A Two-Step Approach to Estimating Detailed State-to-State Commodity Trade Flows*

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ABSTRACT

A major problem in developing interregional-interindustry models, including multiregional input-output (MRIO) models, is how to combine seemingly incompatible databases. This research aims to estimate state-to-state commodity trade flow tables by major industrial sectors for the U.S. useful for creating an MRIO-type National Interstate Economic Model (NIEMO). The model is based on IMPLAN and related data for 2001. Constructing NIEMO was challenging because of the limited availability of commodity freight shipment data between the states. This helps to explain why a NIEMO-type model has not been developed in recent years, in fact not since Polenske (1980). As one of the two basic sets of tables along Chenery-Moses lines necessary to construct NIEMO, interregional trade tables to estimate trade coefficients by states and industry had been available from the U.S. Commodity Transportation Survey Data since 1977, but reporting was discontinued for some years. For the years since 1993, this data deficit can be met to some extent with the recent (CFS) data from the Bureau of Transportation Statistics (BTS). Available since 1993, the CFS data are widely used, but they have several inherent problems (Erlbaum and Holguin-Veras, 2005: 3). Recent attempts estimate interregional trade flows using data from the 1997 Commodity Flow Survey (CFS), based on IMPLAN data made this clear to us. This study suggests a new approach to estimating the trade tables (between all 50 States plus D.C. and the rest of the world) assembled via a two-step method, to adjust for incomplete reported trade flows, and to update the adjusted trade flows by estimating values via the Fratar Model based on the 1997 Commodity Flow Survey (CFS) data. Reconciliation of the IMPLAN and CFS databases present various problems that are also addressed in this paper.

I. Introduction

Many economic disruptions from natural or man-made disasters have led economists to evaluate the socioeconomic impacts on the U.S. economy, especially since the 2001 terrorist attacks. This is because even a small disaster that does not involve many fatalities could cause enormous economic losses. The most widely used impact models are input-output (IO) models. They offer considerable sectoral detail along with computability.

Generally, the national IO models aggregate over large numbers of diverse regions. However, the disasters under discussion should be studies by tracing effects via inter-regional commodity flows as well as inter-connected industries, because the economic impacts have an inevitable spatial incidence. This suggests adding spatial detail to traditional IO. First, political representatives have an obvious interest in their own constituency and jurisdiction. Second, subnational impacts can cancel each other in the aggregate, causing national measures to obscure key dimensions of the event. So far, the U.S. multi-regional input-output models (MRIO) suggest an attempt at regional disaggregation but these are difficult to construct because sub-national trade data are hard to develop even though commodity flow data between regions and states of the U.S. are published every five years.

To examine the full-costs through the U.S. economy using an integrated model of losses, spatial connections between states must be considered, a major problem in developing integrated interregional-interterindustry models is how to combine not easily compatible databases. Although Chenery (1953) and Moses (1955) formulated an interregional framework based on the early discussion of Isard (1951), data problems still stymie applications. This explains why an operational Chenery-Moses model has not been available since Polenske (1980) and Jack Faucett Associates (1983). Also, U.S. Commodity Transportation Survey reports on inter-regional trade flows since 1977 have been discontinued. This data deficit can be met to some extent with the Commodity Flow Survey (CFS) from the Bureau of Transportation Statistics (BTS), but currently available CFS data are incomplete with respect to interstate flows.

The primary purpose of this study is, therefore, to suggest a useful way to create trade flows between U.S. states as the basis for a new National Interstate Economic Model (NIEMO) for the U.S. Direct economic impacts are relatively easily estimated in the aftermath of an attack. If plausible scenarios for the time-profile of reduced shipping facilities are available, spatially detailed indirect and induced economic effects can be estimated with a NIEMO-type model. Standard applications of IO determine indirect and induced impacts that typically do not include interactions among industries and states. To estimate such short-term impacts, multi-regional models consisting of two sets of tables, regional coefficient tables and trade coefficient tables, are appropriate (Miller and Blair, 1985). These NIEMO-type Chenery-Moses models can be used to estimate inter-state industry effects as well as inter-industry impacts on each state. To proceed this way, it is necessary to calculate multi-regional industry coefficients among U.S. states; the regional tables that give us intra-regional industry coefficients by state and the interregional trade tables to give us trade coefficients by industry. This paper, therefore, suggests a sequence of computational steps for estimating inter-state trade flows required to implement such a model.

To construct the trade tables - between all 50 states plus D.C. and the rest of the world -, we applied an Adjusted Flow Model, a Double constrained Fratar Model based on 1997 CFS and 2001 IMPLAN data. Due to the different industrial code systems that characterize the two data sources, however, reconciliation of the IMPLAN and CFS databases presented several problems which will be discussed in the next section, where what we describe the "USC (reconciled) Sectors" which are developed to enable a matching of two code systems used in the North American Industry Classification System (NAICS), the Bureau of Economic Analysis (BEA), or the new 509 IMPLAN industry codes. In the third section of this paper, two methodologies, the Adjusted Flow Model and the Double constrained Fratar Model, are explained. The results of the methods developed are in the third section and we show the estimated results in the fourth section.

II. Background

As Lahr (1993) had noted, a major problem in developing an MRIO-type model stems from the fact that it is difficult to obtain data representing U.S. trade flows between the states, not to mention the problem of data reconciliation. Actually, the U.S. Commodity Transportation Survey Data on interregional trade flows had been available since 1977, but the reporting was discontinued for some years. For the years since 1993, this data deficit can be met to some extent with the recent Commodity Flow Survey (CFS) data from the Bureau of Transportation Statistics (BTS). While the CFS data have been widely used, the data have several inherent problems (Erlbaum and Holguin-Veras, 2005: 3). The most serious one among them is that the CFS data do not include trade flows below the state level but also they are not complete trade flows, even between the states. Since the trial models of Polensky (1980) and Faucett Associates (1983), there has been no comprehensive inventory of flows for probably these reasons.

The existence of many unreported values has required relying on other data sources for completeness. Harrigan et al (1981) compared old methodologies to estimate interregional trade flows and showed 'more information, better results' based on the 1973 Scotland data, because all of their techniques are simple ratio-based methodologies. In a similar trial to estimate trade inflows of subregional below the state-level using the CFS, Liu and Vilain's (2004) location quotients, however, require very restrictive assumptions, resulting in sizable errors in the estimates. Based on the approach of Wilson (1970) and

Batten (1982), Canning and Wang (2005) suggested a new method for estimating interregional trade flows for MRIO and IRIO models, along with an empirical test of performance.

The two recent studies used the CFS and IMPLAN data as their basic data set. Jackson et al. (2007) used IMPLAN data to adjust incomplete CFS information primarily by adopting a Box-Cox transformation as well as double-log distance-decay functions. The second attempt is to use a doubly-constrained gravity model based on the county-level data from IMPLAN and ton-mile data from CFS (Lindall et al, 2005). Details are shown below.

II-1. The approach of Jackson et al (2006)

Jackson et al (2006) are suggesting the following formula to obtain γ and θ, which minimize the percentage error between the predicted trade flows using CFS data ($\hat{Y}_i^{mn}$) and the buffer(b)-minimized regressed trade flows (T_i^{mn}) based on IMPLAN data that are adjusted to SCTG codes.

$$\underset{\gamma,\theta}{Min}\sum_m\sum_n\left(\frac{\hat{Y}_i^{mn}-T_i^{mn}}{T_i^{mn}}\right)^2 \qquad (1)$$

where, 1) $\hat{Y}_i^{mn}=\dfrac{g_i(p_i^n)f_i(d^{mn})}{\sum_n g_i(p_i^n)f_i(d^{mn})}\bar{y}_i^m$, $g_i(x)=x^{\gamma_i}$, $f_i(x)=e^{-\theta_i x}$, and $\bar{y}_i^m=\sum_{n\neq m}y_i^{mn}$.

2) $T_i^{mn}=\underset{b}{Min}\left|\sum_m \Gamma_i^{mn}-\tau\right|$, $\sum_m \Gamma_i^{mn}$ is the regression-based total import demand for region n of sector i and τ is the corresponding IMPLAN import demand. Here, commodity flow Γ_i^{mn} from region m to n with regression-based estimates $\hat{\beta}_0$ and $\hat{\beta}_1$ are shown as $\Gamma_i^{mn}=e^{\{\hat{L}(d_{mn}-C_m+b)-\hat{L}(d_{mn}-C_m-b)\}}*X_i^r$, where $\hat{L}(x)=\hat{\beta}_0+\hat{\beta}_1\ln(x)$ and X_i^r are domestic exports of sector i obtained from IMPLAN data. Note that the estimates $\hat{\beta}_0$ and $\hat{\beta}_1$ are obtained from a Box-Cox transformation regression $\dfrac{h_i^{\lambda_i}}{\lambda_i}=\beta_0+\beta_1\dfrac{\tilde{d}_i^{\lambda_i}}{\lambda_i}$ or a double-log regression $\ln(h_i)=\beta_0+\beta_1\ln(\tilde{d}_i)$ in the case unfitted by Box-Cox transformation for sector i, where $\tilde{d}_i$ is the distance range and λ_i is the Box-Cox transformation parameter.

Then, the estimated γ and θ can be used for the equation, $\hat{Y}_i^{mn} = \frac{g_i(p_i^n) f_i(d^{mn})}{\sum_n g_i(p_i^n) f_i(d^{mn})} \bar{y}_i^m$, and hence the newly calculated $\hat{Y}_i^{mn}$ will be obtained via the error-minimized equation (1). However, because there are no trade data of service sectors in CFS, the authors used the average $\hat{\beta}_0$ and $\hat{\beta}_1$ for all other services and then estimated γ, θ, and $\hat{Y}_i^{mn}$.

Further, according to the CFS definitions, foreign imports which are transported from port of entry to the destined state have been included in the CFS inter-state commodity flow. However, in the IMPLAN data, foreign imports refer to the imports which are consumed in the local area. The foreign imports which are not consumed in the local area and transported to other state(s) are excluded from the state or county-level IMPLAN data (Park et al, 2007; Giuliano et al, 2006). Therefore, it is necessary to adjust the gaps between the two, sources.

II-2. Doubly-constrained gravity model

Generally, doubly-constrained gravity models reflect the interactive effects of trades, not only allocations of exports to regions. The model basically accepts that the attractiveness of an economy is proportional to the trade flows but distances between two regions are inversely proportional. Given gross domestic supply and demand of which sum over all regions is same, trade flow of a sector i between region m to n, or T_i^{mn} is as follows (Lee, 1973: 82~87).

$$T_i^{mn} = A_i^m B_i^n O_i^m D_i^n d_{mn}^{-\omega} \tag{2}$$

where, $A_i^m = (\sum_n B_i^n D_i^n d_{mn}^{-\omega})^{-1}$,

$B_i^n = (\sum_m A_i^m O_i^m d_{mn}^{-\omega})^{-1}$,

O_i^m is total supply originating in region m of sector i,

D_i^n is total demand consumed in region n of sector i, and

$d_{mn}^{-\omega}$ is the distance decay function with ω exponent,

subject to, $O_i^m = \sum_n T_i^{mn}$ and $D_i^n = \sum_n T_i^{mn}$

Lindall et al (2005) used three data sets for this estimation: Oak Ridge National Labs (ORNL) for county-to-county distances by mode of transportation, CFS for ton-miles by sector, and IMPLAN data for total supply and demand by county. The ORNL data support an "impedance index as a combination of distance, time, and cost fact" (*ibid*: 4) adopting employment centroids. The CFS data are used for a criterion index to determine whether the average of the estimated ton-miles is matched to the CFS ton-miles or not. However, there might be three problems at least when using the CFS data. First, it is still not clear whether Lindall et al (2005) constructed a compatible data bridge between the CFS and IMPLAN data. Second, though the IMPLAN data only support dollar values without tons, the authors did not report the way to switch dollar values of IMPLAN estimates to ton values to compare the average ton-miles. Finally, IMPLAN data are not shipments but transaction values, so the data must be adjusted by following the CFS definitions, as mentioned above.

Further, the authors set the ω exponent at 2 for non-service sectors. However, they only set high (not expressed explicitly) for service sectors to return the effect that higher ω induces lesser volumes in these sectors' trades. In the service sector cases, because there is no ton-mile information in the CFS, it is still unclear how Lindall et al (2005) estimated trade flows for service sectors. Although they include many caveats, however, their results may be the first attempt to estimate trade flows at the county level. They reported that 36 hours were required processing a 3140x3140 county-by-county matrix for 509 IMPLAN sectors without the service sectors.

The common problem on the all of these attempts is that there are no clear discussions of how to estimate trade flows based on elaborate reconciliation between IMPLAN's sectors and the SCTG sectors of the CFS. Also, it might be naïve to accept the low levels of trade for the service sectors and this might lead to distorted results. .

III. Data Reconciliation

Basic data for our study are obtained from the 1997 CFS and 2001 IMPLAN. The 1997 CFS reports trade flows between U.S. states, although the flow data are not complete because of high sampling variability or disclosure limits on individual company status. Yet, these data can be a useful base-line to update to 2001 year using 2001 IMPLAN data. However, incompatibility between different code systems from different data sources is especially difficult when data reconciliation is attempted without any standardized and tested conversion bridge. To estimate 2001 trade flows from the 1997 CFS, therefore, required various intermediate conversion steps between the SCTG code system used in the 1997 CFS and the IMPLAN system of sectors, because there are not always one-to-one matched pairs between BEA and NAICS codes. Our approach followed the data reconciliation process suggested by Park et al (2006) so as to create a SCTG-IMPLAN conversion bridge enabling aggregation of 509 IMPLAN sectors to 43 SCTG sectors. The various matches are shown in Appendix 1.

