes $536 per horse and costs $2,319 annually. The two largest expenses in all segments are Feed, Bedding, and Grooming Supplies, and Boarding and Training. Veterinary services annually cost an average across the industry of $251 per horse. The top five states of the 15 breakout states specifically surveyed in the AHC/Deloitte Survey are listed by four different measurements, shown in table 10.4.

The NAHMS Equine 2005 report included a section on how horse owners identified their horses. According to NAHMS, approximately 1.5% of horses are microchipped, approximately 47.8% of horses have registration papers, and other forms of identification include: hot iron brand, freeze brand, tattoos, permanent brand inspection, Coggins test papers, halters/collars with name/number, passport, and other unique identification. According to the data, 49.3% of operations had at least one resident equid that had no unique form of identification, and 28.7% of equids had no form of unique identification in their sample. The comparison between 1998 and 2005 equine identification data shows that both premises using unique identifications and actual number of equines with unique identification had increased. However, the additional options in the 2005 survey (Coggins/EIA test paperwork and Passport) which were not offered in the 1998 survey, and could have reduced the numbers of horses with no unique identification. Overall, fewer horses were being identified using hot iron branding, tattooing, and permanent brand inspections, while freeze branding of individual equids had increased. Microchipping numbers in horses were similar across the years (1.1% in 1998 to 1.5% in 2005), but 3.1% of premises had at least one microchipped horse in 2005, compared to only 2.1% in 1998.

Table 10.3. Equine Sales and Average Value.

Year	Number Sold (head)	Total Value	Average Value ($/head)
1997	539,600	$1,641,196,000	$3,042
1998	557,600	$1,753,996,000	$3,146
2002	487,808	$1,328,733,000	$2,724

Sources: USDA Census Data and NASS Equine 1998 Survey

Table 10.4. Top Five Equine States.

Rank	By Total Effect on GDP	By Number of Horses	By Number of Industry Participants	By Total Effect on Full-Time Equivalent Employment
1	California	Texas	Texas	California
2	Texas	California	Florida	Florida
3	Florida	Florida	California	Texas
4	Kentucky	Oklahoma	Kentucky	Kentucky
5	Louisiana	Kentucky	Ohio	Missouri

Source: American Horse Council Foundation Economic Impact Survey

10.2 Horse Movement and Competition

The Equine 2005 report states that 36.6% of horse properties did not have a horse leave their premises during the year, while premises that reported having equids leave and return to their property had the largest percentage (22.2%) travel between 100 and 499 miles from home, and 19.0% had horses that traveled between 10 and 49 miles. Small operations (5-9 equids) have less horses move off the property, with 41.8% of small operations reporting no equids leaving and returning in the past year, compared to only 27.5% of medium operations (10-19 equids) and 20.6% of large operations (20+ equids). By type of operation, pleasure, farm/ranch operations, and breeding operations were the highest categories reporting no equids moving off and back onto the

premises in the past year. Small operations were less likely to have horses leave and return after contact with other equids than large operations. By type of operation, show/competition, lessons/school, racing, and breeding operations had higher percentages of horses that left the property then returned after contact with outside horses than pleasure or farm/ranch work operations. The comparison portion indicates that horses traveled less and for shorter distances when they did travel in 2005 than in 1998. The number of operations not having horses that left the premises increased from 19.3% in 1998 to 36.6% in 2005. The report also states that transporting equine with vehicles had declined, with 73.5% of premises doing this in 1998 versus 58.4% in 2005. The study states that out-of-state travel increased, in-state travel decreased, and contact with outside equids on trips decreased from 1998 to 2005.

The NAHMS 2005 study also included a portion specifically on equine events, though it was specifically from only six states, as it was the first attempt to survey equine events. For all types of horse events, approximately 39.0% of events included horses that came from "beyond adjacent states," while 40.9% were events with only in-state horses. The remaining 20.1% were regional events, or events where horses came from only within the state and adjacent states. Overall, 9.6% of events had horses that came from outside the United States; most of these were race/polo events or western events/fairs/rodeos. The average event lasted 3.3 days, and had 151.0 equids at the event on a typical day during the duration of the event. Race/polo events lasted longer than shows or western events on average. National events and race/polo meets averaged higher numbers than regional or state events and then shows, western events, or "other" events, respectively. Over the entire course of an event, an average number of 270.9 equids attended. National events averaged 499.9 equids attending the event, compared to 124.5 and 123.9 for regional and state events, respectively. The majority of equine events has horses that are 5 to 20 years of age (also the most common age category for horses in the NAHMS studies), with the next most common being 18 months to 5 years, followed by horses more than 20 years old. At these events, cattle were on the premises 28.8% of the time on average. The frequency of events that had other species on the

same premises as the equids were goats, 5.7%, sheep 4.7%, pigs 2.4%, camelids (such as alpacas) 1.8%, and “other” animals 2.0%. About half (48.8%) of events required verification of individual animal identification, which is a process that may be simplified with the use of microchips. Some of the forms of individual identification used to verify identity of equids were tattoos, markings, and drawings from registration papers or Coggins papers. “Microchip scanned” and “smart cards” were each used to verify identification at 0.1% of events. Over 90% of events recorded the participant/owner’s name, address, and phone number, with 70.8% of events requiring the horse registration/ID number, as well. On average, 20.3% of events required health certificates for all equids, and 22.4% required certificates from equids from out of state. Events that required health certificates required that they be inspected visually by an official at the event 70.7% of the time. 10.8% of these events received health certificates in electronic form. Only 17.1% of events recorded the information on the certificates as part of the event. EIA testing was required more often, at 64.7% of events overall. State and regional events required EIA tests more often, due to the requirements for Coggins tests in crossing state lines. Vaccinations were required by 14.3% of events overall, and the required vaccines included Herpesvirus, Influenza, Strangles, VEE, Rabies, and to a lesser extent Tetanus, WNV, EEE, and others. Slightly under one-fourth (22.8%) of events hire on-site veterinarians to monitor for illness or provide care to equids. Selected data from this section is summarized in table 10.5.

