The State-by-State Effects of Mad Cow Disease Using a New MRIO Model*

Jiyoung Park
Ph.D. Candidate
Von Kleinsmid Center 382
School of Policy, Planning, and Development
University of Southern California
Los Angeles, CA 90089-0001
Email: jiyoungp@usc.edu
Phone: (213) 821-1351
(Contact Author)

Changkeun Park
MA Candidate
CALS 200-8205
Department of Agricultural Economics and Rural Development
Seoul National University
San 56-1 Sillim-dong Gwanak-gu
Seoul Korea 151-742
Email: beinji2@snu.ac.kr
Phone: 82-2-880-4736
(Presenter and Co-Author)

Sangjeong Nam
Ph.D. Candidate
University of Illinois at Urbana-Champaign
402 Mumford Hall, MC-710
1301 West Gregory Drive
Urbana, IL 61801
E-mail: snam@uiuc.edu
Phone: (217) 333-3417
(Co-Author)

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Abstract

Until recently, it is hard to find studies to estimate how much the total economic losses for U.S. or other states by the BSE incidents except one dominant study by Devadoss et al (2005), which used CGE (Computable Generalized Equations) model for U.S. However, they are not reporting the direct impacts by each state and indirect impacts resulting from state-by-state economic relations. The interindustry relations and spatial connections have required to developing the Multiregional Input-Output (MRIO) type model, and in the sense, the experience of beef export closures to foreign countries is the suitable case enabling to estimate the economic impacts via inter-regional inter-industrial connections. Therefore, this study estimated the U.S. economic losses by foreign export closures of each state due to the BSE incident in Washington State using a different, newly developed methodology, complementing the previous study.

To assess the economic impacts of BSE on each state and U.S. national economy, we used two methodologies. First, we forecasted normal status of beef exports from January in 2004 to April in 2005 using time-series analyses, based on monthly pre-2004 foreign historical exports data obtained from WISERTrade data, in order to calculate the direct gaps between the estimated exports which would have been had if the BSE had not been discovered and the actually decreased exports. Second, a newly constructed MRIO-type model by Park et al (2006), the NIEMO (National Interstate Economic Model), addressed how much the impacts within each state including Washington, interstate effects, and U.S. national losses by the BSE are, based on the final demand losses from the ex-post incidents.

While domestic U.S. market can find the equilibrium rapidly by tightening supply side, international barriers to hinder U.S. exports still become a critical agricultural policy for U.S. government. The closure of U.S. exports of bovine by mad cow disease occurred in Washington State yielded a huge shock into the U.S. economy due to simultaneous closures of other state exports. Currently, the only available MRIO model, the NIEMO, enables to estimate the economic losses by the simultaneous closures of each state export of beef and related products. In terms that the NIEMO can supply information comparing the different economic impacts of state-by-state to agricultural policy-makers, they can distribute the national subsides due to the incident, considering the spreading impacts.

Key Words: BSE, Time-series, Multiregional Input-Output, Economic Impacts, Agricultural Policy

Introduction and Issues

On Dec. 23, 2003, the USDA announced that a cow in Washington state was positively tested for bovine spongiform encephalopathy (BSE), so to speak Mad Cow Disease, which has led to shutdown U.S. beef exports not only for Washington, but even for other states. The U.S. exported about 1.1 MMT (million metric tons) of beef and veal meats, in terms of monetary value at $3.9 billions before the BSE discovery from a dairy cow in WA. The U.S. beef exports had rapidly increased since 1992, and reached up to approximately 10% of U.S. farm value of cattle and calves in 2003 (CRS, 2006). While this discovery of BSE decreased average retail price of beef in the U.S. by about 6% between December in 2003 and January in 2004, the retail price moves back into the original prices during February and March of 2004, and remains since then due to tight supply into domestic markets (Haley, 2005).

However, the U.S., one of the world major exporters of beef and related products, had declined their beef-related products to rest of world instantly about 90 percent after the BSE incident. As seen in the Figure 1, for example, Northeast Asian countries including Japan, South Korea, and the big China which had been the major importers completely closed the imports of beef and related products from U.S., while some countries such as Mexico still accepted U.S. exports partly during the period.

This means that the ban of three major Asian countries importing the U.S. beef and cattle products does not affect significantly on U.S. domestic beef demand, but have led the sizable amount losses on U.S. beef and cattle industry. Furthermore, it is clear that those losses are not restricted only to its own industry or state, but also have indirect effects on the economy of the other states and the U.S.

Until recently, however, it is hard to find studies to estimate how much the total economic losses for U.S. or other states by the incidents except one study by Devadoss et al (2005), which used CGE (Computable Generalized Equations) model for U.S. However, they are not reporting the direct impacts by each state and indirect impacts resulting from state-by-state economic relations. The interindustry relations and spatial connections have required to developing the Multiregional Input-Output (MRIO) type model, and in the sense, the experience of beef export closures to foreign countries can be the suitable example enabling to estimate the economic impacts via inter-regional inter-industrial connections. Therefore, this study estimated the U.S. economic losses by foreign export closures of each state due to the BSE incident in Washington State based on a different, newly developed methodology, complementing the previous study.

To assess the economic impacts of BSE on each state and U.S. national economy, we used two methodologies. First, we forecasted normal status of beef exports from January in 2004 to April in 2005 using time-series analyses, based on monthly pre-2004 foreign historical exports data obtained from WISERTrade data. This is used to calculate the direct gaps between the estimated exports which would have been had if the BSE had not been discovered and the actually decreased exports. The calculated final demand losses from the ex-post incidents, then, are used for the National Interstate Economic Model (NIEMO) as the inputs. Second, a newly constructed MRIO-type model by Park et al (2006), the NIEMO, addresses how much the impacts within each state including Washington, interstate effects, and U.S. national losses by the BSE are.

The next section provides backgrounds on the BSE and major empirical applications, as well as the application of NIEMO. The third section draws two methodologies, data, and procedures used in this study, necessary to implement the NIEMO. The results of time-series forecasting the trends that would have been if the disease had not occurred and the intra- and inter-state economic impacts via the NIEMO will be addressed in the fourth section. The paper concludes with a brief summary and agricultural policy implications in the final section, including its contributions and caveats.

