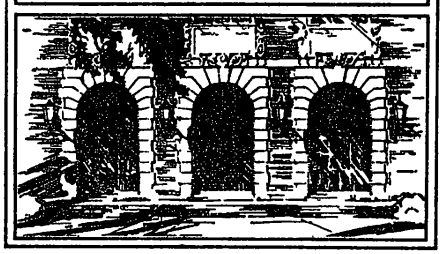
The Regional Impacts of Conversion A Multiregional Modeling Approach *

Adrian Esparza
Department of Geography
University of Illinois-Urbana

* Funding for this research was provided by the McArthur Foundation and the Program in Arms Control Disarmament and International Security University of Illinois

Abstract

Governamental perding in the United States i marked by shif s that tend to favor either defense or non-defense programs Evaluating the impacts of spending changes is vitally important since government expenditures significantly influence regional economic growth and decline Using a 24 sector 20 region multiregional input-output model of the United States this paper identifie the regional interregional and ectoral impacts of a reduction in defense spending and an accompanying increase in non-defense pending



INTRODUCTION

Federal expenditures often reflect political ideologies that tend to favor either defense or non-defense programs the guns versus butter issue The changing tide of political dominance and spending policies are extremely important for regional scientists since federal spending induces differential economic activity across space [3] [9] [10] [18] In particular it is likely that the geographical patterns of industrial activity induced by defense and non-defense spending respectively will differ Therefore as the focus of governmental spending shifts regional economic activity will be differentially affected contributing to economic growth or decline

In view of the relationship between federal spending and regional economic activity this paper examines the impact of changes in governmental expenditures Specifically a multiregional input-output (MRIO) model is used to simulate the regional economic impacts of a reduction in defense spending and an accompanying increase in non-defense spending The MRIO model specifies 24 industrial sectors and 20 regions of the United States

The paper is divided into four sections The first section discusses the dimensions of federal spending and identifies patterns of defense and non-defense pending over time The data and modelling methodology are discussed in the second section and the results of the simulation are presented in the third section

The paper concludes with a summary of the results and discussion of implications for policy makers and planners

FEDERAL SPENDING IN PERSPECTIVE

Examination of government spending patterns indicates that the amount and distribution of expenditures has changed markedly over time As Table 1 illustrates since the conclusion of the Viet Nam conflict the federal government has continually increased spending and by 1983 accounted for over 25 percent of total GNP Since 1983 the percentage of GNP claimed by the federal government has declined but the absolute amount of spending has continued to increase

Columns 2 and 3 of Table 1 show defense and non-defense spending as a percent of GNP The trend in spending generally suggests that the two are inversely related with defens spending declining as the Viet Nam conflict drew to a close while non-defense spending increased After 1978 however the pattern reverses with defense spending continuing to increa e through 1985 as non-defense spending is reduced This relationship is reinforced by the trends seen in Table 2 where defense and non-defense spending are shown as a percent of total federal outlays

Although Tables 1 and 2 indicate a move towards increased defense spending no information is offered concerning the allocation of funds for specfic defense programs It is therefor necces ary to examine defense spending more closely since the

distribution of funds determines which industrial activities are likely to be most affected

Current defense policies favor the innovation and development of advanced technological weapon systems such as the Strategic Defense Initiative (SDI) As of 1984 approximately 50 percent of all prime defense contracts involved research and development [10] The move towards increased technological innovation is illustrated in Figure 1 During the period 1972-1985 investment in conventional forces declined approximately 14 percent while expenditures on research and development testing and evaluation and weapons procurement increased 12 percent These trends are quite significant since the Department of Defense relies on private industry to provide technological innovation and production of new weapon systems

Two primary effects will result from current Defense Department polices First the acceleration of technological development will significantly impact regional labor markets Most notably the demand for skilled workers will increase while the demand for unskilled labor will diminish As a result the labor force will experience increased segmentation Technological innovation accentuates the problems of structural unemployment by placing greater emphasis on problem solving jobs (engineers scientists and the like) while unskilled jobs are de-emphasized [12] This process impedes the transferability of work skills between employment sector (skilled and unskilled) and results in high national unemployment while sustaining a high demand for skilled workers [8] The implications of the shift towards

increased technology and the accompanying demand for killed workers becomes more important when it is noted that the Department of Defense supports over 33 percent of all research and development in the public and private sectors and employs nearly 40 percent of the nation s scientists and engineers [1]