Table 10.5. Event Requirements/Records

Requirement	Percent Events Requiring
Verification of Animal ID	48.8%
Used Microchips	0.1%
Used Smart Cards	0.1%
Health Certificates - All Equids	20.3%
Health Certificates - Out of State Only	22.4%
EIA Test	64.7%
Vaccinations	14.3%
Recording	
Participant/Owner Name	96.8%
Participant/Owner Address	93.0%
Participant/Owner Phone	91.1%
Horse ID/Registration	70.8%

Source: NAHMS Equine 2005 Events Survey

The actual number of events that occurs on an annual basis is as hard to quantify as equine numbers, but it is safe to say that it's in the tens of thousands, based on numbers we do have from individual organizations. The Professional Rodeo Cowboys Association (PRCA) sanctions approximately 650 rodeos in 12 circuits in North America, which includes approximately 50 rodeos in Canada. The National High School Rodeo Association (NHSRA) sanctions approximately 1,200 rodeos annually nationwide. The United States Equestrian Federation (USEF) licenses approximately 2,500 competitions annually, most of which are dressage, jumping, cross country, eventing, or any combination of the above. They reported holding approximately 2,600 shows with 85,000 unique horses competing at these shows and reported a membership of 92,000 in 2007. AQHA, the largest breed organization in the United States, reports 2,088 approved shows and 537 special events (including organized trail rides and charity events) in 2007. Approximately 250 individuals across the nation are certified as AQHA show managers. AQHA also reports that the average number of entries for all shows in the 49 states holding sanctioned AQHA shows was 329 entries, and the average number of

participants in special events, which were held in 34 states, was 63. The AQHA totals for 2007, including international shows and events, were 2,449 shows, 554 special events, 351 average entries per show, 860,529 total show entries, 33,738 total special event entries, for a grand total of 893,991 total show and event entries. In addition to these numbers, American Quarter Horses held 9,274 races in 2007 with 16,607 total starters in those races. Finally, for the recreational segment of AQHA, the AQHA Ride Program organizes trail rides for AQHA members and hosted 110 trail rides with 6,314 participants in 2007. The AQHA horseback riding program, which is a program where individuals record their riding time on AQHA horses to collect prizes, had 13,481 people enrolled (meaning they recorded at least one ride on an AQHA horse in 2007) and additionally had 1,124 people enrolled in the all-breeds category in 2007.

In summary, the equine species in the United States is incredibly difficult to quantify and track. There are anywhere from 5-9.5 million head of horses in the United States according to the most recent available studies. Such a large range of horse population estimates across studies provides motivation for premises registration to better determine animal density and location of equine in the United States to improve surveillance and disease management. Horses tend to be highly valued on an individual basis, have considerable domestic and export market sales, have long lives, and participate in a wide, varied, and growing array of events. Because of their frequent movement around the country and commingling with other horses at competitions, ID and animal tracing is challenging, but also potentially very important for disease management. The current studies only constitute a small portion of the information needed to fully construct a benefit-cost analysis on this industry. In the following sections, we outline the recommendations, lay out the process for constructing a cost-benefit analysis on NAIS in the equine species, show some costs and benefits of this system, and discuss further information and research which needs to be conducted before such a system can be fully evaluated and mandated.

10.3 NAIS IN THE EQUINE SPECIES

TO CONDUCT BENEFIT-COST ANALYSIS of NAIS adoption for equine, guidelines of how the system would work are important to describe. *A Business Plan to Advance Animal Disease Traceability*, by APHIS and the most recent available Equine Species Working Group (ESWG) recommendations are relied upon to formulate assumptions for benefit-cost analysis. The Business Plan outlines the priorities for NAIS in the livestock industry. The plan is currently based on voluntary participation; that the system will only hold limited information to protect confidentiality; if an animal leaves its property and comingles with other livestock, it needs to be officially identified to support disease traceability efforts; and the system is technology neutral on animal identification devices. The three stages, or components, of the NAIS system are Premises ID, Animal ID, and Animal Tracing. The goal of NAIS is to have at least 70% participation for each species. Specific to the equine industry, Tier 1 Medium priority designation horses require either an official EIA test or health certificate when moved. Tier 2 includes horses that do not move around and comingle with other equine as much as the Tier 1 horses. The general plan for the NAIS also notes that Electronic Certificates of Veterinary Inspection (eCVI's) could provide a useful tracking system for livestock, especially horses, since the top priority for horses are those that require health certificates.