Backgrounds

The BSE stands for bovine spongiform encephalopathy, and it is widely referred to as "mad cow disease" after finding it in the UK. It is a chronic degenerative disease that affects the central nervous system of cattle. The BSE is named because sponge-type phenomena appear in the brain tissue of the infected cattle when being examined under a microscope. The BSE is resulted from the prions which are unique proteins leading animal to die by altering the composition, not due to bacteria. It is believed to transmit not by direct contact or air, but by eating the infectious proteins, especially dangerous to the animals genetically vulnerable to the disease (www.mad-cow-facts.com).

Although it is generally known that the BSE doesn't have direct infection from beef, the disease widely affects on an economy and human lives. According to Atkinson (1999), outbreak in Europe destroyed the beef industry in Great Britain. In 1992, over 37,000 cows infected, which were about 1 percent of the cattle in Great Britain were found. Furthermore, in 1995, since scientists connected the BSE with human disease called new variant Creutzfeld-Jacob disease, the people in the UK started eating beef less and less, and by the end of 1996 people ate beef 30 percent less than before. 1.3 million cattle in Britain were killed, and more than 45,000 people lost their jobs as a result of the BSE. Historical experiences shows that once cows with the BSE were found in a country, more cattle would be slaughtered and more people would lose their jobs, besides of the lost of a good source of food.

Only single BSE disease was found in the U.S. on Dec. 23, 2003. However, the experience is not limited to the single case, although it is believed not to transfer to other cows by direct touch. The international regulations to ban importing cows and related products from the U.S. resulted in dramatically dropping the U.S. exports of the products over 80 percent during 2004.

However, it is hard to find how much the economic impacts are due to the exports shutdown, while there are several papers analyzing the effect of Mad Cow Disease in Washington State. Among them, the trial of Devadoss et al (2005) is a dominant study to show the economic impacts of the Mad Cow Disease on the economy of Washington state and the U.S. using a computable general equilibrium (CGE) model. The study simulated by four scenarios shows various results of quantity and price changes on the Washington and U.S. economy, respectively, according to the scenarios.

At the somewhat different aspects, Mattson at al (2005) and Coffey at al (2005) address some important results by the BSE. Mattson at al (2005) analyzed the effect decreasing in the U.S. beef export on U.S. beef price after the discovery of BSE in the Washington State. In the study, they investigated the importance of export markets to determine the U.S. beef prices and the effects on beef and cattle prices when decreasing in the beef exports. They also showed how the pork and poultry prices are affected from the change of beef price. In the study of Coffey at al (2005), the authors assessed the costs associated with BSE regulations after interviewing seven firms, represented more than 60 percent of 2003 beef slaughter and U.S. beef packing industry. They appraised the impact of lost exports on beef industry using a trade model, incorporated assumptions about the elasticity of domestic demand for beef and offal, and conducted a regionally targeted consumer survey to investigate the potential impact of additional BSE discoveries on the U.S.

Similarly to the previous studies, however, the analysis of almost studies depends on their own scenarios. Yet, it should be addressed various hypothetical assumptions include wide-range of magnitude often much too vague to be useful (Howe, 2004). Also, it is rare to find the spatial information supporting decision makers to decide the policies for possible local losses (Park et al, 2006).

To address the spatial incidence, multiregional or interregional Input-Output model (MRIO or IRIO) are useful. As a simplified model of IRIO suggested by Isard (1951), the Chenery-Moses type MRIO (Chenery,1953; Moses, 1955) had been operated by Polenske (1980), who used the 1963 U.S. trade data sets for 51 regions and 79 sectors. While another trial of Jack Faucett Associates (1983) and its updated MRIO by various Boston College researchers (Miller and Shao, 1990) formulated, still data problems have persisted and stymied most applications so far.

Primary prerequisites to construct a new NIEMO for the U.S. are two sets of tables: interindustry coefficient tables of each state and trade coefficient tables of each industry. Because this NIEMO-type Chenery-Moses models can be used to estimate inter-state industrial effects as well as inter-industry impacts on such state, we adopted the NIEMO coefficient matrix and its own industry sectors. The NIEMO consists of 47 USC sectors developed newly by the

SPPD team of University of Southern California and reconciled easily with other U.S. industry sectors, and 52 regions of 50 states, D.C. and rest of world, totally about six millions multipliers. In the study of Park et al (2006), as well as the construction processes, they also tested how much the state-by-state impacts of terrorist attacks on three ports are. Richardson et al (2006) shows another practical study using the NIEMO to analyze the U.S. economic impacts of major U.S. theme parks when being attacked by terrorists using the NIEMO. Also, Park and Gordon (2005) addressed the reliability and efficiency of the NIEMO given at low cost.

Model and Data

This study follows the demand-driven NIEMO, which is believed as the only operational MRIO for the U.S. at the state-level. The processes constructing the NIEMO are well reported in the studies of Park et al. (2004, 2006). The NIEMO has 52 regions of 50 states, D.C., and rest of world and 47 "USC sectors" of 29 non-service and 18 service sectors, and hence tally 5,973,136 (=2444*2444) cells in the inverse matrix.[1]

However, note the model includes no inter-industry data for trade between foreign countries, so the off-diagonal cells representing trade between locations in the rest of the world are necessarily zeros. Thus, the NIEMO inverse coefficients for diagonal cells in the foreign-to-foreign region are ones. Let X^s be the total input row vector for $m(=1,...,47)$ non-service and service commodities, labeled as the USC Sectors and $n(=1,...,52)$ states, and X^d be total output column vector for m commodities and n regions. If Z is a $nm \times nm$ block diagonal matrix of

[1] The sector definitions are shown in the Table A1 in the appendices.

direct technical flows between industries within a region, and C is a $nm \times nm$ diagonal block matrix of interregional trade flows, then,

$$X^d = C^d A X^d + C^d D \tag{1}$$

$$X^d = (I - C^d A)^{-1} C^d D \tag{2}$$

$$\therefore X^d = (I - C^d A)^{-1} D^* \tag{3}$$

where, $A = Z(\hat{X}^s)^{-1}$ and $\hat{X}^s$ a $nm \times nm$ block diagonal matrix of vector X^s, and hence the elements in all blocks off the regional diagonal would be zero,

$C^d = C(\hat{C}_j^m)^{-1}$ and $\hat{C}_j^m$ is a $nm \times nm$ diagonal matrix of $1 \times nm$ row vector $C_j^m = \sum_i c_{ij}^m$, that is, off-diagonals for a specific region block should be zero and c_{ij}^m is an element of matrix C for region i to j trade flow of USC sector m, and

D^* is a column vector of regional specific final demand losses.