Another reconciliation task between IMPLAN and CFS data concerns basic concepts. In other words, the concepts in these two data sources should refer to the same thing. For example, based on CFS definitions, foreign imports which are transported from a port of entry to the destination state, are included in CFS inter-state commodity flow. However, in IMPLAN data, foreign imports refer to imports that are consumed in the local area. Those foreign imports that are not consumed in the local area and transported to other state(s) are excluded from the state or county-level IMPLAN data. In order to make the concept of "inter-state commodity flow" consistent within these two data sources, Foreign Imports in IMPLAN data (${}^{IM}I_i^f$) are adjusted by dividing by our new 29 ratios, meaning proportions of Foreign Imports of sum of every states over U.S. Foreign Import by 29 USC commodity sector. Adjusted foreign imports (${}^{a}I_i^f$), therefore, will include the foreign imports consumed in other states (${}^{c}I_i^f$) as well as the foreign imports consumed in the local area that is used as a port of entry (${}^{IM}I_i^f$). In this way, CFS and IMPLAN data could be reconciled conceptually.

Table 1. IMPLAN Reconciliation with 1997/2002 CFS Producer Prices by USC Sector

Sectors	**2001 IMPLAN**		**2002 CFS_Revised**		**1997 CFS_Revised**		**2002 Ratio**		**1997 Ratio**	
USC	V1*	P1**	V4	P4	V5	P5	V1/V4	P1/P4	V1/V5	P1/P5
USC01	192,478	3.18%	171,981	2.92%	153,997	3.03%	1.12	1.09	1.25	1.05
USC02	130,536	2.16%	131,504	2.24%	115,470	2.27%	0.99	0.97	1.13	0.95
USC03	45,911	0.76%	41,433	0.70%	50,130	0.99%	1.11	1.08	0.92	0.77
USC04	86,329	1.43%	86,226	1.47%	79,122	1.56%	1.00	0.97	1.09	0.92
USC05	302,706	5.01%	263,970	4.49%	252,361	4.96%	1.15	1.11	1.20	1.01
USC06	80,602	1.33%	76,558	1.30%	58,148	1.14%	1.05	1.02	1.39	1.17
USC07	54,172	0.90%	49,519	0.84%	36,191	0.71%	1.09	1.06	1.50	1.26
USC08	20,141	0.33%	19,396	0.33%	17,936	0.35%	1.04	1.01	1.12	0.94
USC09	11,054	0.18%	14,729	0.25%	11,794	0.23%	0.75	0.73	0.94	0.79
USC10	480,173	7.94%	270,347	4.60%	253,304	4.98%	1.78	1.73	1.90	1.59
USC11	104,099	1.72%	120,479	2.05%	126,464	2.49%	0.86	0.84	0.82	0.69
USC12	174,086	2.88%	300,630	5.11%	158,114	3.11%	0.58	0.56	1.10	0.93
USC13	22,231	0.37%	29,431	0.50%	23,606	0.46%	0.76	0.73	0.94	0.79
USC14	159,819	2.64%	172,452	2.93%	154,153	3.03%	0.93	0.90	1.04	0.87
USC15	231,896	3.83%	248,130	4.22%	201,484	3.96%	0.93	0.91	1.15	0.97
USC16	122,282	2.02%	115,614	1.97%	113,525	2.23%	1.06	1.03	1.08	0.91
USC17	154,827	2.56%	160,021	2.72%	158,010	3.11%	0.97	0.94	0.98	0.82
USC18	133,501	2.21%	106,600	1.81%	202,729	3.99%	1.25	1.22	0.66	0.55
USC19	292,878	4.84%	316,653	5.39%	236,813	4.66%	0.92	0.90	1.24	1.04
USC20	113,064	1.87%	114,330	1.94%	87,240	1.72%	0.99	0.96	1.30	1.09
USC21	169,411	2.80%	213,769	3.64%	240,745	4.73%	0.79	0.77	0.70	0.59
USC22	200,391	3.31%	199,880	3.40%	193,294	3.80%	1.00	0.97	1.04	0.87
USC23	433,014	7.16%	424,514	7.22%	347,545	6.83%	1.02	0.99	1.25	1.05
USC24	844,544	13.96%	799,929	13.60%	733,800	14.43%	1.06	1.03	1.15	0.97
USC25	654,570	10.82%	620,959	10.56%	481,910	9.48%	1.05	1.02	1.36	1.14
USC26	143,113	2.37%	157,354	2.68%	124,723	2.45%	0.91	0.88	1.15	0.96
USC27	160,050	2.65%	166,576	2.83%	118,491	2.33%	0.96	0.93	1.35	1.14
USC28	92,277	1.53%	82,582	1.40%	59,471	1.17%	1.12	1.09	1.55	1.30
USC29	436,417	7.22%	404,687	6.88%	295,358	5.81%	1.08	1.05	1.48	1.24
ALL	6,047,838	100%	5,880,253	100%	5,085,927	100%	1.03	1.00	1.19	1.00

* Unit: (million$)
** {(Each SCTG sector value)x100}/ (ALL value).

With this reconciliation, some minor manual adjustments are still required on the basis of judgment, using sector names of 5-digit SCTG and 6-digit NAICS to adjust default even-proportions assumptions arising from aggregation in the case of 'one- or multi-sectors to multi-sectors'. Also, a producer/purchaser dollar value adjustment was conducted because the IMPLAN data include producer values, while CFS data are based on purchaser values which include transportation cost, wholesale markup, and retail markup besides the producer values.

The steps involved in data reconciliation, the definition of USC sectors, and the quality of results are described in Appendix 2. According to the two Appendices 2e and 2f and the USC sectors defined at Appendix 2g, Table 1 shows the final 2001 IMPLAN reconciliation with 1997 and 2002 CFS data, all in producer prices by USC sector, where 2001 IMPLAN value ratios with 2002 CFS (=V1/V4) in USC sectors are mostly near one.

IV. Model

Based on the data bridges to reconcile different data code systems, a two-step approach via an Adjusted Flow Model (AFM) and a Doubly-constrained Fratar Model (DFM) was developed. Estimated 2001 commodity trade flows among all 50 states plus Washington, D.C. and the rest of the world were developed from the original 1997 CFS for 29 USC Commodity Sectors. The first step in order to use the DFM is to complete the 1997 CFS' unreported values for a variety of commodities, including some marginal values such as total shipments originating in each state, total shipments destined for each state, and the matrix of cells representing commodity trade flows between pairs of states. The 2001 IMPLAN data report total origin and destination values by state. Then the 2001 commodity trade flows could be estimated with a Fratar model. First, the procedures for missing value estimation are followed as described in the section IV-1.

IV-1. Two-Step Approach: Adjusted Flow Model (AFM)

To calculate the values in each unreported cell of the trade flows between states, first, total origin and total destination values should be fixed. Let reported total origin and destination from CFS be O_i^T and D_j^T respectively. To calculate unreported total origin (output) value of state i ($=O_i^{UT}$), the ratio of 2001 IMPLAN total origin of state i ($={}^{IM}O_i^T$) to the sum and 1997 CFS reported total value of each USC sector m ($={}_mV^T={}_m\sum_i(O_i^T+O_i^{UT})={}_m\sum_j(D_j^T+D_j^{UT})$, $m=1,...,29$) was used as shown in equation (3), based on a specific USC sector m.

$$O_i^{UT} = \left(\frac{{}^{IM}O_i^T}{\sum_i {}^{IM}O_i^T} \right) \times V^T , \tag{3}$$

where, 1) ${}^{IM}S_i$ is total supply commodity, ${}^{IM}N_i^d$ is net domestic products ($= {}^{IM}N_j^d, i = j$), ${}^{IM}E_i^d$ is domestic export, and ${}^{IM}E_i^f$ is foreign export. All these are supported by IMPLAN data.

2) ${}^{IM}O_i^T = {}^{IM}S_i + {}^{a}I_i^f$,where ${}^{IM}S_i = {}^{IM}N_i^d + {}^{IM}E_i^d + {}^{IM}E_i^f$, then ${}^{IM}O_i^T = {}^{IM}N_i^d + {}^{IM}E_i^d + {}^{IM}E_i^f + {}^{a}I_i^f$. This is because foreign imports should be counted in the trade flows in U.S. domestic trade, or ${}^{IM}I_i^f$ (IMPLAN foreign imports in state i, that remains in each state) plus ${}^{c}I_i^f$ (foreign imports for state i consumed in other states), once commodities are imported. Hence, adjusted foreign imports ${}^{a}I_i^f = {}^{IM}I_i^f + {}^{c}I_i^f$, although IMPLAN data only count ${}^{IM}I_i^f$. Also, foreign imports are more compactly related to regional economic conditions than foreign exports (${}^{IM}E_i^f$). Therefore, ${}^{IM}E_i^f$ assumes no trade to other states because i) they cannot separate which amount directly goes to rest of world from each state and which amount goes outbound and then to the rest of world, and ii) economically those are only related to the transportation services sector once they are produced..

Then, IMPLAN total destination ${}^{IM}D_j^T$ can be calculated as ${}^{IM}D_j^T = {}^{IM}N_j^d + {}^{IM}I_j^d + {}^{a}I_j^f$, where ${}^{IM}N_j^d$ is the sum of net domestic products, ${}^{IM}I_j^d$ is domestic imports obtained from IMPLAN data, and adjusted foreign imports ${}^{a}I_j^f$. Then, for a specific USC sector m , unreported total destination (input) values of state j , D_j^{UT} were calibrated similarly.

$$D_j^{UT} = \left(\frac{{}^{IM}D_j^T}{\sum_j {}^{IM}D_j^T} \right) \times V^T \tag{4}$$

Then, from the estimated and original total origin/destination values, unreported trade flow values between states i and j (V_{ij}^U) can be filled in the matrix. In this computation, the cross-effects of origin and destination values are considered to estimate any unreported cell values. For instance, the cell computed from an unreported destination ($= D_{ij}^U$) can be calculated from total unreported residuals ($R_{ij^p}^U = D_j^{(U)T}$ - $\sum_{j^p} V_{ij^p}$) by multiplying the portions of total origin corresponding to unpublished cells sector V_{ij}^U as shown in equation (5-1). Similarly, cells computed from an unreported origin ($= O_{ij}^U$) are computed as in equation (5-2). However, because two matrices (D_{ij}^{U} and O_{ij}^{U}) are adjusted only based on total origin or total destination from the two equations of (5-1) and (5-2), by taking the mean value of the two in equations (5-3), one side based on estimates yields the adjusted values of each cell.

$$D_{ij}^{U} = R_{ij^p}^{U} \times \left(\frac{O_k^{(U)T}}{\sum_k O_k^{(U)T}} \right) \qquad (5\text{-}1),$$

$$O_{ij}^{U} = R_{i^p j}^{U} \times \left(\frac{D_k^{(U)T}}{\sum_k D_k^{(U)T}} \right) \qquad (5\text{-}2),$$

$$V_{ij}^{U} = \left(\frac{D_{ij}^{U} + O_{ij}^{U}}{2} \right) \qquad (5\text{-}3).$$

where, subscripts i^p and j^p indicate only published cells and hence V_{ij^p} or $V_{i^p j}$ mean only reported or 0 values of each cell in the given trade matrix. Also, subscript k of $O_k^{(U)T}$ or $D_k^{(U)T}$ indicates the corresponding cells in $O_k^{(U)T}$ or $D_k^{(U)T}$ to unreported cells V_{ij}^{U} in the given matrix, irrespective of the estimated O_k^{UT} (or D_k^{UT}) or the known O_k^{T} (or D_k^{T}).

To obtain the optimal ${}_tV_{ij}^{U}$, those equations (5.) should be iterated as shown in (6.).

$${}_tD_{ij}^{U} = {}_{t-1}R_{ij^p}^{U} \times \left(\frac{{}_{t-1}O_k^{(U)T}}{\sum\limits_k {}_{t-1}O_k^{(U)T}} \right) \qquad (6\text{-}1),$$

$${}_tO_{ij}^{U} = {}_{t-1}R_{i^p j}^{U} \times \left(\frac{{}_{t-1}D_k^{(U)T}}{\sum\limits_k {}_{t-1}D_k^{(U)T}} \right) \qquad (6\text{-}2),$$

$${}_tV_{ij}^{U} = \left(\frac{{}_tD_{ij}^{U} + {}_tO_{ij}^{U}}{2} \right) \qquad (6\text{-}3).$$

Then, the optimal value ${}_tV_{ij}^{U}$ in the t^{th} iteration was chosen as the maximum value (= MV_{ij}^{U}) in equation (7) to satisfy the following criteria:

$$MV_{ij}^{U} = MAX \sum_j \sum_i {}_tV_{ij}^{U} \qquad (7)$$

subject to 1) $\sum\limits_j \sum\limits_i {}_tV_{ij}^{U} \left(= \sum\limits_i \sum\limits_j {}_tV_{ij}^{U} \right) \le V_m^{T}$, or

$$2)\ \sum_j \sum_i {}_{t-1}V_{ij}^U \left(= \sum_j \sum_i {}_{t-1}V_{ij}^U \right) < 0.999$$

Note that the optimal value ${}_mMV_{ij}^U$ for USC sector m from this model is the closest value to V_m^T, but only considers destination attractions and origin supply power without distance decay effect.

IV-2. Two-Step Approach: Doubly-constrained Fratar Model

Fratar models are useful for estimating updated commodity trade flows, where the starting matrices include numerous estimated values for missing entries in the CFS data. However, the traditional Fratar model calibrates only off-diagonal interregional cells. In this application, new diagonal values accounting for intrastate trade flows had also to be estimated. For this, the doubly-constrained Fratar model (DFM), a new formulation that updates the diagonal values in the CFS matrix combined with the traditional Fratar model to estimate the off-diagonal values was developed. The DFM iteratively estimates all the updated CFS values simultaneously and consistently. The estimated values for each USC sector are the base values for the next iterative step of the DFM.

Define $\hat{O}_i^T$ and $\hat{D}_j^T$ as the observed or estimated values of $O_i^{(U)T}$, the total origin (output) value for state i, and $D_j^{(U)T}$, the total destination (input) values for state j, respectively. These estimates are provided by the procedure used to estimate missing values in the 1997 CFS data with the AFM. Also, define net destination ${}^{IM}ND_i$ ($= {}^{IM}N_i^d + {}^{IM}I_i^f = {}^{IM}NO_i$) as the diagonal entries in a matrix consisting of IMPLAN's net domestic products (${}^{IM}N_i^d$) plus the remaining IMPLAN foreign imports for each state i (${}^{IM}I_i^f$).