Specific to the equine industry, the business plan estimates horse population at 5.8 million in June 2007, and states (p. 24) that a "significant number of horses are individually identified." Estimates on number of horses and the number that are individually identified, based on earlier discussions of other surveys, are debatable. In reference to the equine industry structure, the Business Plan comments on the uniqueness of horses in their lifespan, generally higher value, and greater rates of transportation interstate, internationally, and through importation and exportation. They also note that many horses are already identified, especially if they are competing in racing or the show industry, and that these existing identification programs can be used in disease traceability efforts. Horses are divided into two major categories of priority for identification. Tier one horses are horses that require

health documents to travel or compete, including the subgroups of race horses and show horses. The subgroup race horses are defined by The Jockey Club, United States Trotting Association, and AQHA. Show horses are identified through the USEF Horses Identification Program. Tier two includes all other horses.

As far as tracing capabilities already in place in the equine industry, the Business Plan states that EIA tests are done on about 2.2 million horses each year. EIA testing provides an opportunity to check for and institute some level of equine tracking, as well as allowing for some simplification of the CVI, Brand Inspection, and EIA testing process; having a microchip will make it easier to definitively match the right test to the right horse, instead of just going by markings, color, and hair whorls as is commonly done with grade and even registered horses currently. The plan also notes that many horses are registered in the numerous breed registries in the United States. Both the traceability plan and the ESWG recommendations are that horses that need an official EIA test and/or CVI when moved be a priority due to their movement intensity, as well as their often higher values.

The Business Plan further states that developing national EIA testing requirements for interstate movement and change of ownership would be an excellent way to implement a tracking system. Horses have to be identified on the EIA test certificates, and if premises registration was required along with the EIA test, horses and premises identified would both substantially increase. Through show registration information, as well as the information recorded on CVIs prior to a horse traveling interstate, some tracking abilities already exist. With the addition of the EIA testing requirement at change of ownership, EIA tests increased three-fold in the state of Texas, and it is likely that at least some sort of increase would be experienced if change of ownership testing was a nationwide requirement. Finally, the ESWG recommends ISO-compliant microchips to be the required form of ID for horses.

In summary, the Business Plan recommends: implementing and standardizing the use of PIN's on EIA and CVI paperwork for destinations, premises of origin, and exportation; expanding the use of interstate electronic CVI's; work with established equine organizations to integrate

the use of the AIN "840" devices (in the case of horses, the 840 microchips); and establish some sort of communication systems between industry efforts for automated data capture at equine events and interfaces with APHIS-VS systems. The Business Plan states that they want 70% of horses linked to an EIA test or interstate CVI to be at a level of 48-hour trace-back by October 2009, and 90% by October 2010. Through utilization of EIA and CVI requirements, they want competition horses identified with NAIS-compliant methods, of which the only currently NAIS approved identification is the ESWG recommended 840 ISO-compliant equine microchips.

The Equine Species Working Group published specific recommendations for the application of NAIS to the equine species. These will be listed and discussed here, and provided part of the guidance for the following benefit-cost analysis. In general, the horse industry agrees that they need a national identification plan for the following reasons: to control disease outbreaks, protect human health, address bio-terrorism threat, protect food industry livestock from zoonotic diseases, stabilize the equine economic environment, provide a 48-hour trace-back capability, prevent diseases from stopping equine movements, sustain the ecological environment, and simply to be a responsible member of the livestock industry. The most recent ESWG recommendations are broken down by categories, Premises Identification, Animal Identification, Data Reporting Recommendations, and General Recommendations. The ESWG presented original recommendations in 2004, and updated them in 2006.

For Premises Identification, they recommend that a firm definition of what a premise is in the equine world is necessary, and that State Animal Health Officials, Area Veterinarians, and producers when necessary should be involved in describing unique geographic identities to the premises. The 2004 Recommendations by the ESWG gave the following list of equine premises that is in order of their priority for identification:

- Ports of Entry
- Quarantine Facilities
- Auctions and Sales
- Breeding Farms
- Boarding Facilities
- Training Facilities
- Equine Clinics and Hospitals
- Racetracks
- Show/Exhibition/Competition Facilities
- Public and Private Stables
- Rodeo Arenas
- Fairgrounds
- National or State Parks
- Universities (Educational/Research Facilities/Diagnostic Laboratories)
- Ports of Exit
- Dude Ranches

For Animal Identification, the ESWG suggests that CVI requirements be standardized across states, with identification including electronic ID and a more complete description of the horse. They recommend that any horse that requires a brand inspection, CVI, VS 127 permit, or ICVI because of traveling to a different location should be a priority for official identification. They also recommend the ISO/ANSI compliant 11784/11785, 134.2 kHz microchip be the recommended standard of equine identification, implanted in the nuchal ligament on the left side of the neck. However, they note that NAIS should incorporate the older 125 kHz microchips and other existing forms of identification as much as possible, but not recommend them. Additionally, they recommend to reader/scanner manufacturers to make all purpose readers for both the ISO compliant chips and the 125 kHz chips, so as to prevent missing a microchip. They recommend that new technologies should be continuously pursued to make the process more efficient, accurate, and cost effective. The current rate of technological advancement in animal ID, coupled with a possible increase in demand for electronic ID, the technologies will advance and costs may decrease as competitors enter the market and veterinarians gain more knowledge and skill with the process. Finally, ESWG recommends that the buyer/seller be responsible to report changes of ownership, as is currently the case with most horses

registered with breed associations (the buyer and seller must send in transfer papers if the buyer chooses to keep the registration papers up to date).