Here, a use matrix (U^A) instead of A for the demand-side NIEMO is used. Also, to obtain final demand losses as direct impacts, D^*, the WISERTrade data were adopted, where three HS sectors (0201, 0202, and 0206) are selected for bovine related products among HS sector 02, ‘MEAT AND EDIBLE MEAT OFFAL’ sector, and combined to USC sector 0101 ‘Bovine Animals, Live’ from the HS 01 ‘Live animals and live fish & Meat, fish, seafood, and their preparations’. Figure 2 shows the whole procedure from the input data to the output via the NIEMO.

From the selected sectors, the foreign exports of U.S. by each state are dramatically decreased since Dec. 2003, especially for top six states, as shown in Figure 3. This figure clearly shows that if any BSE incidents had not been occurred, no rapid decrease of foreign exports would have happened for those HS sectors. Therefore, if assuming the forecasted values are the foreign exports in the normal status, then differences between the forecasted and the actual exports would be the direct decreases occurred by the BSE, which affect negatively on U.S. economy via interstates and interindustries.

To forecast the aftermath exports by the BSE, the stepwise autoregressive technique is applied. The STEPAR autoregressive process is fitted using a backwards-stepping method to select parameters in sequence. Based on the data during Jan. 2002 to Nov. 2003, the time-series estimation compute autocovariance step-by-step up to 12 months to find the least significant unless it is greater than 0.05. The equations (4) to (6) shows the econometric form of the stepwise autoregression for region n.

$$FX_M^n = \beta_0^n + \beta_1^n M + \mu_M^n \tag{4}$$

$$\mu_M^n = \sum_k \rho_k^n FX_{M-k}^n + \varepsilon_M^n \tag{5}$$

$$\therefore FX_M^n = \beta_0^n + \beta_1^n M + \sum_k \rho_k^n FX_{M-k}^n + \varepsilon_M^n \tag{6}$$

where, FX indicates monthly data of foreign exports,

M is column vector of months, and

ρ is autoregressive parameter.

Final demand losses are calculated by subtracting the ‘forecasted exports’ from the ‘actual exports’ and summed to the first (Dec. 2003 to Nov. 2004) and the second year (Dec. 2004 to Apr. 2005). Note that the demand losses are assumed as zero unless the losses of first or second year are less than zero in order to reflect direct losses, although those are negligible in its magnitude.

Results

The statistical results of export forecasting for seventeen months after Nov. 2003 by each state are shown in Table 1. Major states exporting the eatable bovines to the rest of world have higher adjusted R^2s than other minor states. Based on the estimated parameters βs and ρs, the forecasted exports for leading months during Dec. 2003 to Apr. 2005 are obtained. Final demand losses by BSE can be calibrated by subtracting the original exports from the forecasted exports for leading seventeen months. Because NIEMO is one-year model, final demand losses of first and second year can be recalculated, as shown in Table 2. The California State is the largest affected state by the Washington state’s BSE, losing the total final demand as \$1.4 billions during seventeen months, while the Washington state itself had a direct loss by \$0.49 billion due to the BSE. Total losses of U.S. due to the BSE reached up to \$4.64billions.

Based on the final demand losses shown in Table 2, the indirect and total impacts of sum of intra- and inter-state results estimated by NIEMO are presented in Table 3. As expected, the indirect impacts are largest in CA as \$1.47 billions totally. The total U.S. economic losses increase up to \$13.7 billions only for seventeen months’ closure of exports via \$9 billions of indirect impacts, while the direct losses of Washington State are $0.49 billions. The multiplier summed across all states is 2.95 (=$13.7billions/$4.64billions). Moreover, since top six states to export the eatable bovine, as shown in Figure 3, take about 80 percent losses from the total U.S. losses, those are the largest states shocked economically by the BSE. As sectoral effects, USC02, USC03, and USC05 are the most damaged non-service sectors except USC01, and USC32 sectors are the most damaged service sectors respectively, although the result of USC 01 is only shown in the Table A2 in appendices.

Conclusions

While domestic U.S. market can find the equilibrium rapidly by tightening supply side, international barriers to hinder U.S. exports still become a critical agricultural policy for U.S. government. The closure of U.S. exports of bovine by mad cow disease occurred in Washington State yielded a huge shock into U.S. economy due to simultaneous closures of other state exports. However, any economic researches for BSE affecting on U.S. economy have not been studied using the MRIO-type model until now. Currently the only available MRIO model, the NIEMO, enables to estimate the economic losses by simultaneous closures of each state export of beef and related products. Also, in terms that NIEMO can supply information comparing the different economic impacts of state-by-state to policy-makers, they can distribute the national subsides due to the incident, considering the spreading impacts.

However, some caveats should be addressed when applying the NIEMO and the forecasting method. First, according to the characteristic of linearity in the NIEMO, a variety of substitutions and adjustments may be conducted. In the case, the current results of the NIEMO might overestimate the economic impacts of the BSE. Second, since the initial version of the NIEMO couldn't deliver the trade flows of the service sectors, the economic impacts can be somewhat underestimated. Third, while the approach used in this study only assumes the losses of foreign exports, still there are some additional direct costs to be counted. Fourth, since the NIEMO is open to household sectors, it couldn't address the consumption behavior of household in farms. Finally, the stepwise forecasting method might estimate over- or under-estimate for some states because of the poor data, but our trials using other approaches to resolve the seasonal effects did not show better results than the current in terms of statistical probabilities.

However, in spite of the problems, the NIEMO results are useful for agricultural policy. First of all, this result can help to collect nationwide support for the BSE prevention measures and research in specific locations, often distant from the states where the measures are taken. Much of agricultural politics are conducted at the local level, even in a federal system, and hence, it can be easily expected that decision makers will benefit from information that includes the spatial incidence of losses from the BSE event. Finally, because the results via the NIEMO can provide the state-by-state indirect impacts by the USC sector, each local government understands which sectors are much severely affected by the BSE than other sectors, and hence can distribute the local support more efficiently based on the detail results.