Then, IMPLAN net total originating values (outputs) in state i, ${}^{IM}NO_i^T$, are defined in equation (8.)

$${}^{IM}NO_i^T = {}^{IM}O_i^T - {}^{IM}E_i^f \tag{8-1}$$

$$= ({}^{IM}N_i^d + {}^{IM}E_i^d + {}^{IM}E_i^f + {}^{a}I_i^f) - {}^{IM}E_i^f \tag{8-2}$$

$$= ({}^{IM}N_i^d + {}^{IM}E_i^d + {}^{IM}E_i^f + {}^{IM}I_i^f + {}^{c}I_i^f) - {}^{IM}E_i^f \tag{8-3}$$

$$= {}^{IM}N_i^d + {}^{IM}E_i^d + {}^{IM}I_i^f + {}^{c}I_i^f \tag{8-4}$$

$$= {}^{IM}NO_i + {}^{IM}E_i^d + {}^{a}I_i^f \tag{8-5}$$

Similarly, IMPLAN's net total destined values (inputs) for state j, ${}^{IM}ND_j^T$, is defined as,

$${}^{IM}ND_j^T = {}^{IM}D_i^T - {}^{c}I_i^f \tag{9-1}$$

$$= ({}^{IM}N_j^d + {}^{IM}I_j^d + {}^{a}I_j^f) - {}^{c}I_i^f \quad (9\text{-}2)$$

$$= ({}^{IM}N_j^d + {}^{IM}I_j^d + {}^{IM}I_i^f + {}^{c}I_i^f) - {}^{c}I_i^f \quad (9\text{-}3)$$

$$= {}^{IM}N_j^d + {}^{IM}I_j^d + {}^{IM}I_i^f \quad (9\text{-}4)$$

Then, by excluding the corresponding diagonal outputs ${}^{IM}N_i^d$ and ${}^{IM}N_j^d$ respectively, net values (NO_i^T and ND_j^T) of ${}^{IM}NO_i^T$ and ${}^{IM}ND_j^T$ can be obtained.

$$NO_i^T = {}^{IM}NO_i^T - {}^{IM}N_i^d \quad (10\text{-}1)$$

$$= {}^{IM}E_i^d + {}^{c}I_i^f \quad (10\text{-}2)$$

$$ND_j^T = {}^{IM}ND_j^T - {}^{IM}N_j^d \quad (11\text{-}1)$$

$$= {}^{IM}I_j^d \quad (11\text{-}2)$$

Therefore, by excluding corresponding diagonal outputs ${}^{IM}N_i^d$ and ${}^{IM}N_j^d$ respectively, net values ($\hat{NO}_i^T$ and $\hat{ND}_i^T$) of $\hat{O}_i^T$ and $\hat{D}_j^T$ can be obtained.

$$\hat{NO}_i^T = \hat{O}_i^T - {}^{IM}N_i^d \quad (13),$$

$$\hat{ND}_j^T = \hat{D}_j^T - {}^{IM}N_j^d \quad (14).$$

The growth factors for origin states i and destination states j, G_i and G_j, are calculated from equations (15) and (16),

$$G_i = \frac{NO_i^T}{\hat{NO}_i^T} \quad (15),$$

$$G_j = \frac{ND_j^T}{\hat{ND}_j^T} \quad (16).$$

These growth factors are substituted into equations (15) and (16) to obtain balance factors L_i and L_j, which are used to update off-diagonal CFS entries iteratively. Let MV_{ij} be the observed and estimated cell values from AFM and ${}_1FV_{ij}$ be the starting values to estimate the 2001 CFS off-diagonal flows from state i to state j.

$$L_i = \frac{\hat{NO}_i^T}{\sum_j (MV_{ij} \times G_j)} \quad (17),$$

$$L_j = \frac{\hat{ND}_j^T}{\sum_i (MV_{ij} \times G_i)} \quad (18).$$

This is a standard application of the traditional Fratar model that relies on the calibrated factors provided by equations (15) to (18).

$${}_1FV_{ij} = MV_{ij} \times G_i \times G_j \times \left\{ \frac{(L_i + L_j)}{2} \right\} \quad \text{for all } i \neq j. \quad (19)$$

Equations (20) to (21) define DG_i and DG_j, diagonal entry growth factors for origin state i to destination state j.

$$DG_i = \frac{O_i^T}{\hat{O}_i^T} \quad (20),$$

$$DG_j = \frac{D_j^T}{\hat{D}_j^T} \quad (21)$$

Similarly, equations (22.) and (23.) define DL_i and DL_j, the diagonal entry balance factors used to update the diagonal (intrastate) entries of the CFS matrix iteratively.

$$DL_i = \frac{\hat{O}_i^T}{\sum_j (MV_{ij} \times DG_j)} \quad (22),$$

$$DL_j = \frac{\hat{D}_j^T}{\sum_i (MV_{ij} \times DG_i)} \quad (23)$$

Estimated Diagonal Values (${}_1DV_{ij}$) are calculated via equation (24), which defines a second Fratar model estimating trade flows within each state i. These results also account for new foreign imports remaining within each state.

$${}_1DV_{ij} = MV_{ij} \times DG_i \times DG_j \times \left\{ \frac{(DL_i + DL_j)}{2} \right\} \quad \text{for all } i = j. \quad (24)$$

These initial estimates of the updated diagonal values, ${}_1DV_{ii}$, the diagonal entry growth factors, DG_i and DG_j , and the diagonal entry balance factors, DL_i and DL_j , are all updated iteratively until they converge to consistent values across equations (20) to (24).

$$ {}_tDV_{ij} = {}_{t-1}DV_{ij} \times {}_{t-1}DG_i \times {}_{t-1}DG_j \times \left\{ \frac{({}_{t-1}DL_i + {}_{t-1}DL_j)}{2} \right\} \quad \text{for all } i = j . \tag{25} $$

The ${}_tDV_{ii}$ replaces ${}^{IM}NO_i$ if and only if ${}_tDV_{ii} > {}^{IM}NO_i$, and hence, the finally iterated diagonal values at t times ${}_tDV_{ii}$ replace the diagonal values ${}_{t-1}DV_{ii}$ in the CFS matrix if and only if ${}_tDV_{ii} > {}_{t-1}DV_{ii}$. Note the CFS totals for each state are reduced by the difference between the corresponding values ${}_tDV_{ii}$ and the original diagonal values ${}^{IM}NO_i$, and hence, sum of off-diagonal flows (or residuals) for the corresponding state will be decreased.

The initial estimates of the updated off-diagonal CFS flows, ${}_1FV_{ii}$, the growth factors for origin states i and destination states j , G_i and G_j , and the balance factors, L_i and L_j are all updated iteratively until they converge to consistent values across equations (15) to (18).

$$ {}_tFV_{ij} = {}_{t-1}FV_{ij} \times {}_{t-1}G_i \times {}_{t-1}G_j \times \left\{ \frac{({}_{t-1}L_i + {}_{t-1}L_j)}{2} \right\} \quad \text{for all } i \neq j . \tag{26} $$

The stopping rule to identify the optimal values of ${}_tFV_{ij}$ from equations (25) and (26) is shown in equation (27). The stopping condition is met by maximizing

$$ MAX \sum_i \sum_j {}_tFV_{ij} \tag{27} $$

subject to

$$ 0.999 < \left(\sum_i {}^{IM}NO_i^T / \sum_i \sum_j {}_tFV_{ij} \right) < 1.001, \text{ and} \tag{28-1} $$

$$ 0.999 < \left(\sum_j {}^{IM}ND_j^T / \sum_i \sum_j {}_tFV_{ij} \right) < 1.001; \text{ or, alternatively,} \tag{28-2} $$

$$ 0.999 < \sum_i \sum_j {}_{t-1}FV_{ij} / \sum_i \sum_j {}_tFV_{ij} \;) < 1.001. \tag{28-3} $$

Due to only limited information available about interstate trade in services, trade in services between states was assumed to be negligible. However, it is essential to estimate service sector trades with above non-service 29 sectors to complete trade flows between states and it might be a serious caveat that this two-step approach cannot provide a useful way to estimate the 18 service sectors.

Another approach developed in Park (2006) will address this caveat by using the geographical weighted regression (GWR) method for the service sectors.

V. Results

The 2001 trade flows between the U.S. states for 29 USC commodities are estimated according to the AFM and DFM. In Table 2 and Table 3, we suggest a summary of the estimated trade flow matrices for USC Sector 15 (Plastics and Rubber) as an example, respectively, to show AFM and DFM estimates.

Table 2. Summary of 1997 Estimated Trade Flows between U.S. States by Adjusted Flow Model for USC Sector 15, 'Plastics and Rubber' ($M.)

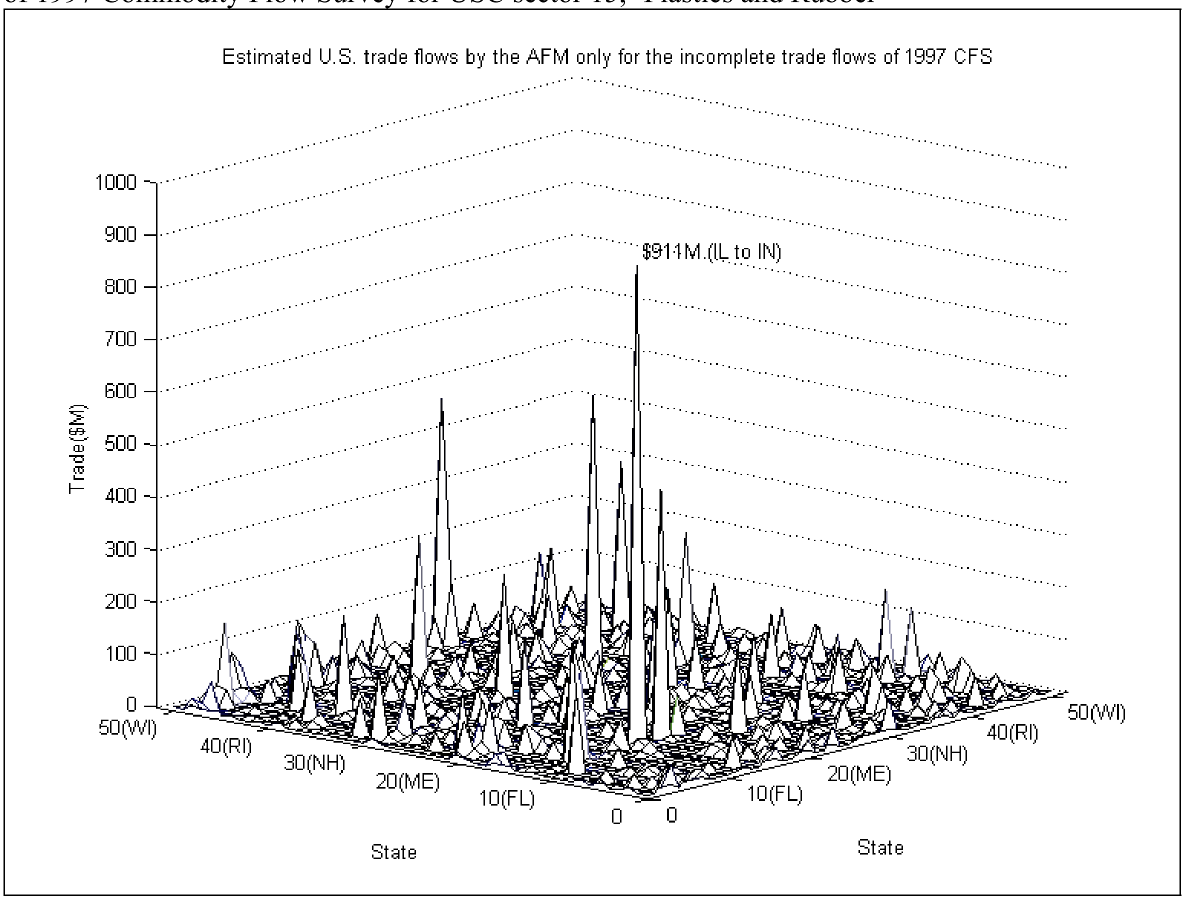
State	O^T_i	$\sum_i V_{ij}$	$(\sum_i V_{ij})/O^T_i$	D^T_j	$\sum_j V_{ij}$	$(\sum_i V_{ij})/D^T_j$
Alabama	3869	3914	1.012	3809	3826	1.005
Alaska	79	84	1.069	148	182	1.227
Arizona	1789	1908	1.067	3106	3105	1.000
Arkansas	3114	3138	1.008	3775	3601	0.954
California	19867	19953	1.004	24374	24451	1.003
Colorado	1911	1924	1.007	2632	2636	1.001
Connecticut	2768	2765	0.999	2596	2582	0.995
Delaware	791	788	0.997	1715	1574	0.918
District of Columbia	77	40	0.512	113	121	1.075
Florida	6385	6423	1.006	9291	9312	1.002
Georgia	9658	9536	0.987	11559	11621	1.005
Hawaii	188	201	1.071	320	394	1.230
Idaho	557	626	1.123	830	922	1.111
Illinois	22300	22039	0.988	16948	16968	1.001
Indiana	7732	7843	1.014	9600	9434	0.983
Iowa	4148	4175	1.006	3233	3252	1.006
Kansas	3140	3173	1.011	2687	2641	0.983
Kentucky	4436	4486	1.011	5384	5335	0.991
Louisiana	7343	7377	1.005	2803	2846	1.015
Maine	479	477	0.995	1004	1022	1.018
Maryland	2165	2248	1.039	3710	3720	1.003
Massachusetts	6765	6713	0.992	5731	5631	0.983
Michigan	9923	10005	1.008	14241	14259	1.001
Minnesota	5073	5094	1.004	5610	5700	1.016
Mississippi	2993	2862	0.956	2743	2699	0.984
Missouri	4329	4442	1.026	6054	6077	1.004
Montana	143	159	1.115	530	561	1.058
Nebraska	1231	1237	1.005	1639	1637	0.999
Nevada	554	646	1.166	1026	1124	1.095
New Hampshire	1284	1201	0.935	1312	1238	0.944
New Jersey	13705	13574	0.990	10216	10243	1.003
New Mexico	311	350	1.126	670	744	1.111
New York	10325	10376	1.005	13047	12805	0.981
North Carolina	11207	11250	1.004	9723	9788	1.007
North Dakota	216	247	1.142	626	630	1.006
Ohio	20427	20434	1.000	17050	17111	1.004
Oklahoma	2775	2779	1.001	2281	2295	1.006
Oregon	1978	2150	1.087	2752	2886	1.049
Pennsylvania	14060	13827	0.983	12099	12104	1.000
Rhode Island	953	766	0.804	1001	921	0.920
South Carolina	6012	6027	1.003	6025	6001	0.996
South Dakota	412	400	0.971	470	502	1.069
Tennessee	9947	9771	0.982	7608	7539	0.991
Texas	29313	29425	1.004	24996	25091	1.004
Utah	1014	1078	1.063	1825	1760	0.964
Vermont	377	388	1.028	703	729	1.036
Virginia	6007	5915	0.985	5812	5530	0.951
Washington	3126	3323	1.063	4507	4608	1.023
West Virginia	2582	2449	0.949	1832	1938	1.058
Wisconsin	8769	8677	0.989	6713	6752	1.006
Wyoming	155	113	0.726	352	349	0.992
TOTAL	278763	278797	1.000	278831	278797	1.000

Note: V=Value, O^T_i = Total Origin (Output) value of State i, D^T_j= Total Destination (Input) value of State j.