The ESWG recommends that movement tracking not be included in the NAIS system for the equine species, but rather that animal health officials rely on current files of CVI's, Brand Inspections, VS-127 permits, and any other current paperwork to find out where horses are or have been if a disease problem arises. Animal Health Officials can look to existing state databases that keep track of CVI and EIA testing information in the case of a disease outbreak. ESWG recommends that animal health data should be electronic so that the speed of tracking can be increased, rather than going through lots of paperwork. They made the recommendation that the equine industry should not have to report any additional movements due to the fact that these systems are already common business practices in the equine species and that reporting all equine movements on and off premises would place a major burden on premises managers at the current levels of technology and reporting capabilities.

The ESWG recommends a voluntary testing period for any NAIS system, that the information is FOIA-exempt, and that no mandated system should be required before 2010. They also note that, "horses are livestock," and list various reasons why the equine industry should stay under that designation. The 2004 ESWG notes that due to the nearly 200 race tracks and tens of thousands of horse shows held across the United States on an annual basis, horses regularly move from their home premises to other locations and regularly comingle with horses and other livestock species. They state that hundreds of thousands of Americans ride every week at shows, tracks, and other equine events. They also note that due to the wide variety of levels of competitions, the ability for some of the horse-related activities to comply with NAIS standards will vary widely. The 2006 ESWG recommendations give the following list of characteristics that differentiate the equine industry from other livestock industries in the NAIS agenda, to highlight reasons that the equine industry must be handled differently than other livestock species when implementing a NAIS. The unique size, scope, and uses of horses create a

difficult environment in which to apply an animal identification system. To quote the ESWG list, horses:

- Have longest life expectancy of livestock species (20 – 35 years).
- Are generally more valuable on an individual basis.
- Are transported more often and for greater distances.
- Participate in internationally recognized competitions including the Olympics.
- Require accurate identification to insure the integrity of a multi-billion dollar racing industry with state regulated pari-mutuel wagering.
- Are imported and exported on a regularly basis at significant expense.
- Are at great risk of theft.
- And, are in many instances already properly identified by the appropriate breed registry or horse identification services.

Another general recommendation of the ESWG is that NAIS should provide benefits that outweigh the costs to the horse industry. The system should provide definite benefits which justify the costs to industry stakeholders. NAIS should also be as compatible as possible with other nations, especially Canada and Mexico due to their close nature and common importation/exportation of equines with the United States. ESWG recommends that identification and movement databases should be exempt from the Freedom of Information Act (FOIA), and that only approved state and federal animal health staff be allowed to use and see the information for the express purpose of disease surveillance, monitoring, and prevention.

Recommendations from APHIS and the ESWG provide a guideline for developing a cost-benefit analysis for applying NAIS to the equine species. However, some of the recommendations and comments about the equine industry also suggest needs for further research. In addition to these recommendations, the ESWG has published a list of diseases of concern in the equine species, to emphasize the importance of including the equine species in an animal identification system, which are discussed in the benefits section.

10.3.1 Process of Evaluating NAIS for Horses

The entire process of developing a benefit-cost analysis for the equine species in the United States is challenging. NAIS adoption costs are not readily available and have to be estimated, especially as related to animal movement recording database and labor costs. Benefits of NAIS adoption are difficult to enumerate because many of the benefits are realized in the event of crisis management of events with unknown probability of occurrence. The horse industry is an exceptionally large, diverse industry that is difficult to track or quantify. As the ESWG mentions, horses live longer, travel more, and experience a greater diversity in their life than any other livestock species, and probably than most "pet" species, as well. Horses are also valued higher than most livestock species.

The initial step in benefit cost analysis was to gather articles, publications, studies, and whatever written or online information was available on the horse industry, since one of the biggest problems with researching this industry is a lack of information. Comparisons of the proposed NAIS in the United States to identification systems in place in other nations for the equine industry did not appear to be useful. Most other nations that ID horses have more centralized governments, in some cases going so far as to have horse registries as part of the national government, and the industries are not as diverse as in the United States. Numerous interviews were conducted with various members of the equine industry to define the industry and create a comprehensive list of costs, benefits, and concerns about NAIS adoption in the United States equine industry. This section outlines the information gathered on the costs, benefits, and concerns of NAIS adoption in equine species.

10.4 Equine Industry Costs

THE MAIN COSTS ASSOCIATED with NAIS adoption in the equine industry are:

- The microchip electronic identification mechanism
- Cost of veterinary services to insert the microchip
- Universal readers
- Database costs
- Training and labor costs for each step

These and a few other relatively minor costs are discussed in this section. A couple of general notes are that before a horse can have a microchip implant, the premises where the horse is located must have a premises identification number. Also, the costs discussed here apply to the horse industry as it currently is, as time goes on and older horses are implanted, costs of implanting will decline.

10.4.1 Microchip Costs

A great deal of information was gathered on the equine microchips. Only two microchips are currently approved by NAIS, and are ISO/ANSI Compliant. They are both Destron-Fearing chips, which are also approved by the International Committee for Animal Recording (ICAR). One is the Destron-Fearing Equine Biotherm Lifechip, and the other is the Equine Lifechip. To make and sell the country coded "840" chip, where the first three digits are the code of the nation that the animal originated in, the microchip has to be NAIS approved. If not NAIS approved, the 15-digit chips are coded with the manufacturer's code for the first three digits. In addition, one microchip called the EZID Transponder Implants by AVID/EZiD is currently listed as "Interim Approved." Several other companies produce microchips. For example, Allflex has a 134.2 kHz ISO 11784/11785 compliant microchip that is marketed only for pets and coded with the manufacturer code "982" for the first three digits as opposed to the "840" (nation coded) chip. In addition, Crystal Import Corporation and Datamars (the same company) have 134.2 kHz microchips, but these are not NAIS approved for use in the United States.