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www.mad-cow-facts.com

Table 1. Forecasting Results by State

State	β_0	β_1	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	R^2	**Adj_** R^2	N	DF
AK	0.0472	-0.0007								0.003	-0.045	23	21
AL	-0.0476	0.0118								0.174	0.135	23	21
AR	0.2753	0.0273								0.175	0.136	23	21
AZ	4.0104	-0.0143					-0.4337			0.225	0.147	23	20
CA	-3.4641	3.0702	0.7868							0.895	0.885	23	20
CO	22.0664	0.4129								0.445	0.418	23	21
CT	0.0337	-0.0003								0.003	-0.045	23	21
DC	0.0020	-0.0001								0.103	0.061	23	21
DE	0.0082	0.0004								0.005	-0.042	23	21
FL	2.6464	0.0346								0.201	0.163	23	21
GA	0.7198	0.0152								0.232	0.195	23	21
HI	0.1147	0.0066								0.016	-0.031	23	21
IA	15.6826	-0.4524								0.515	0.492	23	21
ID	1.0061	0.0240								0.156	0.116	23	21
IL	8.7578	-0.1903								0.598	0.579	23	21
IN	1.3845	-0.0532								0.390	0.361	23	21
KS	59.3951	0.1563				-0.4260				0.232	0.155	23	20
KY	0.0875	-0.0040								0.161	0.121	23	21
LA	0.2050	0.0025								0.017	-0.030	23	21
MA	1.5432	-0.0628								0.469	0.444	23	21
MD	0.2370	0.0869								0.602	0.583	23	21
ME	0.1436	-0.0028								0.051	0.006	23	21
MI	5.9457	-0.1152	0.7508							0.646	0.610	23	20
MN	1.3005	-0.0052								0.008	-0.039	23	21
MO	0.1742	0.0286								0.253	0.218	23	21
MS	0.6980	-0.0368								0.130	0.089	23	21
MT	0.4263	-0.0145	0.4799							0.319	0.251	23	20
NC	0.8965	-0.0039								0.024	-0.023	23	21
ND	0.2287	-0.0021								0.036	-0.010	23	21
NE	39.1467	-0.1515								0.030	-0.016	23	21
NH	0.0060	-0.0001								0.002	-0.046	23	21
NJ	1.1628	0.0321					-0.4257			0.375	0.313	23	20
NM	0.3282	-0.0150				-0.6038				0.711	0.682	23	20
NV	-0.0042	0.0007								0.051	0.005	23	21
NY	2.9718	-0.0345								0.186	0.147	23	21
OH	0.5655	-0.0243								0.470	0.444	23	21
OK	0.2508	0.0108								0.050	0.004	23	21
OR	0.8915	-0.0181								0.297	0.264	23	21
PA	2.7222	0.0729								0.240	0.204	23	21
RI	-	-								-	-	-	-
SC	0.1641	0.0006								0.005	-0.042	23	21
SD	6.9963	-0.0233								0.007	-0.041	23	21
TN	-0.0649	0.0154								0.137	0.096	23	21
TX	37.3784	0.6006								0.283	0.249	23	21
UT	1.1495	0.0801	0.4667							0.628	0.590	23	20
VA	0.5518	-0.0022								0.002	-0.046	23	21
VT	0.6950	-0.0161	0.6827							0.688	0.657	23	20
WA	3.2848	0.9648								0.714	0.701	23	21
WI	5.8812	-0.0188							-0.4774	0.270	0.197	23	20
WV	-0.0012	0.0002								0.125	0.083	23	21
WY	0.0269	-0.0010								0.030	-0.016	23	21

Note: The RI doesn't have foreign exports for the defined sectors.

Table 2. Final Demand Losses by State ($Millions)

Code	State	Fisrt_Year	Second_Year	Total
AK	ALASKA	-0.243	-0.091	-0.334
AL	ALABAMA	-3.407	-1.435	-4.842
AR	ARKANSAS	-8.178	-2.906	-11.084
AZ	ARIZONA	-20.585	-6.677	-27.262
CA	CALIFORNIA	-969.072	-430.698	-1399.770
CO	COLORADO	-282.893	-96.937	-379.830
CT	CONNECTICUT	-0.265	-0.096	-0.361
DC	DISTRICT OF COLUMBIA	0.000	0.000	0.000
DE	DELAWARE	-0.083	0.000	-0.083
FL	FLORIDA	-8.767	-2.726	-11.492
GA	GEORGIA	-0.385	0.000	-0.385
HI	HAWAII	-0.431	-1.454	-1.885
IA	IOWA	0.000	0.000	0.000
ID	IDAHO	-20.001	-7.605	-27.606
IL	ILLINOIS	-17.193	0.000	-17.193
IN	INDIANA	0.000	0.000	0.000
KS	KANSAS	-557.056	-192.072	-749.128
KY	KENTUCKY	0.000	0.000	0.000
LA	LOUISIANA	-1.757	-1.009	-2.765
MA	MASSACHUSETTS	0.000	0.000	0.000
MD	MARYLAND	-24.954	-11.037	-35.991
ME	MAINE	-0.686	-0.073	-0.759
MI	MICHIGAN	-13.102	-0.996	-14.098
MN	MINNESOTA	0.000	0.000	0.000
MO	MISSOURI	-6.349	-3.908	-10.257
MS	MISSISSIPPI	0.000	0.000	0.000
MT	MONTANA	0.000	0.000	0.000
NC	NORTH CAROLINA	-2.224	-0.732	-2.956
ND	NORTH DAKOTA	-1.377	-0.358	-1.735
NE	NEBRASKA	-367.857	-119.763	-487.621
NH	NEW HAMPSHIRE	0.000	0.000	0.000
NJ	NEW JERSEY	-15.926	-6.565	-22.490
NM	NEW MEXICO	0.000	0.000	0.000
NV	NEVADA	-0.197	-0.093	-0.289
NY	NEW YORK	-12.737	-3.413	-16.151
OH	OHIO	0.000	0.000	0.000
OK	OKLAHOMA	-5.034	-2.503	-7.537
OR	OREGON	-3.735	-0.673	-4.409
PA	PENNSYLVANIA	-49.126	-20.352	-69.478
RI	RHODE ISLAND	0.000	0.000	0.000
SC	SOUTH CAROLINA	-1.177	0.000	-1.177
SD	SOUTH DAKOTA	-45.625	-8.832	-54.457
TN	TENNESSEE	-3.811	-2.036	-5.847
TX	TEXAS	-470.760	-185.315	-656.075
UT	UTAH	-33.416	-13.724	-47.140
VA	VIRGINIA	0.000	0.000	0.000
VT	VERMONT	-0.900	0.000	-0.900
WA	WASHINGTON	-336.028	-151.661	-487.690
WI	WISCONSIN	-57.000	-19.827	-76.827
WV	WEST VIRGINIA	-0.039	-0.018	-0.057
WY	WYOMING	0.000	0.000	0.000
U.S.	UNITED STATES	-3342.377	-1295.583	-4637.961