Values in Table 2 are rounded off to the nearest integer and only unreported values are estimated, represented as Symbol 2 or 3, without changing all of the given values shown in Appendix 3. The total estimated value for USC Sector 15 is 278,797 million dollars, showing 35 million dollars difference from 1997 CFS's, corresponding to very high levels of accuracy.

For the results of each state, the ratios, $\sum_i V_{ij} / O_i^T$ (or $\sum_j V_{ij} / D_j^T$), are near 1.00.[1] Although the AFM does not consider the effects of distance in the estimation, it is hard to say that the results violate distance effects for its estimator when comparing the estimated matrix and the raw matrix of 1997 CFS.

Figure 1. Estimated U.S. Trade Flows by the Adjusted Flow Model only for the Incomplete Trade Flows of 1997 Commodity Flow Survey for USC sector 15, 'Plastics and Rubber'



Note: Order of States follows the order shown in Table 1.

[1] There are all reported total value for destination and almost reported total value for origin except D.C. and Wyoming in Appendix 3. Since these unreported total values are adjusted first by equation (1) such as D.C. and Wyoming, the estimators by AFM show bigger different ratios than other reported values. Also, smaller total values lead to bigger different ratios from 1 between $\sum_i V_{ij}$ (or $\sum_j V_{ij}$) and O_i^T (or D_j^T).

Figure 1 shows the estimated trade flows using the Adjusted Flow Model only for the incompleted 1997 CFS trade flows, represented as Symbol 2 or 3 in Appendix 3. This summarizes the state-to-state trade flows at the 15 degree heights and the largest amount of the hide trade for the sector is $911 million from Illinois to Indiana. This figure reveals that the AFM approach provides the information of unreported trades without touching any published amounts in CFS

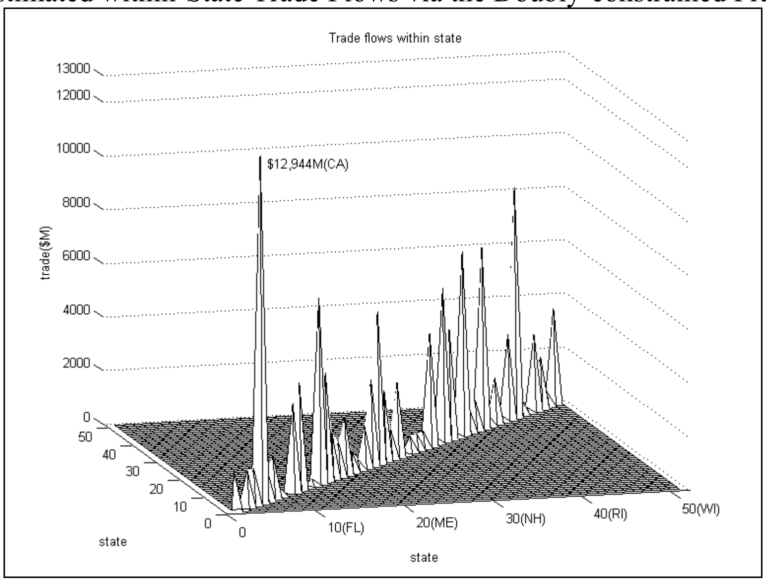
Table 3. Summary of Estimated Trade Flows between U.S. States for 2001 by Doubly-Constrained Fratar Model for USC sector 15, 'Plastics and Rubber' ($M.)

State	${}^{a}I^{f}_{i}$	$\sum_j V_{ij}$	${}^{IM}ND^{T}_{j}$	Sale_VD	${}^{IM}E^{f}_{i}$	$\sum_i V_{ij}$	${}^{IM}NO^{T}_{i}$	Sale_VO
Alabama	390	2967	2963	4662	598	3503	3500	5695
Alaska	55	300	299	494	1	83	81	118
Arizona	354	2776	2776	4347	142	1662	1662	2506
Arkansas	249	2216	2215	3424	341	2510	2510	3961
California	2432	21377	21373	33068	1778	16527	16525	25424
Colorado	382	2910	2910	4572	167	1732	1732	2638
Connecticut	298	2740	2740	4220	280	2252	2252	3518
Delaware	88	605	605	962	157	900	900	1467
District of Columbia	53	296	295	485	2	61	61	88
Florida	1148	8254	8238	13057	457	4521	4508	6914
Georgia	687	6292	6287	9694	708	5853	5847	9113
Hawaii	82	490	486	794	6	152	149	219
Idaho	109	728	728	1163	23	331	330	491
Illinois	1143	10437	10436	16084	1573	12397	12399	19403
Indiana	739	6344	6347	9837	1073	8782	8782	13687
Iowa	354	2787	2787	4362	411	2954	2954	4673
Kansas	285	2231	2230	3494	255	1999	2000	3131
Kentucky	447	3506	3505	5490	836	4498	4498	7408
Louisiana	349	2346	2343	3743	867	2788	2783	5076
Maine	105	834	834	1305	45	536	536	808
Maryland	403	3130	3130	4906	162	2034	2033	3049
Massachusetts	506	4927	4926	7546	651	4996	4996	7843
Michigan	1290	9712	9711	15280	1252	10120	10122	15796
Minnesota	478	4339	4339	6691	457	4121	4121	6359
Mississippi	204	1835	1834	2832	261	2068	2067	3234
Missouri	502	4408	4407	6820	551	4101	4100	6460
Montana	80	475	475	770	7	145	145	211
Nebraska	224	1485	1484	2373	112	1113	1112	1701
Nevada	148	1170	1171	1831	77	792	792	1206
New Hampshire	117	1046	1046	1616	150	1513	1513	2310
New Jersey	642	6317	6316	9665	792	6435	6435	10037
New Mexico	127	784	772	1265	14	421	415	605
New York	1334	10901	10899	16993	1087	7826	7825	12378
North Carolina	751	6662	6658	10295	981	7363	7358	11589
North Dakota	75	466	466	752	16	216	216	323
Ohio	1397	11142	11141	17416	2328	16044	16042	25516
Oklahoma	323	2192	2191	3492	350	2496	2497	3953
Oregon	264	2145	2145	3345	161	1452	1453	2240
Pennsylvania	950	9680	9679	14764	1652	11798	11798	18681
Rhode Island	76	709	709	1090	126	925	925	1461
South Carolina	506	3390	3375	5412	949	5463	5450	8906
South Dakota	78	545	545	864	33	334	334	509
Tennessee	625	5160	5158	8034	984	5949	5948	9629
Texas	1645	14284	14281	22125	2369	14954	14950	24059
Utah	174	1418	1418	2212	81	890	890	1349
Vermont	60	475	475	743	25	260	260	395
Virginia	563	4738	4737	7362	733	4909	4909	7836
Washington	460	3743	3744	5838	198	2333	2333	3514
West Virginia	136	1041	1040	1634	472	1758	1759	3098
Wisconsin	605	5588	5587	8601	901	7646	7647	11872
Wyoming	48	292	292	471	12	118	118	180
TOTAL	24538	204634	204546	318294	27665	204634	204571	322637

Note: Sale_VO={($\sum_i V_{ij}$ + ${}^{IM}E_i^f$)/0.72}, Sale_VD= ($\sum_j V_{ij}$ + ${}^{a}I_i^f$)/0.72}

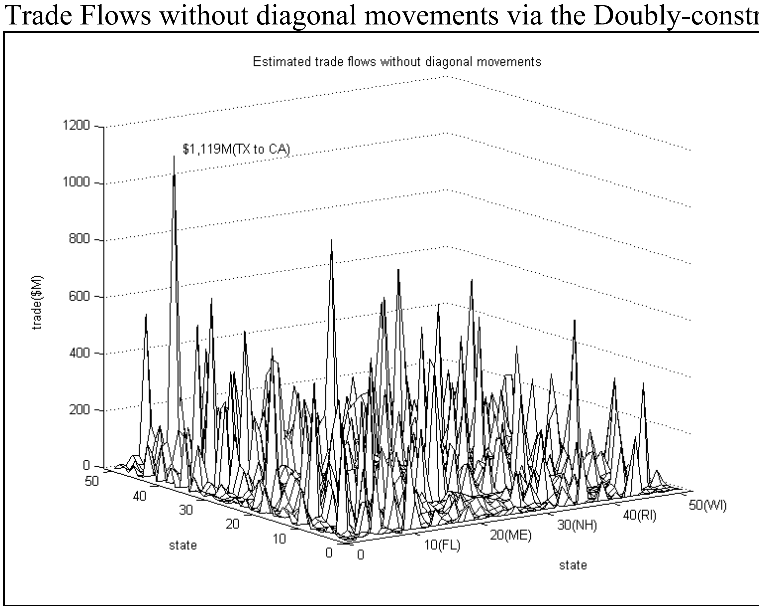
Based on the completed trade flows matrix via the AFM, the DFM was used to estimate 2001 trade flows between states. The summary of the estimation is shown in Table 3 and the state-to-state trade flows are suggested in Figure 2-1 for the trade flows within-state and Figure 2-2 for the state-to-state trade flows without the diagonal movements for the USC sector 15, ‘Plastic and Rubber’. The hightest within-state trade flows for 2001 occurrs in California, at $13 billion, while Texas accounted for the largest outbound flow to California, with $1,119 million in current dollars, among all states.

Figure 2-1. Estimated within-State Trade Flows via the Doubly-constrained Fratar Model



Note: Order of States follows the order shown in Table 1.

Figure 2-2. Estimated Trade Flows without diagonal movements via the Doubly-constrained Fratar Model



Note: Order of States follows the order shown in Table 1.

For the sake of accuracy of the estimated values, we suggest the sum of trade flow between states ($\sum_i V_{ij}$ or $\sum_j V_{ij}$) and IMPLAN total value (${}^{IM}O_i^T$ or ${}^{IM}D_j^T$) and by comparing the ratios of the two, which are very close to 1.00 for every state. Foreign exports and foreign imports are suggested as the trade flows to/from the Rest of World, although foreign imports are already included in domestic trade flows between the states.

Because the values in the trade matrix estimated by the DFM are producer values, dividing by 0.72 meaning the producer/purchaser ratio for USC Sector 15, the sales value enables comparisons with the raw CFS trade flows or the trade flows matrix via the AFM. For instance, because the estimated producer value for California-to-California shipments in 2001 is $12,944 million, about 43 percent (=100*(12,944/0.72 -12,557)/ 12,557), increasing from 1997 total origin value (=12,557 million dollars) in current dollars.

Similarly, all other values in Table 3 can be compared with those in Table 2. However, because our current estimated values of trade flows in the states with ports does not include foreign exports, the values might be overestimated if ${}^{IM}E_i^f$ is added to the diagonal value in trade flows and compared with the CFS which counts foreign exports as domestic flows. Also, Sale_VO or Sale_VD, meaning {($\sum_i V_{ij}$ + ${}^{IM}E_i^f$)/0.72} or {($\sum_j V_{ij}$ + ${}^{a}I_i^f$)/0.72} respectively, is suggested in Table 3 to compare to total values of Table 2. For instance, the sum of origin flows from California is increased by 30 percent (=100*(25,424-19,953)/19,953) in 2001 as the nominal value, while the total sum of the estimated trade flows is different by 15.7 percent from the total sum in Table 2 (=100*(322,637-278,797)/ 278,797).

VI. Conclusions

Although a large variety of IO models have been developed, the construction of multiregional IO models has remained a challenging task. In this study, we suggest how trade flows between the U.S. states can be estimated and updated using secondary data, as a basis on which to build a NIEMO-type multiregional IO model for the U.S.

We applied a two-step method, based on incomplete 1997 CFS trade flow data between states and IMPLAN regional commodity balance data. Before doing any estimating, we created several kinds of conversion tables to reconcile different data code systems. With the adjusted flow model, incomplete trade flows for 1997 CFS are filled out. Based on this trade flows matrix, including foreign imports/exports in the U.S. trade flows, we estimated the 2001 trade flows matrix, only including foreign imports using a doubly-constrained Fratar Model. Those 2001 trade flows are constructed for 29 USC commodity sectors in the final step. As an example, USC Sector 15 is highlighted in the results section, where we can verify that our model and estimations are acceptable at a reasonable level of accuracy.

However, our 2001 model based on 1997 data has some limitations. Limited data on the sources of service trade flows has restricted reporting the economic interrelationships of the services sectors between regions. The rapid increases in telecommunications, especially web-based industries, however, require us to investigate the amount of service trades between regions. Although there are some suggestions on how to estimate service trade flows, these still require strong assumptions. Therefore, in order to overcome these limitations an alternative methodology is still required.