Datamars is a Swiss company. These, and possibly some other manufacturer's chips, are currently available in Europe and other nations and may eventually apply for NAIS approval in the United States. Some veterinarians have reported clients getting the microchips from another source, such as Warmblood registration associations in Europe or other locations, and calling the veterinarian simply to implant the chips.

The Destron-Fearing chips are 134.2 kHz ISO-compliant microchips. Several studies have been conducted using these chips, some to study the effectiveness of the biotherm chips in reading an equid's body temperature, others for tracking purposes, and some simply utilized the chips as a form of individual animal identification for research purposes. The studies generally have found the chips to have a read range of two inches for the biothermal chip and four inches for the regular identification chip. In a study at Colorado State University, a 100% read rate was found using 82 biotherm chips in Quarter Horses and Welsh Ponies (Robinson, et al., 2008). The University of Kentucky reports using the microchips for numerous studies, and stated that they had used to have minor migration problems with the Avid microchips, but since switching to the Destron-Fearing chips, they have had no failures or migrations (Ennis, 2008). Texas A&M University did a study on broodmares using the biotherm chips, and had no failures in 20 broodmares (Morgan, et al.). Montana State University conducted a study using microchips and found one chip that failed after one week out of 38 microchips – they suspect the chip had been damaged on insertion, and it was later found to intermittently work. The state of Colorado conducted a study on "Smart Cards," which are credit-card sized cards showing a picture of the horse, ownership information, and having a chip or barcode which can contain information about the horse (Heckendorf, 2008). In a study with 61 rodeo horses using a few different brands of microchips, there were no failures (Heckendorf, 2008). The largest microchip study was conducted in California in racehorses (Evans, 2007). In this study, 2,052 horses (including some from overseas that had been microchipped prior to entering the United States) were implanted with microchips. Of these microchips, seven chips failed immediately and two chips failed later in the study. One horse had a minor skin reaction at the injection site of the microchip, and five chips were difficult to read. Most

of the chips used in past studies were either the Destron-Fearing biotherm chips or regular microchips, though a few of the studies used chips from Allflex or Crystal as well as Destron-Fearing chips. Combining all these studies, we estimate chip failure rate of 0.44%.

The Colorado project testing Smart Cards also assessed horse reactions to being injected with microchips. Of the horses included in the study, 72.6% showed little or no objection to the microchip implant, 17.6% objected slightly, 5.8% jumped away, and 4% required two injections. No horses required any additional physical restraint devices, such as a twitch. This indicates that the majority of horses will have little or no objection to the microchip implant, and problems only exist at approximately the same rate as with common vaccinations in the equine industry. The Colorado State University study indicated that the chips were extremely helpful throughout the course of the project as a quick, reliable method to identify each animal in the study. They did, however, experience problems with the accuracy of the biothermal chip. This and other studies have indicated that the chip is not always accurate, possibly because of the location of implantation. The nuchal ligament is in a location of exposure to the elements and has very little blood flow; therefore the ability to read an implanted chip can be affected by environmental conditions.

A few industry members estimated the cost of the microchips to be between $5 and $20 per chip. The current retail costs of chips were researched by contacting Destron-Fearing distributors. Two distributors of the Destron-Fearing microchips are Dr. Kevin Owen, in Texas, and Milburn Equine/Webster Veterinary. Dr. Owen sells the regular microchips for $10 and the biotherm microchips for $12 to veterinarians and state agencies. Dr. Owen also said that the failure rates on the chips is <1%. Milburn Equine/Webster Veterinary distributes both the manufacturer coded “985” chips and the “840” country coded chips. The normal microchips are around $15/chip, but come in boxes of ten, or $150 per box. The biotherm chips are around $16/chip and also come in boxes of ten, or $160 per box. Both distributors sell almost exclusively to veterinarians or state agencies. A representative of Destron-Fearing stated that the microchips and readers will remain at approximately the

same costs over time, but the technology, such as read range, will improve.

The Jockey Club recently became a microchip distributor of the "840" country-coded chip for Destron-Fearing. The Jockey Club charges $20 per chip to everyone, plus a sales tax in New York and Kentucky, and as of August, 2008 had distributed 120 microchips to mostly Thoroughbred breeding farms. They allow free reporting of the microchip number and microchip lookup features on The Jockey Club website behind a secure login. Sany Thoroughbred foals born in the United States that might race or be breeding stock to produce racehorses must be registered and DNA tested with The Jockey Club. Such foals also must be reported annually in "Mares Bred" and "Live Foals" reports. DNA testing kits are sent out when the foal is born and microchips can be distributed with this testing kit so that the veterinarian can do all the procedures at one time to reduce cost of each individual procedure. The Jockey Club registers over 30,000 foals annually between the United States, Canada, and other territories at a cost of $200 per registration.