Secondly increased defense spending will accelerate regional economic growth as defense dollars circulate through the economy Higher incomes result in increased consumption of commodities produced in the non-defense sector Increased consumption of non-defense commodities induces multi-firm organizations to locate branch plants in areas of high potential profitability Additional profits are obtained through extension of the product s life cycle and expansion of market share [4] [17] For example during the period 1967-1975 39 percent of the 551 new plants established in the Dallas-Ft Worth Texas area were branch plants operated by multiplant organizations [16] The growth of the defense sector also induces defense sub-contractors to expand operations This is critically important since primary defense contracts rely heavily on subcontractors [5] [10]

In the long run however past trends suggest that the process of rapid growth will likely be followed by accelerated decline as once again the political focus and spending policies change Figure 2 displays defense spending over the last 25 years for California and Texas These states have maintained a strong link to defense spending over time

This brief review of current and past governmental spending clearly indicate the importance of identifying the patial

patterns of defense and non-defense related industrial consumption and production. Equally important since spending policies have a tendency to favor either defense or non-defense spending over time, it is necessary to see how shifts from defense to non-defense spending will affect the regional and interregional production and consumption of industrial goods. The modelling methods described in the next section provide this type of analysis.

DATA AND METHODOLOGY

Implementation of the MRIO model requires three sets of data: inter-industry transactions tables for each region, a set of trade flow tables that show sales of industry i in region r to region s, and final demand estimates for each region. All data for the MRIO model were obtained from the Department of Health and Human Resources. Data were assembled for 1977 by Jack Faucett Associates under contract to the government.

Since a complete description of the MRIO model used for the analysis is available elsewhere [2], [11], [14], [15], the methodology will only be briefly outlined. Two sets of matrices are required in the MRIO model. First, a set of inter-industry coefficient matrices, one for each region must be constructed. This procedure is identical to that of a single region model, with current accounts of sales and purchases to and from each industry, estimates of value added, and final demand incorporated into each matrix (see [6], [7] for a comprehensive review of input-output

accounting systems) The 24 industrial sector used for the input-output tables are listed in Table 3 and the 20 regions are listed in Table 4 To implement the 20 region model each coefficient matrix is placed into a diagonal block matrix A with the regional matrices forming the principal diagonal All off diagonal elements are set to zero resulting in a 480x480 matrix

Secondly a set of trade flow table indicating the shipments of each commodity i from region r to region s are required Thus 24 tables each with dimensions 20x20 must be constructed It is necessary to note that consistency between the input-output tables and the trade-flow tables is required to insure that purchases and sales throughout the system are balanced [15] Trade flows are converted to coefficients for each industry Each element of a trade flow coefficient matrix is calculated by $_{rs}c_i = {}_{rs}x_i / {}_{s}x_i$ The coefficient $_{rs}c_i$ represents the amount of commodity i shipped from region r to region s as a proportion of total consumption of industry i in region s Hence $_{rs}x_i$ is the flow of commodity i from region r to region s and $_{s}x_i$ is total consumption of commodity i in region s

The trade flow coefficient matrices must also be rearranged into a diagonal block matrix C Each diagonal in the block matrix represents the proportion of commodity i consumed in region s shipped from region r Thus the principle diagonal of the 480x480 matrix represents the intraregional transfer of goods for the each region All off-diagonal elements of the C matrix are zero

Final demand sectors represent terminal purchases by non-industrial sectors. In this case two final demand sectors are used: defense and non-defense. Final demand values were obtained for each industry in all 20 regions.

Two sets of results are produced by the MRIO model. The first set consists of estimates of industrial output for each region. The following equation provides these estimates:

$$(1) \quad X = (C^{-1} - A)^{-1}Y$$

where X = a (480x1) column vector of output for each industry i in each region

C = a (480x480) diagonal block matrix of trade flow coefficients

A = a (480x480) block diagonal matrix of regional technical coefficients

Y = a (480x1) column vector of final demand

Inversion of the C and MRIO matrix $(C^{-1} - A)^{-1}$ used the partitioned bordering inversion method [13].

A set of interregional trade flows is the second set of outputs from the MRIO model. These results indicate the interregional interaction occuring in response to defense and alternatively to non-defense final demand. The following equations are used to estimate the interregional trade flows:

(2) $D = A \text{ cm } X^t$

(3) $D^* = \Sigma_j d_{ij}$

(4) $G = D^* + Y$

(5) $T = C \text{ cm } G^t$

where D = intermediate industry demand for all regions and has dimensions (480x480)

X^t = transpose of the output column vector (1x480)

cm = column multiplication

D^* = row summation of intermediate demand (480x1)

G = column vector of total consumption (480x1)

G^t = transpose of total consumption vector (1X480)

T = matrix of trade flows (480x480)

The simulation begins by calculating the regional outputs and interregional trade flows for defense and non-defense spending respectively. Next defense related regional output and interregional trade flows are reduced 20 percent. Regional output and interregional trade for the non-defense sector are increased by a corresponding 32 percent. This insures that the absolute dollar amount of the conversion is held constant. Although it is unlikely that reductions and increase would be equal for all industries and regions it is impossible to determine the composition of new expenditures especially since ultimate changes are decided along political lines. Thus an across the board cut was chosen.