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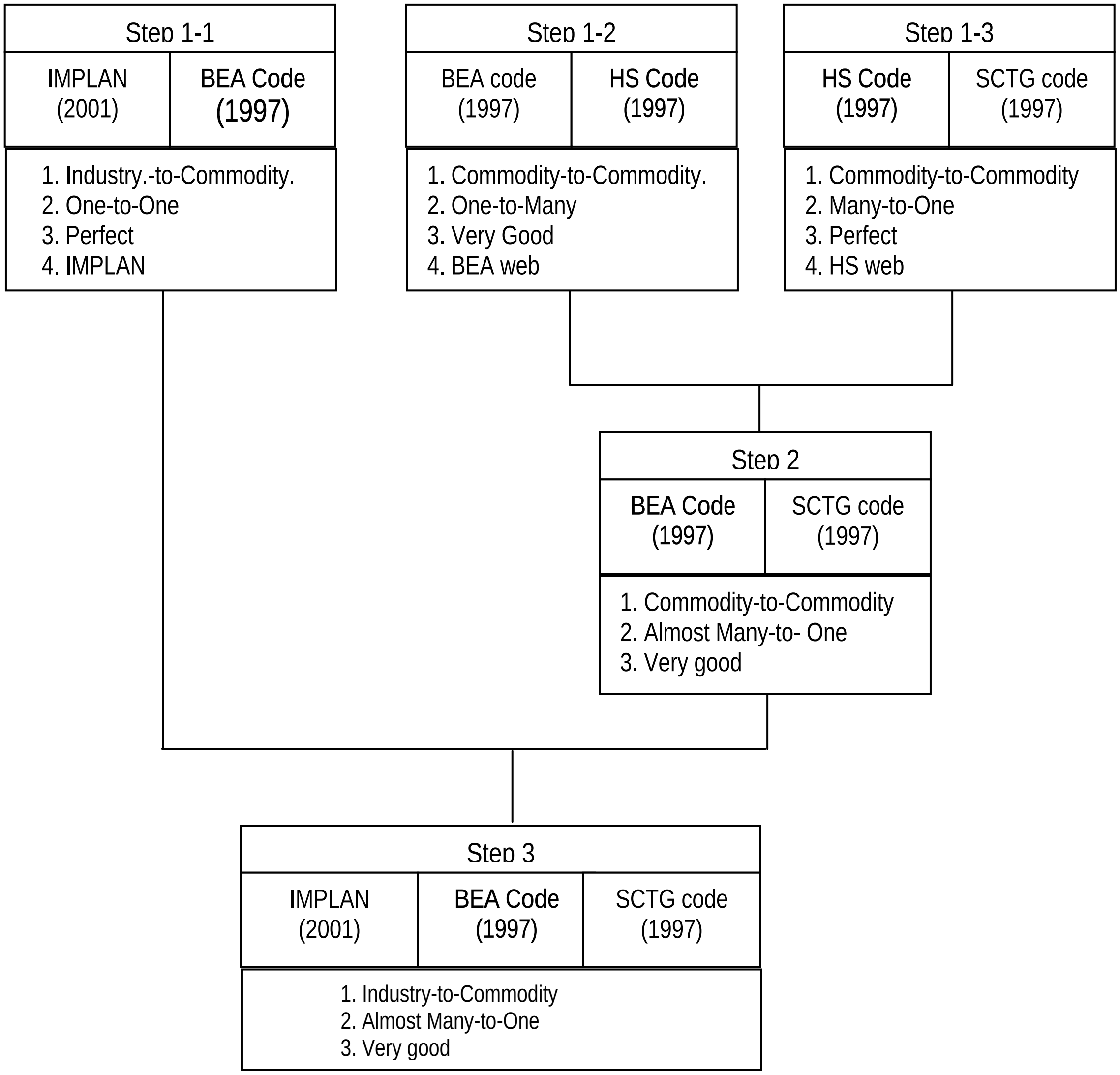
Appendices

Appendix 1. Data Reconciliation Steps, SCTG and IMPLAN



Notes:
Bold: Used as Reconciliation Code
1: Sector type
2: One = One sector, Many = Multiple Sectors
3: Quality of Reconciled Data
4: Sources and Abbreviations:
IMPLAN
BEA: Bureau of Economic Analysis (http://www.bea.doc.gov)
SCTG : Standard Classification of Transported Goods (http://www.bts.gov/cfs/sctg/welcome.htm)
HS : Harmonized System (http://www.statcan.ca/trade/htdocs/hsinfo.html)
5. Source: Park et al. (2007)

Appendix 2. Data Reconciliation and Definition of USC Sectors

The aggregation of 2001 IMPLAN sectors was in light of the fundamental characteristics of sectors: commodity sectors vs. non-commodity (service) sectors. IMPLAN's commodity sectors are based on NAICS and BEA sectors and were aggregated into 43 SCTG sectors used in the 1997 CFS, as shown in Appendix 1. Although the 43 (1997) CFS SCTG commodity sectors were based on SIC industry codes, and not the NAICS industry codes, SCTG commodity classification names in 1997 CFS and 2002 CFS remain the same. Because at the time of our work, the 2002 CFS full data sets are not available, we worked with the 1997 CFS data. To test our converted results, we compared aggregates to the currently available 2002 CFS values (Appendix 2f). After noting the reasonability of our sector aggregations at the national level, the final USC sectors and various conversion bridges were used in NIEMO construction which required the same data conversion processes at the state level.

Starting in 2001, IMPLAN adopted the NAICS industry codes, while also maintaining matches to the BEA commodity codes. Owing to its basis in the NAICS codes, the remaining IMPLAN sectors are relatively easily aggregated into 19 NAICS two-digit service sectors added to the commodity aggregations and redefined as aggregation codes in Appendix 2a, which were combined with the 19 USC service sectors.

In addition to the IMPLAN service sector aggregation, the reconciliation to the final 29 commodity USC sectors was accomplished by further manual adjustments, producer/purchaser dollar value adjustments, and minor sector (SCTG 16 and 43) corrections at the national level. Minor manual adjustments were based on judgments and using sector names. A detailed sector bridge table for IMPLAN->BEA->SCTG->USC for all commodity and service sectors is shown in Appendix 2 of Park et al (2006).

Dollar-value comparisons by aggregated sectors make it easier for data reconciliation to be confirmed. Producer/purchaser dollar value adjustments were conducted because the IMPLAN data uses producer values, while the CFS data are based on purchaser values which include transportation costs, wholesale markups, and retail markups besides the producer values. Appendix 2b shows dollar value adjustments of all the CFS data using price ratios (= producer prices/purchaser prices) at the sector-level. These were adjusted by calibrating producer/purchaser ratios aggregated to the two-digit SCTG sectors following the conversion steps shown in Appendix 1, utilizing producer and purchaser values at the BEA five-digit level from BEA NDN-0307 data at the BEA website. This step allows the estimated commodity flows in terms of producer values to be converted to flows in terms of purchaser values consistent with the CFS reports. Any estimated flows can be compared with CFS flows using these conversion ratios (the P-ratios; for SCTG 43 is assumed as equal to one due to its unavailability).

Appendix 2a. Selected IMPLAN Sector Aggregation to Two-Digit NAICS Codes

IMPLAN 2001 (509)	Aggregation Codes	Aggregation Descriptions	NAICS 2 digit codes
19	**16**	Oil Extraction	-
33-45	**53**	Construction	Construction
390	**54**	Wholesale Trade	Wholesale Trade
401-412	**57**	Retail Trade	Retail Trade
30-32	**52**	Utility	Utility
391-397	**55**	Transportation	Transportation
398-400	**56**	Warehousing	Warehousing
416,420-424	**58**	Broadcasting and information services	Part Information (Publishing, Motion pictures, and Recording (IMPLAN 413-415, 417-419) are excluded in this sector and included in Commodity Flows)
425-430	**59**	Finance and Insurance	Finance and Insurance
431-436, 509	**60**	Real estate and rental and leasing	Real estate and rental and leasing
437-450	**61**	Professional, Scientific, and Technical services	Professional, Scientific, and Technical services
451	**62**	Management of companies and enterprises	Management of companies and enterprises
452-460	**63**	Administrative support and waste management	Administrative support and waste management
461-462	**64**	Education Services	Education Services
463-470	**65**	Health Care and Social Assistances	Health Care and Social Assistances
471-478	**66**	Arts, Entertainment, and Recreation	Arts, Entertainment, and Recreation
479-481	**67**	Accommodation and Food services	Accommodation and Food services
495-499, 503-506	**68**	Public administration	Public administration
482-494	**69**	Other services (except public administration)	Other services (except public administration)
18, 27-29, 243	**69**	Support activities (18=Agriculture and forestry, 27-29=Mining) and Etc. (243=Machine shops)	-
500, 507-508	**99**	Unknown commodity	Unknown
All other IMPLAN sectors[1]	**1-15, 17-41, 43**	SCTG 1-15, 17-41, 43	-

Notes: Detail sector bridge between IMPLAN and SCTG in this Aggregation Codes is shown in Appendix 2 of Park et al. (2006)

Appendix 2b: Aggregated 1997 BEA Benchmark: Producer/Purchaser Values and Ratios

SCTG	V_PRO	P_PRO	V_PUR	P_PUR	P-Ratios (=V_PRO/V_PUR)
1	15,217	0.35%	15,346	0.27%	0.99
2	44,068	1.01%	57,901	1.01%	0.76
3	93,060	2.13%	135,909	2.37%	0.68
4	33,075	0.76%	44,105	0.77%	0.75
5	157,516	3.60%	195,765	3.41%	0.80
6	72,776	1.67%	101,044	1.76%	0.72
7	174,908	4.00%	240,070	4.18%	0.73
8	77,799	1.78%	117,648	2.05%	0.66
9	40,018	0.92%	62,357	1.09%	0.64
10	2,686	0.06%	3,914	0.07%	0.69
11	1,967	0.05%	3,181	0.06%	0.62
12	260	0.01%	395	0.01%	0.66
13	4,290	0.10%	8,313	0.14%	0.52
14	9,375	0.21%	10,019	0.17%	0.94
15	23,597	0.54%	35,128	0.61%	0.67
17	83,541	1.91%	146,500	2.55%	0.57
18	338	0.01%	593	0.01%	0.57
19	26,510	0.61%	33,865	0.59%	0.78
20	56,732	1.30%	71,607	1.25%	0.79
21	121,089	2.77%	171,889	2.99%	0.70
22	369	0.01%	427	0.01%	0.86
23	130,938	3.00%	177,939	3.10%	0.74
24	185,554	4.25%	256,787	4.47%	0.72
25	20,189	0.46%	22,050	0.38%	0.92
26	100,980	2.31%	128,085	2.23%	0.79
27	57,525	1.32%	70,262	1.22%	0.82
28	20,104	0.46%	27,944	0.49%	0.72
29	116,818	2.67%	150,008	2.61%	0.78
30	264,847	6.06%	424,046	7.39%	0.62
31	94,800	2.17%	118,661	2.07%	0.80
32	188,172	4.31%	223,302	3.89%	0.84
33	173,656	3.97%	208,604	3.63%	0.83
34	361,183	8.26%	433,471	7.55%	0.83
35	691,944	15.83%	820,069	14.28%	0.84
36	558,530	12.78%	661,763	11.53%	0.84
37	107,897	2.47%	111,758	1.95%	0.97
38	80,347	1.84%	107,100	1.87%	0.75
39	60,851	1.39%	99,511	1.73%	0.61
40	100,010	2.29%	213,248	3.71%	0.47
41	7,432	0.17%	21,146	0.37%	0.35
43	--	--	--	--	--
99	9,251	0.21%	9,251	0.16%	1.00
ALL	4,370,221	100%	5,740,983	100%	0.76

Data source: BEA NDN-0307 data (http://www.bea.gov/bea/dn2/iedguide.htm#IO)
Note: V_Pro=Producer's Value, P_Pro=Proportions of V_Pro,
V_Pur=Purchaser's Value, P_Pro=Proportions of V_Pur

Special adjustments were required for two of the SCTG sectors, CFS 'Mixed Freight' (SCTG 43), and 'Oil and Gas Extraction' (SCTG 16). The CFS Mixed Freight sector has no corresponding BEA or IMPLAN commodity sectors. Using the labels and definitions that accompany the CFS Mixed Freight sector, we assumed that the national value for SCTG 43 from the 2002 CFS preliminary version to be the same as similarly named subsectors' values of Wholesale Trade in 2002 the Economic Census. Appendix 2c shows the subsectors of the Economic Census whose names roughly correspond to SCTG Sector 43.

Appendix 2c. Sales Values Matched to SCTG 43 from 2002 Wholesale Economic Census

2002 NAICS code and Description	CFS Mixed Freight Code and Description	Sales Value($1,000)
4244. Grocery and related products merchant wholesalers	43991. Items(including food) for Grocery and Convenience stores 43992. Supplies and food for restaurant and fast food chains	616,389,515
4237. Hardware, and plumbing and heating equipment and supplies merchant wholesalers	43992. Hardware or plumbing supplies	82,578,288
42412. Stationery and office supplies merchant wholesalers	43994. Office Supplies	34,218,647
--	43999. Miscellaneous	--
Total		733,186,450

*Source: 2002 Economic Census, Industry Series Reports, Wholesale Trade from "http://www.census.gov/econ/census02/guide/INDRPT42.HTM"

Based on this definition, our adjusted subsector value of the wholesale value for 2001 IMPLAN is shown in Appendix 2d. Instead of using $733 billions shown in Appendix 2c we substituted SCTG Sector 43 for the wholesale subsector value of the 2002 Economic Census with sector value from the 2002 CFS. It was better to use 2002 CFS value as the subsector value, because the subsectors of the 2002 Economic Census wholesale still do not reflect the SCTG 43 sector entirely. Therefore, by showing that this SCTG Sector 43 is made up of subsectors of wholesale, we assume that the value of 2002 SCTG 43 can be that subsector's value of wholesale trade. In Appendix 2d, the relevant subsectors' value in the 2002 Economic Census is estimated at 19.6 percent. This was used to adjust 2001 IMPLAN Wholesale total value ($875.3 million) for the following results.