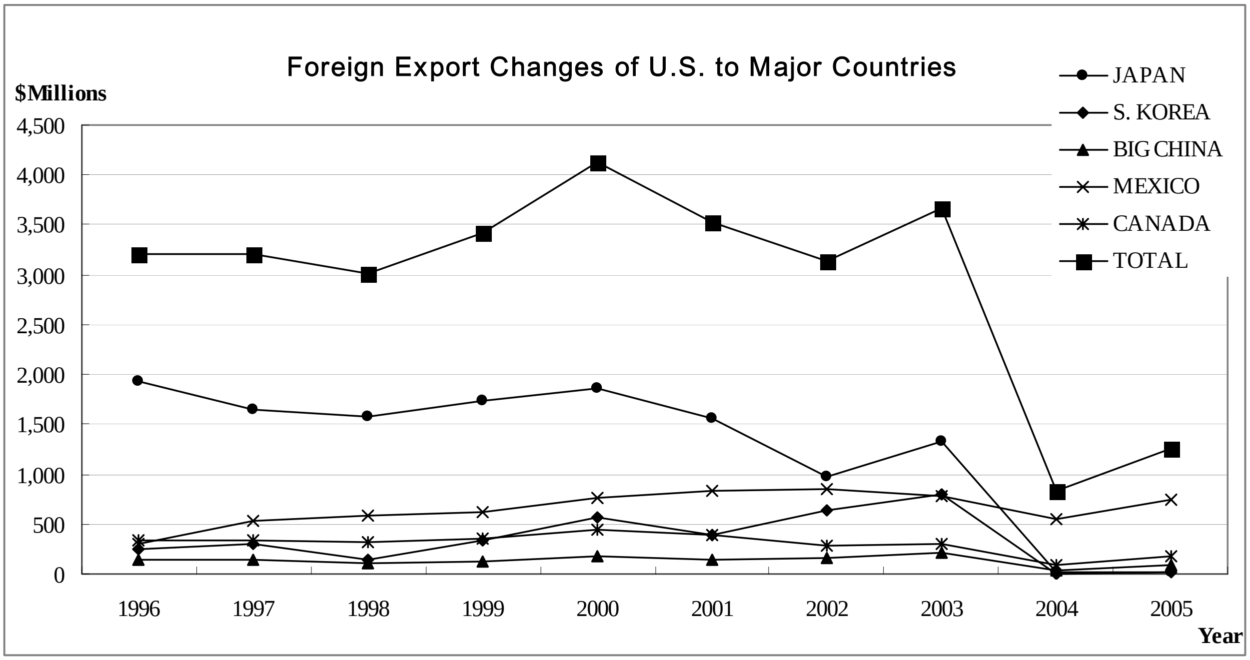
Note: 1. Final demand losses= (Actual exports)-(Forecasted exports)

2. Final demand losses are assumed as zero unless the losses of first or second year are less than zero in order to reflect direct losses, although those are negligible in the magnitude.

Table 3. Sum of Intra- and Inter-state Effects via NIEMO ($Millions)