Avid Equine markets microchips on the web (http://avidequineid.com/). They market to several different sectors – private owners with 1-4 horses can get kits for $33.50 per kit (which includes one chip and lifetime registration in their database and a few other things). For private owners with five or more horses, they offer a 5-pack kit for $142.50 or $28.50 per kit. For private owners with 25 or more horses, the price is $618.75 for a 25-pack or $24.75 per kit. For large operations, they offer 25-packs of the chips only with no database enrollment for $243.75 or $9.75 per chip. They also offer quick-load cartridges (instead of one chip with one loaded needle) for $173.75 or $6.95 per chip. They have a bulk syringe implanter for $7.50 each for the bulk quick-load kit, and extra needles for $2.00 each. In addition, they offer a HORSEcard that contains horse owner information, a picture of horse, and the horse's microchip number and information, for $12.50.

The safety of implanted microchips is occasionally questioned. Numerous studies have shown them to be safe, highly readable, and highly effective as a form of identification. An ESWG Publication states that microchips have been used in the equine species since the 1980's,

and over time have been shown not to migrate if implanted in the nuchal ligament to the proper specifications, have no adverse health effects on the animal, be durable and a virtually fail-safe method of identification that is extremely difficult to tamper with after insertion, and having a failure rate of less than 0.5%. The ESWG Microchip paper stated that at least 600,000 horses had been microchipped successfully in the United States so far, and that approximately 200,000 of those were from Louisiana since the 1994 EIA testing requirement mandates that an equid must be tested for EIA on an annual basis and at that time must have a permanent, individual form of identification. Louisiana encourages the use of microchips as this form of identification, but currently still allows tattoos and individual brands. In Louisiana, the owner bears all costs of microchipping their animals.

10.4.2 Veterinarian costs for insertion

Industry estimates range from $20-$150 for the cost of inserting microchips into horses, depending on many circumstances such as the number of horses, if competition and better technology lowers the cost of the chips or insertion, if fuel charges are included, etc. Two primary sources were used to obtain costs for veterinarians to insert microchips into horses. One source was a survey conducted by Pennsylvania State University researchers, which gave ranges of the costs of microchip insertion from veterinarians. This survey had some problems with the way the question was stated, veterinarians may or may not have included costs such as travel or sedation, and therefore results could be slightly skewed. Due to this uncertainty, a survey of American Association of Equine Practitioners (AAEP) veterinarians was conducted for our study. The survey was designed to separate the costs of the microchip, the implantation including site preparation for the procedure, travel, and any additional costs that the veterinarian chose to include.

The Penn State study posed the question “What do you charge to microchip?” to the veterinarians in their survey. Over half (53%) of the 138 veterinarians who responded were currently microchipping animals. The responses were categorized into price ranges, with 2.7% of veterinarians charging $20 or less, 32.4% charging $21-$40, 36.5%

charging $41-$60, 10.9% charging $61-$80, 2.7% charging $81-$100, and 4.1% charging $101-$150. Using the median values of each of the price ranges ($10, $30, $50, $70, $90, and $125) and multiplying these by the percentages in each range, we can come up with an approximate average cost of $43.43 for the veterinarians to microchip horses.

Due to the inexact nature of the costs in this study, an informal survey was conducted by phone and e-mail to several AAEP practicing veterinarians nationwide (total of 14 surveys sent). We received full or partial responses from 10 veterinarians (71% response rate), including one not originally on the survey list, who was involved in the California racetrack microchipping study. Veterinarians in this survey did not all use the Destron-Fearing microchips which suggests a need for education among veterinarians to encourage uniform microchipping practices. Veterinarians did not generally seem to know a lot about NAIS or microchips in general, with many using the same microchips to identify horses as they use in dogs and cats at their clinic. From this survey we received the following results:

- The cost of the microchip to the veterinarian averaged about $17 per microchip.
- The charge for implanting the chip to the horse owner averaged about $42 per microchip.
- The average travel charge by the veterinarian to the client was a base of $41.96, plus fuel charges ranging anywhere from $1.50-$4.00 per mile. The practices differed widely on the structure of their "farm call" charges.
- Four of the surveyed veterinarians reported that if an individual brought the horse to their office to be microchipped, the office visit would be from $13-$38 ($13, $15, $15, and $38 were the reported charges).
- Two veterinarians also reported sedation costs, if necessary for the horse. One reported a range of $25-$30 for sedation while the other stated a $50 charge for sedation to implant the microchip, if necessary.

In addition to the questions about cost, some general questions about NAIS, the cost and lifespan of microchip readers, and reasons for microchipping were asked. The veterinarians indicated that most of the horses that were microchipped (and most of the benefits, in some

opinions) were competition horses or horses that traveled a great deal. However, some people who simply want to protect their pleasure/recreational horses are also getting microchips implanted. One veterinarian stated that they obtained the Destron-Fearing biotherm chips through alpaca organizations at a cost of $25/chip and $400 for the scanner, because the alpaca associations in her area used the biotherm chips at shows (see Section 11 of this report for more information on alpaca chip adoption). Several of the veterinarians indicated that they felt biothermal chips would be a huge benefit, if the temperature readings were accurate, but this needs work before being useful in veterinary practice. One veterinarian indicated receiving a discount for buying over 2,000 microchips. Veterinarians in general felt that there were great benefits in recovering lost or stolen horses, in the event of a natural disaster where the horses were pooled together, and for disease control. In reference to the scanners, veterinarians had scanners from various manufacturers that had lasted from two up to 15 years, and were still being used.