Appendix 2d. Calculation of SCTG 43 Value From 2001 IMPLAN Using Economic Census

		2002 Economic Census	2002 CFS	2001 IMPLAN
Purchaser Values	Wholesale (Sales) Value	4,376,337,051		
	Subsectors of Wholesale Trade or SCTG 43	858,320,000	858,320,000	
Adjustment Ratio**		0.2074		
Derived Producer Values	Adjusted Wholesale Value	907,457,995		875,318,813
	Adjusted Subsectors' Value of Wholesale value	177,977,459		171,674,082
Subsectors' Proportion		0.196		0.196

* Unit: $1,000
**Source: 1987-1995 average (Gross Margin/Sales price) Ratio from "Annual Benchmark Report for Wholesale Trade: January 1987 through February 1997"

Here follows a summary of the steps followed to derive the adjusted producer value of subsector of wholesale trade matched to SCTG 43: (i) adjust dollar value to producer value by the average of the 1987-1995 ratio of (gross margin)/(sales price) = 20.7percent from the "Annual Benchmark Report For Wholesale Trade" (U.S. Bureau of the Census, 1997); (ii) calculate subsectors ratio (Adjusted Wholesale Value/ Adjusted Subsectors of Wholesale Value=19.6 percent) from the derived producer values cell, and (iii) multiply the calculated ratio by the wholesale sector output value from 2001 IMPLAN (875.3 million dollars). From all these steps, we get $178 million as our estimate of CFS Sector 43 and $172 million correspondently estimated to be our estimate IMPLAN's mixed freight component of the wholesale sector.

Two of the findings in Appendix 2e and Appendix 2f show the results of aggregating the 2001 IMPLAN sectors to the 43 SCTG sectors for 1997 and 2002. In order to improve the correspondence of IMPLAN sectors to SCTG sectors, we aggregated to 29 USC sectors from the 43 SCTG sectors. During aggregation, the SCTG 'Oil and Gas Extraction' sector (#16) which was removed from CFS due to the problem of overwhelming number of shipments; we were able to include it as USC Sector 10, from IMPLAN data. Based on the all the itemized procedures, the final USC Sectors are shown in Appendix 2g.

Appendix 2e. Comparison of Aggregated 2001 IMPLAN with 1997_CFS: U.S. Total, Including SCTG16

2001_IMPLAN_SCTG			1997_CFS		BEA	Revised_1997_CFS		Ratio	
SCTG	V1*	P1**	V2	P2	P_Ratio	V5(=V2xP_Ratio)	P5	V1/V5	P1/P5
1	16,884	0.279%	6,173	0.089%	0.99	6,121	0.120%	2.758	2.398
2	39,472	0.653%	59,642	0.859%	0.76	45,393	0.893%	0.870	0.756
3	91,064	1.506%	102,344	1.474%	0.68	70,078	1.378%	1.299	1.130
4	45,911	0.759%	66,848	0.963%	0.75	50,130	0.986%	0.916	0.796
5	175,594	2.903%	183,784	2.647%	0.80	147,876	2.908%	1.187	1.032
6	86,329	1.427%	109,854	1.582%	0.72	79,122	1.556%	1.091	0.949
7	302,706	5.005%	346,379	4.988%	0.73	252,361	4.962%	1.199	1.043
8	80,602	1.333%	87,932	1.266%	0.66	58,148	1.143%	1.386	1.205
9	54,172	0.896%	56,394	0.812%	0.64	36,191	0.712%	1.497	1.301
10	2,818	0.047%	2,726	0.039%	0.69	1,871	0.037%	1.506	1.309
11	2,374	0.039%	4,279	0.062%	0.62	2,646	0.052%	0.897	0.780
12	5,191	0.086%	11,508	0.166%	0.66	7,572	0.149%	0.686	0.596
13	9,758	0.161%	11,329	0.163%	0.52	5,847	0.115%	1.669	1.451
14	11,054	0.183%	12,605	0.182%	0.94	11,794	0.232%	0.937	0.815
15	24,862	0.411%	25,486	0.367%	0.67	17,120	0.337%	1.452	1.263
16	197,809	3.271%	--	--	--	--	--	--	--
17	114,753	1.897%	217,051	3.126%	0.57	123,772	2.434%	0.927	0.806
18	114,753	1.897%	94,309	1.358%	0.57	53,779	1.057%	2.134	1.855
19	27,996	0.463%	74,900	1.079%	0.78	58,633	1.153%	0.477	0.415
20	104,099	1.721%	159,623	2.299%	0.79	126,464	2.487%	0.823	0.716
21	174,086	2.878%	224,448	3.232%	0.70	158,114	3.109%	1.101	0.957
22	22,231	0.368%	27,334	0.394%	0.86	23,606	0.464%	0.942	0.819
23	159,819	2.643%	209,487	3.017%	0.74	154,153	3.031%	1.037	0.901
24	231,896	3.834%	278,832	4.015%	0.72	201,484	3.962%	1.151	1.001
25	15,593	0.258%	15,129	0.218%	0.92	13,852	0.272%	1.126	0.979
26	106,688	1.764%	126,426	1.821%	0.79	99,672	1.960%	1.070	0.931
27	74,409	1.230%	106,578	1.535%	0.82	87,257	1.716%	0.853	0.741
28	81,685	1.351%	98,347	1.416%	0.72	70,753	1.391%	1.155	1.004
29	133,501	2.207%	260,327	3.749%	0.78	202,729	3.986%	0.659	0.573
30	292,878	4.843%	379,161	5.460%	0.62	236,813	4.656%	1.237	1.075
31	113,064	1.869%	109,197	1.573%	0.80	87,240	1.715%	1.296	1.127
32	169,411	2.801%	285,690	4.114%	0.84	240,745	4.734%	0.704	0.612
33	200,391	3.313%	227,182	3.272%	0.85	193,294	3.801%	1.037	0.901
34	433,014	7.160%	417,103	6.007%	0.83	347,545	6.833%	1.246	1.083
35	844,544	13.964%	869,675	12.524%	0.84	733,800	14.428%	1.151	1.001
36	654,570	10.823%	570,981	8.223%	0.84	481,910	9.475%	1.358	1.181
37	143,113	2.366%	129,185	1.860%	0.97	124,723	2.452%	1.147	0.998
38	160,050	2.646%	157,946	2.275%	0.75	118,491	2.330%	1.351	1.174
39	92,277	1.526%	97,255	1.401%	0.61	59,471	1.169%	1.552	1.349
40	225,430	3.727%	420,883	6.061%	0.47	197,389	3.881%	1.142	0.993
41	18,578	0.307%	32,714	0.471%	0.35	11,498	0.226%	1.616	1.405
43	171,674	2.839%	230,415	3.318%	0.20	49,947	0.982%	3.437	2.988
99	20,735	0.343%	36,524	0.526%	1.00	36,524	0.718%	0.568	0.494
ALL	6,047,838	100%	6,943,985	100%	0.77	5,085,927	100%	1.150	1

*Unit: (million$), **(Each SCTG sector value)x100/ (ALL value).

Appendix 2f. Comparison of Aggregated 2001 IMPLAN with 2002_CFS: U.S. Total, Including SCTG16

2001_IMPLAN_SCTG			**2002_CFS**		**BEA**	**Revised_2002_CFS**		**Ratio**	
SCTG	V1*	P1**	V3	P3	P_Ratio	V4(=V3xP_Ratio)	P4	V1/V4	P1/P4
1	16,884	0.279%	7,200	0.085%	0.99	7,139	0.121%	2.365	2.299
2	39,472	0.653%	55,927	0.659%	0.76	42,565	0.724%	0.927	0.902
3	91,064	1.506%	129,890	1.531%	0.68	88,939	1.513%	1.024	0.996
4	45,911	0.759%	55,251	0.651%	0.75	41,433	0.705%	1.108	1.077
5	175,594	2.903%	204,869	2.415%	0.80	164,841	2.803%	1.065	1.036
6	86,329	1.427%	119,718	1.411%	0.72	86,226	1.466%	1.001	0.973
7	302,706	5.005%	362,312	4.271%	0.73	263,970	4.489%	1.147	1.115
8	80,602	1.333%	115,772	1.365%	0.66	76,558	1.302%	1.053	1.024
9	54,172	0.896%	77,163	0.910%	0.64	49,519	0.842%	1.094	1.064
10	2,818	0.047%	2,451	0.029%	0.69	1,682	0.029%	1.675	1.629
11	2,374	0.039%	4,611	0.054%	0.62	2,851	0.048%	0.832	0.809
12	5,191	0.086%	12,643	0.149%	0.66	8,319	0.141%	0.624	0.607
13	9,758	0.161%	12,680	0.149%	0.52	6,544	0.111%	1.491	1.450
14	11,054	0.183%	15,741	0.186%	0.94	14,729	0.250%	0.751	0.730
15	24,862	0.411%	24,085	0.284%	0.67	16,179	0.275%	1.537	1.494
16	197,809	3.271%	--	--	--	--	--	--	--
17	114,753	1.897%	233,563	2.753%	0.57	133,188	2.265%	0.862	0.838
18	114,753	1.897%	109,618	1.292%	0.57	62,509	1.063%	1.836	1.785
19	27,996	0.463%	74,693	0.880%	0.78	58,471	0.994%	0.479	0.466
20	104,099	1.721%	152,069	1.792%	0.79	120,479	2.049%	0.864	0.840
21	174,086	2.878%	426,753	5.030%	0.70	300,630	5.113%	0.579	0.563
22	22,231	0.368%	34,079	0.402%	0.86	29,431	0.501%	0.755	0.734
23	159,819	2.643%	234,355	2.762%	0.74	172,452	2.933%	0.927	0.901
24	231,896	3.834%	343,386	4.048%	0.72	248,130	4.220%	0.935	0.909
25	15,593	0.258%	5,718	0.067%	0.92	5,235	0.089%	2.978	2.896
26	106,688	1.764%	140,006	1.650%	0.79	110,379	1.877%	0.967	0.940
27	74,409	1.230%	102,406	1.207%	0.82	83,842	1.426%	0.887	0.863
28	81,685	1.351%	105,890	1.248%	0.72	76,180	1.296%	1.072	1.043
29	133,501	2.207%	136,886	1.614%	0.78	106,600	1.813%	1.252	1.218
30	292,878	4.843%	506,992	5.976%	0.62	316,653	5.385%	0.925	0.899
31	113,064	1.869%	143,106	1.687%	0.80	114,330	1.944%	0.989	0.962
32	169,411	2.801%	253,678	2.990%	0.84	213,769	3.635%	0.792	0.771
33	200,391	3.313%	234,922	2.769%	0.85	199,880	3.399%	1.003	0.975
34	433,014	7.160%	509,477	6.005%	0.83	424,514	7.219%	1.020	0.992
35	844,544	13.964%	948,049	11.175%	0.84	799,929	13.604%	1.056	1.027
36	654,570	10.823%	735,730	8.672%	0.84	620,959	10.560%	1.054	1.025
37	143,113	2.366%	162,984	1.921%	0.97	157,354	2.676%	0.909	0.884
38	160,050	2.646%	222,042	2.617%	0.75	166,576	2.833%	0.961	0.934
39	92,277	1.526%	135,049	1.592%	0.61	82,582	1.404%	1.117	1.086
40	225,430	3.727%	404,683	4.770%	0.47	189,791	3.228%	1.188	1.155
41	18,578	0.307%	49,307	0.581%	0.35	17,330	0.295%	1.072	1.042
43	171,674	2.839%	858,320	10.117%	0.20	177,977	3.027%	0.965	0.938
99	20,735	0.343%	19,588	0.231%	1.00	19,588	0.333%	1.059	1.029
ALL	6,047,838	100%	8,483,662	100%	0.77	5,880,253	100%	1.028	1

*Unit: (million$), **(Each SCTG sector value)x100/ (ALL value).

Appendix 2g. Definitions of USC Two-Digit Sectors

Classification	USC	Description	SCTG	NAICS
Commodity Sectors	USC01	Live animals and live fish & Meat, fish, seafood, and their preparations	(1+5)	11,31
	USC02	Cereal grains & Other agricultural products except for Animal Feed	(2+3)	11,31
	USC03	Animal feed and products of animal origin, n.e.c.	4	11,31
	USC04	Milled grain products and preparations, and bakery products	6	31
	USC05	Other prepared foodstuffs and fats and oils	7	11,31
	USC06	Alcoholic beverages	8	31,32
	USC07	Tobacco products	9	11,31
	USC08	Nonmetallic minerals (Monumental or building stone, Natural sands, Gravel and crushed stone, n.e.c.)	(10~13)	21,32
	USC09	Metallic ores and concentrates	14	21,32
	USC10	Coal and petroleum products (Coal and Fuel oils, n.e.c.)	(15~19)	21,32
	USC11	Basic chemicals	20	32
	USC12	Pharmaceutical products	21	32,33
	USC13	Fertilizers	22	32
	USC14	Chemical products and preparations, n.e.c.	23	31,32
	USC15	Plastics and rubber	24	31,32,33
	USC16	Logs and other wood in the rough & Wood products	(25+26)	11,32
	USC17	Pulp, newsprint, paper, and paperboard & Paper or paperboard articles	(27+28)	32
	USC18	Printed products	29	32,51
	USC19	Textiles, leather, and articles of textiles or leather	30	11,31,32,33
	USC20	Nonmetallic mineral products	31	32,33
	USC21	Base metal in primary or semi-finished forms and in finished basic shapes	32	33
	USC22	Articles of base metal	33	33
	USC23	Machinery	34	32,33
	USC24	Electronic and other electrical equipment and components, and office equipment	35	32,33,51
	USC25	Motorized and other vehicles (including parts)	36	32,33
	USC26	Transportation equipment, n.e.c.	37	33
	USC27	Precision instruments and apparatus	38	33
	USC28	Furniture, mattresses and mattress supports, lamps, lighting fittings, and illuminated signs	39	33
	USC29	Miscellaneous manufactured products, Scrap, Mixed freight, and Commodity unknown	(40~99)	11,31,32,33
Non-Commodity (Service) Sectors	USC30	Utility		22
	USC31	Construction		23
	USC32	Wholesale Trade		42
	USC33	Transportation		48
	USC34	Postal and Warehousing		49
	USC35	Retail Trade		(44+45)
	USC36	Broadcasting and information services*		(515~519)
	USC37	Finance and Insurance		52
	USC38	Real estate and rental and leasing		53
	USC39	Professional, Scientific, and Technical services		54
	USC40	Management of companies and enterprises		55
	USC41	Administrative support and waste management		56
	USC42	Education Services		61
	USC43	Health Care and Social Assistances		62
	USC44	Arts, Entertainment, and Recreation		71
	USC45	Accommodation and Food services		72
	USC46	Public administration		92
	USC47	Other services except public administration**		81

*Publishing, Motion pictures, and Recording (IMPLAN 413-415, 417-419, or NAICS 511~512) are excluded in this sector and included in Commodity Sectors

**USC47 includes NAICS 81plus Support activities (18=Agriculture and Forestry, 27-29=Mining) and Etc. (243=Machine Shops) in IMPLAN

Appendix 3. Trade flows matrix between States for USC sector 15 (=SCTG sector 24) from 1997 CFS ($M.)