	Direct_Impacts			Indirect_Impacts			Total_Impacts		
State	First_year	Second_year	Total	First_year	Second_year	Total	First_year	Second_year	Total
AL	-3.4	-1.4	-4.8	-67.7	-25.2	-92.9	-71.1	-26.6	-97.7
AK	-0.2	-0.1	-0.3	-55.9	-25.0	-80.9	-56.2	-25.0	-81.2
AZ	-20.6	-6.7	-27.3	-52.7	-20.9	-73.6	-73.3	-27.5	-100.9
AR	-8.2	-2.9	-11.1	-116.8	-45.3	-162.1	-124.9	-48.2	-173.2
CA	-969.1	-430.7	-1,399.8	-1035.0	-439.4	-1,474.4	-2004.0	-870.1	-2,874.1
CO	-282.9	-96.9	-379.8	-320.5	-112.0	-432.5	-603.4	-209.0	-812.3
CT	-0.3	-0.1	-0.4	-7.7	-3.0	-10.7	-8.0	-3.1	-11.1
DE	-0.1	0.0	-0.1	-5.3	-2.1	-7.4	-5.4	-2.1	-7.5
DC	0.0	0.0	0.0	-1.2	-0.4	-1.6	-1.2	-0.4	-1.6
FL	-8.8	-2.7	-11.5	-43.7	-16.2	-59.9	-52.4	-18.9	-71.4
GA	-0.4	0.0	-0.4	-42.5	-16.3	-58.8	-42.8	-16.3	-59.1
HI	-0.4	-1.5	-1.9	-9.3	-4.5	-13.8	-9.7	-6.0	-15.7
ID	-20.0	-7.6	-27.6	-73.3	-28.9	-102.2	-93.3	-36.5	-129.8
IL	-17.2	0.0	-17.2	-167.2	-58.4	-225.6	-184.4	-58.4	-242.8
IN	0.0	0.0	0.0	-53.6	-20.4	-74.0	-53.6	-20.4	-74.0
IA	0.0	0.0	0.0	-192.6	-71.6	-264.2	-192.6	-71.6	-264.2
KS	-557.1	-192.1	-749.1	-716.4	-254.0	-970.4	-1273.5	-446.0	-1,719.5
KY	0.0	0.0	0.0	-28.6	-10.8	-39.5	-28.6	-10.8	-39.5
LA	-1.8	-1.0	-2.8	-50.5	-20.3	-70.8	-52.2	-21.3	-73.5
ME	-0.7	-0.1	-0.8	-9.0	-3.6	-12.6	-9.7	-3.6	-13.3
MD	-25.0	-11.0	-36.0	-28.4	-11.8	-40.2	-53.3	-22.8	-76.1
MA	0.0	0.0	0.0	-16.3	-6.3	-22.6	-16.3	-6.3	-22.6
MI	-13.1	-1.0	-14.1	-63.2	-21.1	-84.3	-76.3	-22.1	-98.4
MN	0.0	0.0	0.0	-119.2	-44.0	-163.2	-119.2	-44.0	-163.2
MS	0.0	0.0	0.0	-77.7	-28.0	-105.6	-77.7	-28.0	-105.6
MO	-6.3	-3.9	-10.3	-119.0	-45.8	-164.9	-125.4	-49.7	-175.1
MT	0.0	0.0	0.0	-31.0	-11.7	-42.8	-31.0	-11.7	-42.8
NE	-367.9	-119.8	-487.6	-564.6	-193.3	-757.9	-932.5	-313.1	-1,245.5
NV	-0.2	-0.1	-0.3	-9.0	-3.6	-12.6	-9.1	-3.7	-12.9
NH	0.0	0.0	0.0	-3.9	-1.5	-5.5	-3.9	-1.5	-5.5
NJ	-15.9	-6.6	-22.5	-39.6	-15.5	-55.1	-55.5	-22.1	-77.6
NM	0.0	0.0	0.0	-27.1	-10.1	-37.3	-27.1	-10.1	-37.3
NY	-12.7	-3.4	-16.2	-55.3	-20.3	-75.7	-68.1	-23.7	-91.8
NC	-2.2	-0.7	-3.0	-74.1	-28.0	-102.1	-76.3	-28.7	-105.0
ND	-1.4	-0.4	-1.7	-22.0	-8.1	-30.1	-23.4	-8.4	-31.9
OH	0.0	0.0	0.0	-74.0	-27.7	-101.7	-74.0	-27.7	-101.7
OK	-5.0	-2.5	-7.5	-125.9	-47.8	-173.6	-130.9	-50.3	-181.2
OR	-3.7	-0.7	-4.4	-55.3	-22.6	-77.9	-59.0	-23.3	-82.3
PA	-49.1	-20.4	-69.5	-106.1	-42.3	-148.4	-155.2	-62.7	-217.9
RI	0.0	0.0	0.0	-3.4	-1.3	-4.7	-3.4	-1.3	-4.7
SC	-1.2	0.0	-1.2	-17.4	-6.3	-23.7	-18.5	-6.3	-24.8
SD	-45.6	-8.8	-54.5	-100.3	-28.8	-129.1	-145.9	-37.7	-183.6
TN	-3.8	-2.0	-5.8	-51.1	-20.1	-71.2	-54.9	-22.1	-77.0
TX	-470.8	-185.3	-656.1	-695.3	-271.6	-966.9	-1166.1	-456.9	-1,623.0
UT	-33.4	-13.7	-47.1	-58.0	-23.7	-81.7	-91.4	-37.4	-128.8
VM	-0.9	0.0	-0.9	-3.7	-1.1	-4.8	-4.6	-1.1	-5.7
VA	0.0	0.0	0.0	-19.2	-7.4	-26.6	-19.2	-7.4	-26.6
WA	-336.0	-151.7	-487.7	-335.9	-148.4	-484.2	-671.9	-300.0	-971.9
WV	0.0	0.0	-0.1	-6.9	-2.6	-9.5	-6.9	-2.7	-9.6
WI	-57.0	-19.8	-76.8	-163.7	-60.9	-224.5	-220.7	-80.7	-301.4
WY	0.0	0.0	0.0	-22.9	-8.5	-31.4	-22.9	-8.5	-31.4
US_subtotal	-3,342.4	-1,295.6	-4,638.0	-6,138.7	-2,348.6	-8,487.3	-9,481.0	-3,644.2	-13,125.2
FOREIGN	0.0	0.0	0.0	-401.0	-155.5	-556.5	-401.0	-155.5	-556.5
Total	-3,342.4	-1,295.6	-4,638.0	-6,539.7	-2,504.1	-9,043.8	-9,882.1	-3,799.7	-13,681.7

Figure 1. Foreign Export Changes of U.S. for Bovine sectors to Major Countries



Note: 1. Bovine sectors include 0102, 0201, 0202, and 0206 of Harmonized System (HS) codes.

2. Big china includes mainland, Taiwan, and Hong Kong.

3. Data Source: WISERTrade (www.wisertrade.org)

Figure 2. Procedure Estimating Economic Impacts Occurred from the BSE

Data Source: WISERTrade

1. Regions: 50 states and D.C.
2. Sectors: 4 HS code systems

   0102: Bovine Animals, Live
   0201: Meat of Bovine Animals, Fresh or Chilled
   0202: Meat of Bovine Animals, Frozen
   0206: Ed Offal, Bovine, Swine, Sheep, Goat, Horse, Etc.

3. Period: Jan. 2002 to Apr. 2005

↓

Forecasting

1. Methodology: Stepwise Autoregressive Linear Regressions
2. Base period: Jan. 2002 to Nov. 2003 (23 obs.)
3. Target period: First Year - Dec. 2003 to Nov. 2004

   Second Year - Dec. 2004 to Apr. 2005

4. Applied Program: SAS Version 9.0

↓

Direct Losses

1. First Year - Dec. 2003 to Nov. 2004

   Second Year - Dec. 2004 to Apr. 2005

2. Calculations:

   (Actual WISERTrade Data) – (Forecasted Values)