One of the major routes to implement NAIS, or to get horses microchipped, that has been suggested is to use Equine Infectious Anemia (EIA) testing to require individual identification, such as the state of Louisiana has already done. On January 10, 2007 USDA-APHIS published a Uniform Methods and Rules for EIA. This was the first step from APHIS to try to unify the EIA testing requirements across states, by recommending specific regulations. These recommendations included:

- Uniform interstate movements of 12-month intervals are recommended.
- Categories of equines that should be tested include: Horses going to show/competitive events; horses being moved interstate; horses changing ownership; equines entering horse auctions or sales markets.
- Recommend individual animal ID being an important part of an EIA testing program.

EIA Requirements currently are decided by each individual state at the state level. Regulations vary from state to state on both intra- and inter-state requirements. The interstate movement requirements are summarized on an annual basis in an American Horse Council publication,

but the intrastate requirements were harder to find. All 50 state veterinarians were contacted and asked what their EIA testing requirements were for instate horses, and for the few state veterinarians who did not respond, the information was researched using state databases and searching state laws and regulations. The following is a brief summary of currently enforced EIA testing regulations in the United States:

- All states require EIA tests within 3, 6 or 12 months of all horses being imported into their state (with the exception that OR and WA do not require tests between states, and Nebraska and North Dakota do not require tests from South Dakota). The only state requiring 3 months is Hawaii. Some states have special requirements of horses going to sales.
- 21 states do not require any testing on instate horses that do not leave the state.
- Of the other 29 states, the level of testing varies from Louisiana, where any horse that has been in the state over 30 days must be tested on an annual basis, to only racehorses and the equids at the state fair being required to have a test.
- Most of the 29 states require testing for comingling groups of equine of any kind, transportation on public highways, prior to or at public auction, or for change of ownership or if the horse is offered for sale.

Standardizing state testing requirements to meet the Uniform Methods and Rules (UMR) in every state would cover nearly every equid in any kind of commerce. Over a period of time, this method could facilitate getting the second step of NAIS accomplished, getting AIN devices into horses, and possibly to start improving the third step of tracking using data that are already recorded on CVI and EIA test forms required for movement of horses.

10.4.3 Universal readers

Veterinarians have indicated various types of scanners last for over a decade, so the longevity of scanners appears robust. Veterinarians likely need a universal reader which can scan both 125 kHz “pet” chips and the 134.2 kHz microchips. The Colorado State University study reported high levels of reliability with their scanners, and they currently are using the same ones they have had for two to three years. The University of

Kentucky has had some scanners fail that have been returned to the manufacturer for repair or replacement, but they indicate that human error (e.g., dropping the reader too many times, leaving it out in the rain) may have caused reader failures. Currently, only the reader manufactured by Destron-Fearing can read the biotherm chip, though other universal readers should be able to read the number on both the biotherm and non-biotherm chips. Some locations, such as major horse import centers and certain show organizations, already have microchip scanners because foreign horses are currently being microchipped due to regulations in their home nations and/or import restrictions. Some industry leaders expressed concerns about the cost of the readers being too high, especially for smaller equine operations or show circuits, especially if the readers end up not being durable. In addition, some operations would need multiple scanners, and the personnel would have to be trained to scan the horses at appropriate times for farm management or for tracking purposes. Destron-Fearing distributor, Dr. Kevin Owen, sells the scanners to veterinarians and state officials for $350 per reader, and Milburn Equine/Webster Veterinary charges approximately $360 per reader. Other universal scanners are available, but costs were not obtained at this time.

10.4.4 Database Costs

Costs to store equine movements are difficult to estimate, as it depends on what level of tracking and which horses are required to be recorded. The ESWG and many other members of the equine community are concerned about the database for a number of reasons. One of the major problems is the locating and tracking of grade horses – horses which are not currently registered with any breed association and in most cases not identified in any form. Some industry members feel that the federal government should keep the database and carry the costs, but are concerned about remaining FOIA exempt if this were to occur. Other suggestions include using a web-service type model where the USDA houses a basic system with only the numbers and where the information is kept, which could then be traced out to already active breed registries such as the AQHA or The Jockey Club for further contact information and tracking records.

InCompass Solutions keeps track of most of The Jockey Club records, and developed and provided the software used in the California race horse tracking study. InCompass provides the database system for all racetracks in the United States, including Arabian, Paint, and Quarter Horse tracks in addition to the Thoroughbred races. They already have a ship in-out module in their software that tracks use, so the infrastructure for tracking horses is already in place. If a racetrack is using their software, which many do, there is no additional charge for using microchip numbers in the ship in-out module. However, InCompass is strictly for racetracks. Another group linked to The Jockey Club, Jockey Club Information Systems, provides farm management software, and they already have the infrastructure in place from a database standpoint for breeding operations to utilize microchip numbers in their management operations. Software design could be a big expense if other segments of the equine industry choose to develop management software around microchip numbers, but it could also be a major benefit in the long run.

Some of the current databases include the Louisiana system, which is tracked by the state veterinary office just like EIA and CVI records are in other states. A student worker is employed to keep track of the database and therefore also keeps track of the equids' individual identifications. PRCA has a system in which all the bucking stock, horses and bulls, are individually identified and can be traced readily. PRCA also estimates that approximately 10% of horses used in timed events at rodeos are currently microchipped, but they do not scan so they do not have a way to confirm this number. AQHA added an alpha-numeric field into their database (to incorporate the older microchips, some of which have letters as well as numbers), but say that less than 1% of their registered horses have reported a microchip number. The Jockey Club estimates that up to 2% of the Thoroughbred population may be microchipped.