	AL		AK		AZ		AR		CA		CO		CT		DE		DC		FL		GA		HI		ID		IL		IN		IA		KS		KY		LA		ME	
	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S
AL	824	-	-	1	-	2	-	2	220	-	-	2	-	2	-	2	-	1	201	-	305	-	-	2	-	2	154	-	75	-	-	2	-	2	100	-	42	-	-	2
AK	-	1	77	-	-	1	-	1	-	2	-	1	-	1	-	1	-	1	-	2	-	1	-	1	-	1	-	1	-	1	-	2	-	2	-	1	-	1	-	1
AZ	-	2	-	2	1014	-	-	2	284	-	25	-	-	2	-	2	-	2	9	-	-	2	-	2	4	-	-	2	9	-	1	-	3	-	-	2	-	2	-	2
AR	27	-	-	2	-	2	785	-	140	-	21	-	-	2	-	2	-	1	108	-	162	-	-	1	-	2	115	-	128	-	20	-	-	2	80	-	63	-	-	2
CA	76	-	-	2	610	-	104	-	12557	-	228	-	92	-	7	-	-	2	297	-	148	-	66	-	80	-	416	-	206	-	52	-	53	-	66	-	38	-	-	2
CO	-	2	-	1	14	-	11	-	107	-	977	-	-	2	-	2	-	2	13	-	26	-	-	2	-	2	42	-	5	-	-	2	-	2	-	2	-	2	-	2
CT	6	-	-	2	-	2	6	-	262	-	-	2	484	-	-	2	-	2	87	-	61	-	-	2	-	1	53	-	44	-	-	2	-	2	20	-	8	-	11	-
DE	-	2	-	1	6	-	-	2	53	-	-	2	-	2	14	-	-	2	25	-	24	-	-	1	-	2	6	-	19	-	-	2	-	2	-	2	-	2	-	2
DC	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	2	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1
FL	109	-	-	2	19	-	24	-	122	-	17	-	15	-	-	2	-	2	4234	-	260	-	-	2	-	2	105	-	70	-	15	-	19	-	60	-	25	-	-	2
GA	475	-	-	2	65	-	-	2	359	-	19	-	44	-	26	-	-	2	785	-	3085	-	-	2	-	2	259	-	73	-	34	-	13	-	82	-	98	-	-	2
HI	-	1	-	1	-	1	-	1	-	2	-	1	-	1	-	1	-	1	-	2	-	1	186	-	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1
ID	-	2	-	2	-	2	-	2	44	-	-	2	-	2	-	2	-	1	-	2	-	2	-	2	242	-	-	2	-	2	-	2	-	2	-	2	-	2	-	1
IL	106	-	-	2	82	-	105	-	777	-	50	-	-	2	-	2	-	2	212	-	753	-	-	2	-	2	6895	-	-	2	427	-	201	-	-	2	61	-	-	2
IN	49	-	-	2	23	-	73	-	157	-	27	-	26	-	26	-	-	2	118	-	189	-	-	1	-	2	750	-	2129	-	118	-	71	-	336	-	19	-	26	-
IA	-	2	-	2	9	-	34	-	101	-	11	-	-	2	-	2	-	1	29	-	108	-	-	1	4	-	319	-	153	-	813	-	66	-	164	-	37	-	-	2
KS	-	2	-	1	18	-	59	-	207	-	89	-	1	-	2	-	-	2	36	-	59	-	-	1	-	2	154	-	158	-	59	-	750	-	28	-	-	2	-	2
KY	77	-	-	2	7	-	85	-	102	-	9	-	23	-	-	2	-	2	93	-	249	-	-	2	-	2	197	-	274	-	-	2	48	-	865	-	37	-	-	2
LA	254	-	-	2	15	-	350	-	241	-	12	-	-	2	-	2	-	1	114	-	134	-	-	1	-	2	333	-	173	-	162	-	22	-	286	-	1386	-	-	2
ME	-	2	-	1	-	2	-	2	27	-	-	2	9	-	-	1	-	1	-	2	-	2	-	1	-	2	29	-	-	2	-	2	-	2	-	2	-	2	135	-
MD	-	2	-	1	-	2	-	2	-	2	-	2	4	-	49	-	59	-	25	-	8	-	-	1	-	2	50	-	-	2	-	2	1	-	6	-	-	2	-	2
MA	10	-	-	2	-	2	22	-	225	-	16	-	214	-	-	2	-	2	68	-	112	-	-	2	-	2	214	-	121	-	7	-	21	-	51	-	8	-	235	-
MI	39	-	-	1	74	-	-	2	383	-	-	2	9	-	-	2	-	2	143	-	248	-	-	2	-	2	382	-	593	-	33	-	36	-	125	-	46	-	-	2
MN	9	-	-	1	36	-	11	-	269	-	75	-	18	-	-	2	-	2	56	-	49	-	-	2	-	2	326	-	179	-	167	-	29	-	-	2	-	2	-	2
MS	66	-	-	2	-	2	33	-	125	-	8	-	-	2	-	2	-	1	75	-	197	-	-	2	-	1	-	2	88	-	15	-	-	2	42	-	75	-	-	2
MO	35	-	-	2	5	-	101	-	88	-	-	2	5	-	-	2	-	2	-	2	111	-	-	2	-	2	380	-	87	-	93	-	164	-	63	-	-	2	-	2
MT	-	2	-	1	-	2	-	2	-	2	-	2	-	1	-	2	-	1	-	2	-	2	-	1	-	2	-	2	-	1	-	2	-	2	-	1	-	2	-	2
NE	6	-	-	2	5	-	-	2	37	-	-	2	-	2	-	2	-	2	25	-	11	-	-	1	10	-	76	-	-	2	95	-	16	-	52	-	-	2	-	2
NV	-	2	-	2	19	-	-	2	251	-	8	-	-	2	-	2	-	1	-	2	-	2	-	2	7	-	1	-	-	2	-	2	-	2	-	2	-	2	-	2
NH	-	2	-	1	-	2	-	2	-	2	-	1	-	2	-	2	-	1	-	2	-	2	-	2	-	1	-	2	-	2	-	2	-	2	-	2	-	2	-	2
NJ	74	-	-	2	-	2	57	-	611	-	71	-	243	-	-	2	-	2	284	-	181	-	-	2	-	2	356	-	199	-	23	-	98	-	141	-	41	-	29	-
NM	-	1	-	2	-	2	-	2	18	-	11	-	-	2	-	1	-	1	-	2	-	2	-	1	-	2	-	2	-	2	-	2	-	2	-	1	-	2	-	1
NY	49	-	-	2	-	2	36	-	617	-	15	-	248	-	31	-	-	2	136	-	112	-	3	-	-	2	272	-	192	-	15	-	5	-	38	-	17	-	-	2
NC	132	-	-	1	55	-	50	-	422	-	17	-	58	-	79	-	-	2	286	-	787	-	-	2	-	2	184	-	88	-	26	-	32	-	195	-	37	-	15	-
ND	-	2	-	1	-	2	-	2	-	2	3	-	-	2	-	1	-	1	-	2	-	2	-	1	-	2	2	-	-	2	4	-	-	2	-	2	-	2	-	2
OH	301	-	-	2	152	-	174	-	609	-	80	-	93	-	49	-	-	2	366	-	710	-	-	2	18	-	924	-	935	-	231	-	166	-	714	-	55	-	39	-
OK	12	-	-	2	28	-	45	-	241	-	34	-	6	-	-	2	-	2	70	-	150	-	-	2	-	2	155	-	82	-	-	2	58	-	13	-	10	-	-	2
OR	1	-	-	2	-	2	-	2	280	-	18	-	-	2	-	2	-	2	4	-	7	-	-	2	39	-	12	-	-	2	-	2	-	2	-	2	-	2	-	2
PA	123	-	-	2	48	-	51	-	686	-	42	-	153	-	-	2	17	-	340	-	265	-	-	2	26	-	400	-	693	-	128	-	109	-	105	-	83	-	24	-
RI	-	2	-	2	-	2	10	-	-	2	1	-	26	-	-	2	-	1	4	-	-	2	-	1	-	2	21	-	-	2	-	2	-	2	1	-	-	2	-	2
SC	126	-	-	2	31	-	23	-	115	-	-	2	30	-	90	-	-	1	99	-	446	-	-	2	-	2	192	-	48	-	5	-	-	2	114	-	-	2	56	-
SD	-	2	-	2	-	2	-	2	16	-	-	2	-	2	-	1	-	1	10	-	-	2	-	2	-	2	7	-	16	-	7	-	-	2	-	2	2	-	-	2
TN	249	-	-	2	35	-	213	-	283	-	155	-	-	2	-	2	-	1	166	-	1152	-	-	1	-	2	370	-	144	-	111	-	36	-	267	-	103	-	50	-
TX	300	-	-	2	180	-	492	-	1820	-	322	-	47	-	-	2	-	1	411	-	986	-	-	2	27	-	1292	-	659	-	214	-	262	-	278	-	282	-	-	2
UT	-	2	-	2	16	-	-	2	123	-	-	2	-	2	-	1	-	1	4	-	-	2	-	2	65	-	14	-	-	2	3	-	4	-	-	2	-	2	-	2
VM	-	2	-	2	-	2	-	2	5	-	-	2	6	-	-	2	-	1	-	2	-	2	-	2	-	2	2	-	-	2	-	2	-	2	-	2	-	2	-	2
VA	-	2	-	2	10	-	21	-	200	-	39	-	24	-	-	2	-	2	83	-	259	-	-	2	-	2	160	-	98	-	-	2	54	-	156	-	-	2	-	2
WA	-	2	34	-	28	-	-	2	330	-	7	-	-	2	-	1	-	1	-	2	17	-	6	-	87	-	43	-	-	2	-	2	15	-	-	2	-	2	-	2
WV	-	2	-	1	-	2	-	2	-	2	-	2	-	2	-	2	-	1	5	-	18	-	-	1	-	2	-	2	-	2	-	2	-	2	29	-	-	2	-	2
WI	30	-	-	2	49	-	93	-	507	-	44	-	-	2	-	2	-	2	141	-	110	-	-	2	8	-	864	-	282	-	115	-	46	-	99	-	34	-	-	2
WY	-	2	-	1	-	1	-	1	-	2	-	2	-	1	-	1	-	1	-	1	-	1	-	1	-	2	-	2	-	2	-	2	-	2	-	2	-	1	-	1
D^T_j	3809	-	148	-	3106	-	3775	-	24374	-	2632	-	2596	-	1715	-	113	-	9291	-	11559	-	320	-	830	-	16948	-	9600	-	3233	-	2687	-	5384	-	2803	-	1004	-

(Continued)