To complete the simulation corresponding increases and decreases for regional outputs and interregional flows are summed

and a new set of values indicating the net results of conversion are obtained

INTERPRETATION OF RESULTS

To obtain an overall assessment of the effects of conversion industrial activity has been aggregated into total regional purchases and sales (or production and consumption) These value are listed in Table 5 The final column indicates the net effects of conversion Overall California most southern state and the mid-west would benefit from a shift towards non-defense spending With the exception of New Jersey all state in the mid-Atlantic and New England would experience differential changes (increases or decreases in sales or purchases) or total declines

Industrial production before and after conversion is shown in Table 6 Production of each industrial good summed across all regions for defense and non-defense sectors is shown in columns one and two The results of conversion for each industry as well as the percentage change in total production (the sum of defense non-defense and the net change in production) are listed in columns three and four

Primary industries such as agriculture and mining would benefit from conversion while the majority of manufacturing industries would experience declines As expected production in industries directly related to defense such a aircraft and parts ordnance and aircraft propellents would be severely

reduced In contrast missiles and parts show a significant increase in activity This results from accounting procedure of the government where space exploration is considered a non-defense program It is important to note that in 1977 when the data were collected the space program was deeply involved in development of new technology Finally regional governments and services would likely benefit from conversion

The information presented thus far has shown aggregate effects of conversion for regions and industries These results however do not link regional and industrial activity over space Regional trade flows provide this information Three states California Illinois and New York will be used to demonstrate how regions are spatially linked through the production and consumption of industrial goods These states were selected since California and New York are primary recipient of defense contracts (among the top five states receiving defense contracts) and with the inclusion of Illinois represent different regions of the United States

Figures 3-8 present significant production and consumption linkages for each state as well as those linkages experiencing the strongest effects (positive and negative) from conversion Significant links were defined by flows that fall within specific standard deviation intervals In all cases calculation of standard deviations excluded intraregional flows

As expected interregional sales and purchases are most often regionally confined This is particularly true for New York (Figures 3 and 4) where with the exception of California Il

interaction is found along the east coast. Although conversion affects New York's linkages along the east coast, interaction with California would not be significantly altered.

In comparison, Illinois (Figures 5 and 6) operates in a much wider industrial activity space with significant interaction in both sales and purchases throughout mid-western and north-central region. It is important to note that interregional trade patterns vary considerably for defense and non-defense sectors. This is especially apparent when examining the effects of conversion.

California also displays striking differences between defense and non-defense trade flows (Figure 7 and 8). Although industrial activity is primarily confined to the west and south, interaction with mid-western and mid-Atlantic regions is also apparent. The impacts of conversion are most strongly noted in the west and south, where sales decline dramatically. Purchases from the south would increase, while decreases with the mid-Atlantic would likely occur.

Lastly, it is also important to evaluate trade patterns for specific industries. Three industries, iron and steel forging, electrical equipment, and engines and turbines, are used to demonstrate how production and consumption are linked over space. Significant flows were identified by establishing standard deviation intervals, and as above, intraregional flows were excluded. The affects of conversion are represented by identifying those interregional linkages experiencing the greatest percentage change (positive and negative) in total production of

each industry where total production includes defense and non-defense related activity and the net change in production

Figure 9 shows the pattern of flow for the iron and steel forging industry. Although the mid Atlantic and mid-west clearly dominate production spatial trade linkages vary markedly between defense and non-defense sales destination. The effects of conversion are widely dispersed throughout north-central and mid-Atlantic region.

The spatial distribution of the electrical equipment industry is presented in Figure 10. Flow for defense and non-defense are notably different with each showing strong regional concentration of sales and purchases. Significant changes resulting from conversion fall primarily on central regions and Texas.

The Engines and Turbines industry (Figure 11) also displays important differences between defense and non-defense related production and consumption. Consumption varies the most with defense related purchases occurring mostly in the mid-Atlantic region and non-defense purchases occurring in the west south and other sectors of the east coast. Conversion results in significant declines in sales from mid-western and southern regions to mid-Atlantic and New England regions.

CONCLUDING DISCUSSION

From the simulation presented in this paper it is evident that conversion would bring both growth and decline to regional economies. The process of growth would benefit southern and mid-western regions, while other regions would experience decline of varying degree.