↓

NIEMO

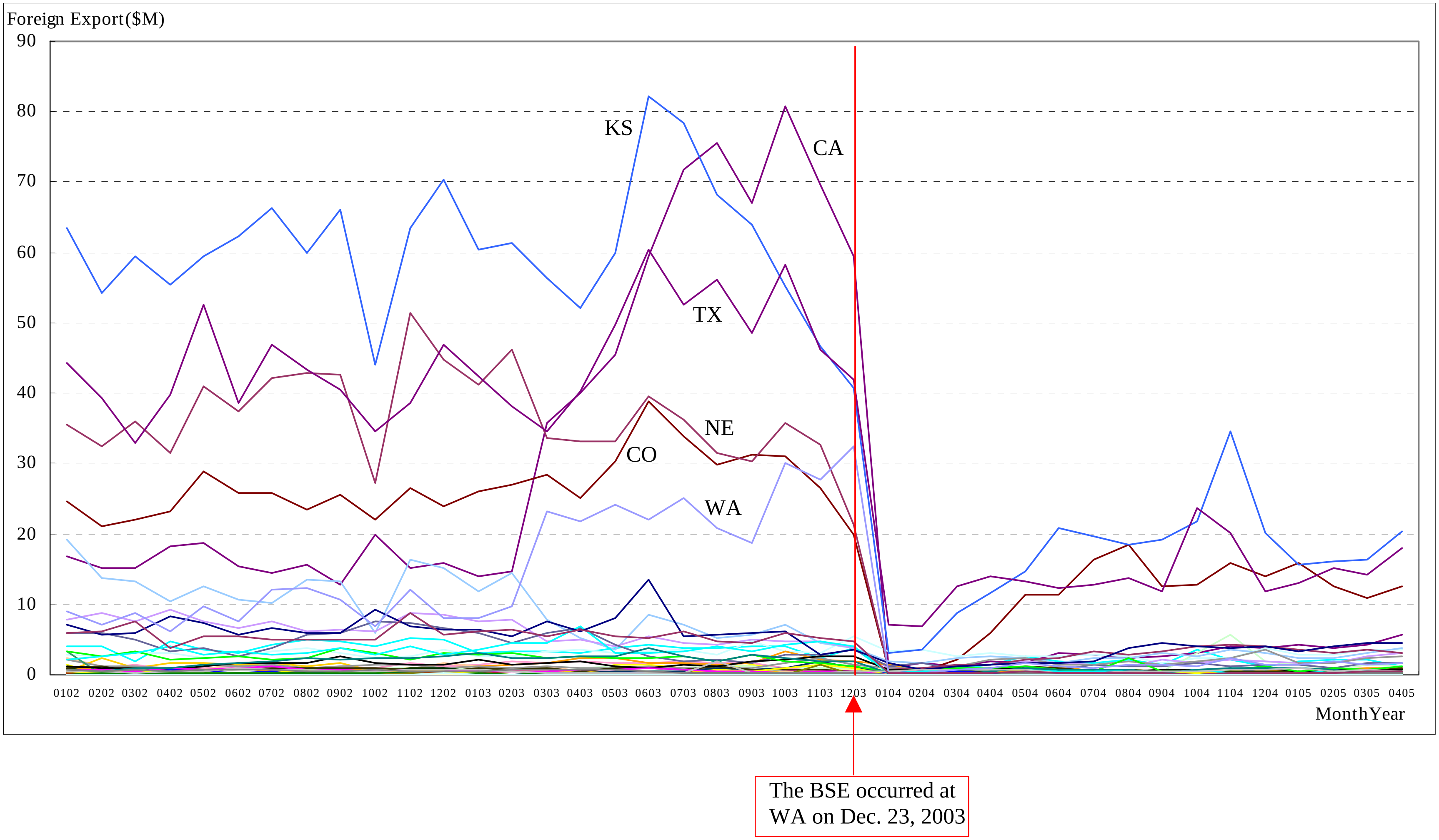
1. Defined sector from the direct losses: USC sector 01
2. Regions: 50 states and D.C.
3. Demand-driven NIEMO

↓

NIEMO Results

1. Affected Regions: 50 states, D.C., and Rest of World
2. Affected Sectors: 47 USC sectors

Figure 3. Foreign Export Trends of U.S. during Jan.02 to Apr. 05 by State



Appendices

Table A1. Definitions of USC Two-Digit Sectors

Classification	USC	Description
Commodity Sectors	USC01	Live animals and live fish & Meat, fish, seafood, and their preparations
	USC02	Cereal grains & Other agricultural products except for Animal Feed
	USC03	Animal feed and products of animal origin, n.e.c.
	USC04	Milled grain products and preparations, and bakery products
	USC05	Other prepared foodstuffs and fats and oils
	USC06	Alcoholic beverages
	USC07	Tobacco products
	USC08	Nonmetallic minerals (Monumental or building stone, Natural sands, Gravel and crushed stone, n.e.c.)
	USC09	Metallic ores and concentrates
	USC10	Coal and petroleum products (Coal and Fuel oils, n.e.c.)
	USC11	Basic chemicals
	USC12	Pharmaceutical products
	USC13	Fertilizers
	USC14	Chemical products and preparations, n.e.c.
	USC15	Plastics and rubber
	USC16	Logs and other wood in the rough & Wood products
	USC17	Pulp, newsprint, paper, and paperboard & Paper or paperboard articles
	USC18	Printed products
	USC19	Textiles, leather, and articles of textiles or leather
	USC20	Nonmetallic mineral products
	USC21	Base metal in primary or semi-finished forms and in finished basic shapes
	USC22	Articles of base metal
	USC23	Machinery
	USC24	Electronic and other electrical equipment and components, and office equipment
	USC25	Motorized and other vehicles (including parts)
	USC26	Transportation equipment, n.e.c.
	USC27	Precision instruments and apparatus
	USC28	Furniture, mattresses and mattress supports, lamps, lighting fittings, and illuminated signs
	USC29	Miscellaneous manufactured products, Scrap, Mixed freight, and Commodity unknown
Non-Commodity (Service) Sectors	USC30	Utility
	USC31	Construction
	USC32	Wholesale Trade
	USC33	Transportation
	USC34	Postal and Warehousing
	USC35	Retail Trade
	USC36	Broadcasting and information services
	USC37	Finance and Insurance
	USC38	Real estate and rental and leasing
	USC39	Professional, Scientific, and Technical services
	USC40	Management of companies and enterprises
	USC41	Administrative support and waste management
	USC42	Education Services
	USC43	Health Care and Social Assistances
	USC44	Arts, Entertainment, and Recreation
	USC45	Accommodation and Food services
	USC46	Public administration
	USC47	Other services except public administration

Source: Park et al., 2006.