	MD		MA		MI		MN		MS		MO		MT		NE		NV		NH		NJ		NM		NY		NC		ND		OH		OK		OR		PA		RI	
	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S
AL	-	2	16	-	30	-	-	2	45	-	74	-	-	2	-	2	-	2	-	2	-	2	-	2	98	-	74	-	-	2	393	-	-	2	-	2	149	-	-	2
AK	-	1	-	1	-	2	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	2	-	1	-	1	-	1	-	1	-	2	-	1	-	1
AZ	4	-	4	-	-	2	15	-	-	2	-	2	-	2	-	2	25	-	-	2	-	2	26	-	10	-	5	-	-	2	8	-	5	-	21	-	-	2	1	-
AR	-	2	9	-	78	-	18	-	41	-	64	-	-	2	11	-	-	2	-	2	46	-	-	2	29	-	102	-	-	2	95	-	140	-	-	2	63	-	-	2
CA	40	-	86	-	163	-	128	-	67	-	129	-	30	-	49	-	247	-	-	2	265	-	32	-	322	-	303	-	-	2	312	-	58	-	395	-	200	-	-	2
CO	6	-	14	-	7	-	37	-	1	-	19	-	-	2	-	2	-	2	-	2	26	-	16	-	14	-	7	-	-	2	-	2	6	-	4	-	-	2	-	2
CT	5	-	204	-	31	-	-	2	-	2	11	-	-	2	8	-	-	2	84	-	232	-	-	2	321	-	118	-	-	2	-	2	-	2	-	2	77	-	-	2
DE	65	-	39	-	-	2	-	2	9	-	-	2	-	2	-	1	-	2	-	2	108	-	-	2	64	-	21	-	-	1	44	-	-	2	7	-	37	-	21	-
DC	-	2	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	2	-	1	-	1	-	1	-	1	-	1	-	1
FL	24	-	36	-	89	-	25	-	23	-	38	-	-	2	15	-	2	-	4	-	-	2	1	-	112	-	81	-	-	2	118	-	-	2	-	2	108	-	2	-
GA	59	-	57	-	223	-	-	2	152	-	108	-	-	2	11	-	10	-	-	2	78	-	-	2	82	-	497	-	-	2	387	-	33	-	12	-	197	-	-	2
HI	-	2	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	2	-	1	-	2	-	2	-	1	-	1	-	2	-	1	-	1	-	1
ID	-	2	-	2	-	2	-	2	-	2	-	2	7	-	-	1	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	22	-	-	2	-	1
IL	563	-	172	-	1463	-	544	-	88	-	599	-	19	-	208	-	-	2	11	-	534	-	12	-	374	-	330	-	50	-	1140	-	139	-	57	-	629	-	-	2
IN	34	-	50	-	648	-	99	-	21	-	281	-	-	2	78	-	22	-	4	-	91	-	-	2	154	-	129	-	-	2	712	-	32	-	7	-	205	-	-	2
IA	7	-	18	-	228	-	223	-	32	-	285	-	21	-	133	-	-	2	-	2	35	-	-	2	64	-	96	-	73	-	177	-	26	-	34	-	82	-	-	2
KS	-	2	7	-	82	-	48	-	-	2	241	-	-	2	81	-	-	2	-	2	70	-	4	-	-	2	31	-	-	2	75	-	58	-	13	-	82	-	-	2
KY	-	2	-	2	297	-	36	-	61	-	64	-	-	2	2	-	8	-	1	-	136	-	-	2	63	-	107	-	-	2	378	-	14	-	6	-	124	-	-	1
LA	6	-	62	-	-	2	74	-	258	-	50	-	-	2	-	2	-	2	-	2	123	-	-	2	180	-	235	-	37	-	219	-	215	-	17	-	190	-	-	2
ME	-	2	36	-	13	-	6	-	-	2	-	2	-	2	-	1	-	2	12	-	-	2	-	1	-	2	-	2	-	1	8	-	-	2	-	1	6	-	-	2
MD	798	-	66	-	35	-	-	2	-	2	11	-	-	2	-	2	-	1	-	2	98	-	-	2	160	-	-	2	-	2	41	-	-	2	-	2	199	-	-	2
MA	88	-	2080	-	116	-	68	-	28	-	50	-	-	2	-	2	-	2	-	2	338	-	-	2	610	-	192	-	-	2	263	-	9	-	13	-	191	-	161	-
MI	62	-	93	-	4766	-	106	-	18	-	270	-	-	2	20	-	-	2	20	-	89	-	-	2	74	-	130	-	3	-	818	-	26	-	-	2	172	-	2	-
MN	22	-	-	2	115	-	2019	-	-	2	157	-	9	-	107	-	5	-	-	2	83	-	6	-	64	-	-	2	57	-	43	-	-	2	-	2	75	-	-	2
MS	3	-	26	-	35	-	-	2	668	-	43	-	-	2	59	-	-	2	-	2	41	-	-	2	33	-	68	-	-	2	200	-	-	2	-	2	62	-	-	2
MO	26	-	18	-	169	-	71	-	-	2	1482	-	-	2	40	-	1	-	6	-	21	-	-	2	-	2	33	-	-	2	133	-	91	-	80	-	65	-	-	2
MT	-	2	-	2	-	2	-	2	-	2	-	2	87	-	-	2	-	1	-	2	-	2	-	2	-	2	-	2	-	2	1	-	-	1	-	2	-	2	-	1
NE	-	2	10	-	73	-	35	-	2	-	58	-	-	2	246	-	-	2	-	2	-	2	-	2	24	-	13	-	-	2	48	-	4	-	3	-	45	-	-	1
NV	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	146	-	-	2	-	2	1	-	-	2	-	2	-	2	-	2	-	2	14	-	-	2	-	2
NH	-	2	-	2	-	2	-	2	-	2	-	2	-	2	1	-	-	2	265	-	20	-	-	1	92	-	-	2	-	1	-	2	-	2	-	2	15	-	12	-
NJ	404	-	518	-	168	-	197	-	49	-	157	-	-	2	-	2	-	2	-	2	3689	-	-	2	1844	-	480	-	-	2	522	-	18	-	-	2	902	-	-	2
NM	-	2	-	2	-	2	-	2	-	2	-	1	-	2	-	2	-	2	-	1	-	2	197	-	-	2	-	2	-	1	-	2	-	1	-	2	-	2	-	2
NY	117	-	178	-	322	-	113	-	16	-	169	-	5	-	-	2	-	2	63	-	851	-	-	2	3489	-	181	-	-	2	515	-	5	-	-	2	1022	-	17	-
NC	156	-	-	2	239	-	102	-	47	-	189	-	1	-	23	-	-	2	-	2	165	-	-	2	-	2	3294	-	-	2	474	-	64	-	82	-	313	-	-	2
ND	-	2	-	2	-	2	29	-	-	2	-	2	15	-	-	2	-	2	-	1	-	2	-	2	-	2	-	2	114	-	-	2	-	2	-	2	-	2	-	1
OH	190	-	255	-	1436	-	258	-	114	-	344	-	10	-	66	-	36	-	25	-	525	-	-	2	778	-	671	-	12	-	5821	-	85	-	154	-	958	-	-	2
OK	24	-	8	-	143	-	-	2	-	2	105	-	-	2	-	2	-	2	-	2	36	-	-	2	69	-	18	-	-	2	155	-	456	-	33	-	76	-	-	2
OR	-	2	-	2	5	-	9	-	-	2	12	-	23	-	-	2	7	-	-	2	-	2	1	-	4	-	4	-	-	2	-	2	-	2	830	-	12	-	-	2
PA	391	-	289	-	434	-	138	-	80	-	144	-	-	2	34	-	-	2	62	-	985	-	6	-	881	-	372	-	13	-	760	-	47	-	57	-	3970	-	61	-
RI	5	-	-	2	-	2	1	-	-	2	3	-	-	2	-	2	-	2	13	-	51	-	-	2	-	2	-	2	-	1	21	-	-	2	-	2	34	-	-	2
SC	-	2	51	-	197	-	61	-	48	-	-	2	-	2	10	-	-	2	56	-	67	-	-	2	190	-	680	-	-	2	290	-	-	2	-	2	124	-	6	-
SD	-	2	1	-	21	-	-	2	-	1	10	-	2	-	11	-	-	2	-	2	-	2	-	2	13	-	8	-	-	2	-	2	-	2	2	-	6	-	-	2
TN	41	-	-	2	635	-	100	-	206	-	155	-	-	2	25	-	15	-	14	-	155	-	-	2	313	-	225	-	-	2	520	-	37	-	-	2	227	-	54	-
TX	91	-	183	-	790	-	201	-	280	-	405	-	69	-	122	-	138	-	53	-	503	-	207	-	382	-	628	-	-	2	987	-	456	-	166	-	674	-	51	-
UT	-	2	-	2	7	-	5	-	-	2	-	2	7	-	-	2	13	-	-	2	-	2	3	-	7	-	3	-	-	2	13	-	3	-	20	-	3	-	-	1
VM	-	2	55	-	2	-	3	-	2	-	-	2	-	2	-	1	-	2	14	-	13	-	-	1	53	-	-	2	-	1	23	-	-	2	-	2	27	-	-	2
VA	172	-	96	-	191	-	27	-	7	-	57	-	-	2	4	-	-	2	67	-	283	-	-	2	263	-	243	-	-	2	423	-	11	-	-	2	317	-	-	2
WA	-	2	10	-	6	-	-	2	6	-	-	2	-	2	7	-	10	-	-	2	16	-	-	2	14	-	10	-	-	2	40	-	-	2	294	-	25	-	-	2
WV	-	2	-	2	128	-	-	2	-	2	-	2	-	2	-	1	-	1	-	2	-	2	-	2	-	2	36	-	-	1	232	-	-	1	-	2	166	-	-	1
WI	62	-	44	-	470	-	463	-	-	2	108	-	-	2	44	-	9	-	-	2	107	-	-	2	-	2	102	-	21	-	422	-	-	2	11	-	185	-	-	2
WY	-	1	-	1	-	2	-	2	-	1	-	2	-	1	-	2	-	1	-	1	-	2	-	2	-	2	-	1	-	1	-	2	-	2	-	2	-	1	-	1
D^T_j	3710	-	5731	-	14241	-	5610	-	2743	-	6054	-	530	-	1639	-	1026	-	1312	-	10216	-	670	-	13047	-	9723	-	626	-	17050	-	2281	-	2752	-	12099	-	1001	-

(Continued)

	SC		SD		TN		TX		UT		VM		VA		WA		WV		WI		WY		O^T_i	
	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S
AL	48	-	-	2	205	-	326	-	-	2	-	2	22	-	4	-	-	2	19	-	-	2	3869	-
AK	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	2	-	1	-	1	-	1	79	-
AZ	-	2	-	2	4	-	-	2	-	2	-	2	-	2	15	-	-	2	11	-	-	2	1789	-
AR	114	-	-	2	79	-	355	-	-	2	1	-	3	-	15	-	-	2	19	-	-	2	3114	-
CA	26	-	8	-	119	-	699	-	204	-	7	-	67	-	585	-	5	-	141	-	21	-	19867	-
CO	-	2	-	2	-	2	91	-	41	-	-	2	-	2	34	-	-	1	-	2	27	-	1911	-
CT	6	-	-	2	-	2	68	-	-	2	47	-	-	2	-	2	-	2	34	-	-	2	2768	-
DE	-	2	-	1	8	-	29	-	-	1	-	2	-	2	4	-	-	2	30	-	-	1	791	-
DC	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	2
FL	59	-	-	2	59	-	191	-	-	2	-	2	32	-	21	-	4	-	23	-	-	1	6385	-
GA	444	-	-	2	434	-	407	-	31	-	-	1	108	-	24	-	-	2	179	-	-	2	9658	-
HI	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	-	1	188	-
ID	-	2	-	1	-	2	11	-	49	-	-	2	-	2	36	-	-	1	-	2	5	-	557	-
IL	67	-	42	-	319	-	1451	-	85	-	-	2	127	-	146	-	-	2	896	-	-	2	22300	-
IN	-	2	-	2	180	-	285	-	-	2	-	2	-	2	40	-	15	-	224	-	-	2	7732	-
IA	29	-	55	-	72	-	194	-	6	-	-	2	55	-	54	-	3	-	185	-	-	2	4148	-
KS	53	-	-	2	35	-	277	-	24	-	-	2	11	-	-	2	7	-	49	-	4	-	3140	-
KY	-	2	-	2	379	-	327	-	-	2	-	2	64	-	12	-	11	-	46	-	-	1	4436	-
LA	88	-	-	2	289	-	967	-	-	2	-	2	192	-	-	2	-	2	121	-	-	2	7343	-
ME	-	2	-	1	-	2	-	2	-	2	-	2	-	2	-	2	-	1	14	-	-	2	479	-
MD	10	-	-	1	-	2	32	-	-	2	-	2	148	-	3	-	-	2	-	2	-	2	2165	-
MA	-	2	-	2	146	-	291	-	8	-	123	-	85	-	34	-	-	2	85	-	-	2	6765	-
MI	37	-	-	2	208	-	335	-	9	-	-	2	68	-	-	2	5	-	135	-	-	2	9923	-
MN	7	-	61	-	45	-	146	-	-	2	-	2	22	-	35	-	-	2	242	-	-	2	5073	-
MS	16	-	-	1	143	-	176	-	1	-	-	2	32	-	16	-	-	2	-	2	-	2	2993	-
MO	44	-	7	-	132	-	305	-	10	-	-	2	-	2	35	-	-	2	55	-	-	1	4329	-
MT	-	2	-	2	-	2	-	2	-	2	-	1	-	2	-	2	-	2	-	2	16	-	143	-
NE	-	2	14	-	-	2	32	-	-	2	-	1	-	2	-	2	-	2	48	-	-	2	1231	-
NV	-	1	-	2	-	2	-	2	13	-	-	2	-	2	17	-	-	2	-	2	-	2	554	-
NH	-	2	-	2	5	-	-	2	-	2	100	-	-	2	-	2	-	2	9	-	-	1	1284	-
NJ	-	2	-	2	165	-	647	-	35	-	28	-	225	-	74	-	17	-	108	-	-	2	13705	-
NM	-	1	-	1	-	2	33	-	-	2	-	1	-	1	-	2	-	1	-	2	-	2	311	-
NY	-	2	-	2	89	-	599	-	24	-	45	-	142	-	74	-	20	-	148	-	-	2	10325	-
NC	1024	-	-	2	541	-	299	-	32	-	15	-	479	-	-	2	93	-	85	-	-	2	11207	-
ND	-	1	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	2	216	-
OH	216	-	20	-	524	-	864	-	43	-	-	2	261	-	110	-	544	-	354	-	18	-	20427	-
OK	-	2	-	2	45	-	292	-	8	-	-	2	13	-	34	-	-	2	149	-	-	2	2775	-
OR	-	2	-	2	7	-	35	-	-	2	-	2	-	2	443	-	-	2	-	2	-	2	1978	-
PA	95	-	6	-	240	-	422	-	30	-	19	-	244	-	51	-	125	-	164	-	-	2	14060	-
RI	-	2	-	2	-	2	20	-	-	2	-	2	-	2	-	2	-	1	-	2	-	1	953	-
SC	1893	-	-	2	119	-	248	-	-	2	23	-	109	-	-	2	-	2	85	-	-	2	6012	-
SD	8	-	121	-	-	2	21	-	-	2	-	1	-	2	-	2	-	2	-	2	7	-	412	-
TN	208	-	-	2	1669	-	540	-	31	-	3	-	-	2	112	-	17	-	128	-	-	2	9947	-
TX	375	-	-	2	588	-	13169	-	120	-	-	2	373	-	229	-	88	-	210	-	-	2	29313	-
UT	-	2	-	2	1	-	36	-	545	-	-	2	5	-	22	-	-	2	7	-	4	-	1014	-
VM	-	2	-	1	-	2	9	-	-	2	74	-	-	2	-	2	-	2	-	2	-	1	377	-
VA	135	-	5	-	-	2	254	-	-	2	-	2	1524	-	26	-	52	-	95	-	-	2	6007	-
WA	-	2	-	2	-	2	36	-	49	-	-	2	6	-	1749	-	-	2	-	2	-	2	3126	-
WV	-	2	-	1	23	-	-	2	-	2	-	1	60	-	97	-	485	-	19	-	-	1	2582	-
WI	46	-	-	2	199	-	267	-	33	-	-	2	129	-	86	-	-	2	2444	-	-	2	8769	-
WY	-	2	-	2	-	2	-	2	-	2	-	2	-	2	-	1	-	2	-	2	-	2	-	2
D^T_j	6025	-	470	-	7608	-	24996	-	1825	-	703	-	5812	-	4507	-	1832	-	6713	-	352	-	278832	

Note: 1. V: Value of Trade 2. S: Symbol. Both are used in CFS

Source: Bureau of Transportation Statistics and U.S. Census Bureau, 2000, *Commodity Flow Survey 1997: CD-EC97-CFS*, Washington, DC