One big problem with database management and the current system of registration is grade horses. The United States Equestrian Federation (USEF) has expressed interest in following The Jockey Club's lead and becoming a distributor of the equine microchips as well, as a service to their clients. USEF currently has a registration system called the Performance Horse Registry (PHR) that is open to any grade horse with a

registration application and DNA sample. Creating a grade horse registry has been a concern of the equine industry pertaining to NAIS, and the PHR offers one possible place for owners of grade horses to record their equids in a database. Some other registries in the United States make it possible to register cross-bred or non-pedigreed horses (certain color breeds and pony breeds with color or height restrictions, respectively). Registries like this may provide a way to solve the problem of identifying grade horses by allowing private systems to expand to incorporate these grade animals. Many grade horses are not actually unregistered animals, however. Registered horses are often sold in the United States, and as it is left up to the buyer and seller to transfer ownership on the registration papers, in many cases this transfer never occurs. This means that even if a horse is currently in the registration system, the registered owner may not have owned that horse for many years. One interesting note about grade horses is that even The Jockey Club, one of the largest equine registries in the United States, is only focused on the horse information and does not traditionally record ownership information, so when a horse is done with its racing career it is often sold without papers, and possibly renamed and registered with USEF or some other sport horse organization, or sometimes just left as a grade horse. Finding the current owner of the horse is necessary to knowing where that animal has been and who or what it has been in contact with. One suggestion that was brought up is that the United States could create a law like the Canadian pedigreed livestock law to require the transfer of papers if an animal is pedigreed. This would solve the problem of the wrong owner being listed on papers and create an incentive for transfer of papers, ownership updates, and database information updates to occur.

Overall, most current breed organizations feel that there is little to no additional database cost required for NAIS to simply identify all horses. However, the database cost could play a much larger role if tracking is required at all levels. Whereas cattle may move 4-5 times in a lifetime PRCA estimates that horses may attend as many as 4-5 rodeos in one weekend, let alone an entire year. Industry members estimated that horses could feasibly attend as many as 200 events in a given year, though the low end for any serious competitor in the show or racing world would be one to two events per year. Even at the low end, horses

will move more times in their lifetime than most other livestock species in the NAIS system, and therefore the database cost associated with tracking these animals will be a much higher total.

10.4.5 Labor Costs

Labor costs are another concern of NAIS adoption to the equine industry, due in part to the number of times a horse moves in its lifetime. Horses that move a lot, if tracking is required, would have to be scanned and reported every time they entered or left a premises, which would mean additional time, personnel, and material costs for these venues. There is an ongoing debate as to whether this system would increase or decrease labor requirements, however. Certain aspects of a NAIS system may allow for quicker check-in processes at shows, rodeos, and racetracks, and more efficient CVI and EIA testing procedures.

A major concern to the industry is the level of enforcement of any NAIS system. There are many current regulations on the movement of horses, though the level of enforcement certainly is not 100%. Having check stations available to enforce laws, having trained personnel who know how to enforce laws, and having punishment for breaking the law large enough to make getting the microchips and reporting horse movements are all important considerations in implementing any NAIS within the equine species. If an NAIS tracking system requires additional labor, major show organizations will require additional job positions, increasing their costs. If the check-in process is not smooth, competitors may also decide to quit showing or only show within their state to avoid needing an individual identification device for their horse. Across the industry, there are concerns with horse movement tracking. USEF, PRCA, and The Jockey Club all stated that horses move in and out of show or racing facilities at all hours of the day or night, and for effective check-in to occur this would require a 24-hour a day position with an individual trained to take and report the information at each major show or racing venue during the times when events are held, and at racetracks even during the off season when they are used as training facilities.

Studies have been conducted to experiment with movement tracking in the equine industry, such as the California racehorse study. This study

suggested a need for increased personnel at the tracks to get perfect movement tracking, but suggested there was some value in having even an imperfect tracking system in racehorses. The study also pointed to the fact that the technology for scanners and software needs to be adjusted to make tracking less cumbersome and therefore more useful. Individuals that participated in the study still had to do a great deal of paperwork and data entry; a system with the ability to automatically upload the information would be more ideal. The same issues with a need for additional labor to sort through paperwork are faced in Louisiana with their equine infectious anemia program. Louisiana hires a student worker to keep track of horses when they are Coggins tested and their individual identifications are recorded in the state database.

10.5 Equine Industry Benefits

Benefits of a National Animal Identification System in the equine species are more numerous but much harder to quantify than adoption costs. Generally speaking, most industry members we visited with recognize potential benefits to equine identification, and feel that the industry should be proactive in creating a system. A large segment of the equine industry exists for pleasure and not business creating an array of benefits of animal ID across ownership incentives and animal uses. Major categories of benefits are discussed below.

10.5.1 Premises Registration

The first step of getting equine premises across the nation identified has already proven to be beneficial in some circumstances that have occurred. Wisconsin animal health officials were able to use their premises registration database to send out mailings with West Nile Virus education during the season when outbreaks commonly occur. Currently, animal health officials sometimes go so far as driving door to door to contact individuals in an area about animal disease outbreaks in the equine species; the ability to identify premises allow for better and faster establishment of quarantine regions and find other possibly