Table A2. Sum of Intra- and Inter-state Effects via NIEMO: USC sector 01 ($Millions)

	Direct_Impacts			**Indirect_Impacts**			**Total_Impacts**		
State	First_year	Second_year	Total	First_year	Second_year	Total	First_year	Second_year	Total
AL	-3.4	-1.4	-4.8	-32.4	-11.9	-44.3	-35.9	-13.3	-49.2
AK	-0.2	-0.1	-0.3	-35.0	-15.7	-50.7	-35.2	-15.8	-51.0
AZ	-20.6	-6.7	-27.3	-5.1	-2.1	-7.2	-25.7	-8.8	-34.4
AR	-8.2	-2.9	-11.1	-51.9	-20.6	-72.6	-60.1	-23.5	-83.6
CA	-969.1	-430.7	-1,399.8	-115.4	-51.0	-166.4	-1084.5	-481.7	-1,566.1
CO	-282.9	-96.9	-379.8	-57.8	-20.1	-77.9	-340.7	-117.1	-457.8
CT	-0.3	-0.1	-0.4	-0.2	-0.1	-0.3	-0.4	-0.2	-0.6
DE	-0.1	0.0	-0.1	-1.2	-0.5	-1.6	-1.3	-0.5	-1.7
DC	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1
FL	-8.8	-2.7	-11.5	-2.9	-1.1	-3.9	-11.7	-3.8	-15.4
GA	-0.4	0.0	-0.4	-10.1	-4.0	-14.1	-10.4	-4.0	-14.5
HI	-0.4	-1.5	-1.9	-0.2	-0.1	-0.3	-0.6	-1.6	-2.2
ID	-20.0	-7.6	-27.6	-11.2	-4.7	-16.0	-31.2	-12.3	-43.6
IL	-17.2	0.0	-17.2	-16.2	-5.3	-21.5	-33.4	-5.3	-38.7
IN	0.0	0.0	0.0	-3.5	-1.3	-4.8	-3.5	-1.3	-4.8
IA	0.0	0.0	0.0	-56.7	-21.4	-78.1	-56.7	-21.4	-78.1
KS	-557.1	-192.1	-749.1	-137.6	-49.4	-187.0	-694.6	-241.5	-936.1
KY	0.0	0.0	0.0	-2.4	-0.9	-3.3	-2.4	-0.9	-3.3
LA	-1.8	-1.0	-2.8	-1.4	-0.6	-2.1	-3.2	-1.6	-4.8
ME	-0.7	-0.1	-0.8	-2.1	-0.9	-2.9	-2.8	-0.9	-3.7
MD	-25.0	-11.0	-36.0	-5.4	-2.2	-7.6	-30.3	-13.3	-43.6
MA	0.0	0.0	0.0	-0.3	-0.1	-0.5	-0.3	-0.1	-0.5
MI	-13.1	-1.0	-14.1	-3.0	-0.7	-3.7	-16.1	-1.7	-17.8
MN	0.0	0.0	0.0	-23.7	-9.3	-32.9	-23.7	-9.3	-32.9
MS	0.0	0.0	0.0	-44.9	-16.0	-60.8	-44.9	-16.0	-60.8
MO	-6.3	-3.9	-10.3	-9.8	-4.3	-14.1	-16.2	-8.2	-24.3
MT	0.0	0.0	0.0	-3.1	-0.9	-3.9	-3.1	-0.9	-3.9
NE	-367.9	-119.8	-487.6	-123.2	-42.9	-166.1	-491.1	-162.6	-653.7
NV	-0.2	-0.1	-0.3	-0.7	-0.3	-1.1	-0.9	-0.4	-1.4
NH	0.0	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.0	-0.1
NJ	-15.9	-6.6	-22.5	-1.8	-0.7	-2.5	-17.7	-7.3	-25.0
NM	0.0	0.0	0.0	-1.3	-0.5	-1.8	-1.3	-0.5	-1.8
NY	-12.7	-3.4	-16.2	-1.9	-0.6	-2.5	-14.6	-4.0	-18.6
NC	-2.2	-0.7	-3.0	-31.2	-11.9	-43.1	-33.4	-12.6	-46.0
ND	-1.4	-0.4	-1.7	-0.5	-0.2	-0.8	-1.9	-0.6	-2.5
OH	0.0	0.0	0.0	-1.7	-0.7	-2.4	-1.7	-0.7	-2.4
OK	-5.0	-2.5	-7.5	-38.5	-14.6	-53.0	-43.5	-17.1	-60.6
OR	-3.7	-0.7	-4.4	-5.4	-2.2	-7.6	-9.1	-2.9	-12.0
PA	-49.1	-20.4	-69.5	-11.0	-4.5	-15.6	-60.2	-24.9	-85.1
RI	0.0	0.0	0.0	-0.2	-0.1	-0.3	-0.2	-0.1	-0.3
SC	-1.2	0.0	-1.2	-1.3	-0.3	-1.6	-2.5	-0.3	-2.8
SD	-45.6	-8.8	-54.5	-21.7	-6.5	-28.1	-67.3	-15.3	-82.6
TN	-3.8	-2.0	-5.8	-6.7	-2.6	-9.2	-10.5	-4.6	-15.1
TX	-470.8	-185.3	-656.1	-140.2	-55.2	-195.4	-611.0	-240.5	-851.5
UT	-33.4	-13.7	-47.1	-8.5	-3.5	-12.1	-41.9	-17.3	-59.2
VM	-0.9	0.0	-0.9	-0.1	0.0	-0.2	-1.0	0.0	-1.1
VA	0.0	0.0	0.0	-1.8	-0.7	-2.4	-1.8	-0.7	-2.4
WA	-336.0	-151.7	-487.7	-65.0	-28.9	-94.0	-401.1	-180.6	-581.7
WV	0.0	0.0	-0.1	-0.4	-0.2	-0.6	-0.4	-0.2	-0.6
WI	-57.0	-19.8	-76.8	-28.3	-10.8	-39.0	-85.3	-30.6	-115.9
WY	0.0	0.0	0.0	-0.5	-0.3	-0.8	-0.5	-0.3	-0.8
US_subtotal	-3,342.4	-1,295.6	-4,638.0	-1,125.4	-433.4	-1,558.8	-4,467.8	-1,729.0	-6,196.8
FOREIGN	0.0	0.0	0.0	-103.5	-41.4	-144.9	-103.5	-41.4	-144.9
Total	-3,342.4	-1,295.6	-4,638.0	-1,228.9	-474.8	-1,703.7	-4,571.3	-1,770.4	-6,341.7