Interregional trade can reinforce or counteract the process of regional differentiation. For example, as Figures 7 and 8 illustrate, California has strong trade linkages (purchases and sales) with western, southern, and mid-western regions. Converting to non-defense spending would reduce sales to western regions, but increase purchases from the south, reinforcing variant patterns of regional growth.

The spatial shift of industrial activity suggests that non-defense industries, as well as migration, would be strongly influenced. As noted previously, increases in defense spending induce expansion in non-defense industries due to the circulation of incomes throughout the economy. The simulation determines that primary industries, some manufacturing and service sectors would benefit from conversion. Expanded employment opportunities in defense and non-defense sectors would motivate migration to growth areas. Due to the increasing reliance on technology in defense related industries, migration will likely be selective.

In contrast, in areas negatively impacted by conversion, a process of economic decline or contraction is likely. As a result, out-migration would occur as other regions experience

benefits from conversion Out-migration will be elective since highly skilled workers can transfer job skills with less difficulty

However it is necessary to consider two limitations of the research First the system of regional and interregional industrial activity is extremely complex and the results presented only represent a small portion of the possible outcomes Relating 24 industries across 20 regions provides an extensive view of activity spaces The use of standard deviations to identify significant flows excludes other flows that may be meaningful especially for regional specific analysis Additionally regional and industrial aggregation often obscure important linkages and may contribute to improper assessments In this respect the information presented in this study only serves to indicate general trends although special consideration was given to regions and industries most directly related to defense programs

Secondly the method of input-output analysis used in this study is insensitive to the temporal dimension in which industrial activity occurs Although the simulation indicates likely changes in regional and industrial activity it is clear that these adjustments are not instantaneous

From this discussion it should be apparent that analyzing shifts in governmental spending only provides a partial view of the overall impacts of conversion where initial shifts in spending activate the complex process of regional economic growth and decline Although th discussion of these processes has been

primarily conceptual several areas of additional research have been suggested In this respect the research presented will hopefully assist policy makers and regional planners in understanding the impacts of governmental spending while offering regional scientists additional opportunities for research

REFERENCES

1 Adam G 1981 The Iron Triangle New York Council of Economic Priorities

2 Blair P and Miller R 1983 Spatial Aggregation in Multi-regional Input-Output Models Environment and Planning 15 187-206

3 Bolton R 1980 Impact of Defense Spending on Urban Areas in The Urban Impacts of Federal Policies ed Norman Glickman Baltimore The Johns Hopkins University Press pp 151-174

4 Erickson R 1981 Corporations Branch Plants and Employment Stability in Nonmetropolitan Areas in Industrial Location and Regional Systems eds John Rees Geoffrey J D Hewings and Howards Stafford New York J F Bergin Publishers Inc pp 135-153

5 Gansler J 1980 The Defense Industry Cambridge Mass The MIT Press

6 Hewings G J D 1977 Regional Industrial Analysis and Development London Methuen Ltd

7 Hewings G J D 1985 Regional Input-Output Analysis Beverly Hills Sage Publications

8 Hill C 1979 Technical Innovation Agent of Growth and Change in Technical Innovation for a Dynamic Economy eds Christopher Hill and James Utterback New York Pergamon Press

9 Leontief W 1966 Input-Output Economics New York Oxford University Press

10 Malecki E 1984 Military Spending and the U S Defense Industry Regional Patterns of Military Contracts and Subcontracts Environment and Planning C Government and Policy 2 31-44

11 Miller R and Blair P 1983 Estimating State-level Input-Output Relationships from U S Multiregional Data International Regional Science Review 8 233-254

12 Piore M 1976 Labor s Role in Technical Change in Technical Innovation and Economic Development National Technical Information Service conf-760491

13 Polenske K 1970 A Multiregional Input-Output Model for the United States Washington D C U S Department of

Commerce

14 Polenske K Anderson C Shirely M 1972 A Guide for User of the U S Multiregional Input-Output Model DOT Report No 2 for Office of Systems Analysis and Information U S Department of Transportation

15 Polenske K 1980 The U S Multiregional Input-Output Accounts and Model Lexington Mass D C Heath and Company

16 Rees J 1978 Manufacturing Change Internal Control and Government Spending in a Growth Region of the U S A in Industrial Change ed F Hamilton London Longman Group Limited

17 Van Duijn J 1983 The Long Wave in Economic Life London George Allen & Unwin

18 Weidenbaum M 1966 Shifting the Composition of Government Spending Implications for the Regional Distribution of Income Papers of the Regional Science Association 17 163-178

Table 1

Federal Spending and Gross National Product

Year	Federal Spending as % of GNP	Defense Spending as % of GNP	Non-Defense Spending as % of GNP
1970	20.5	8.0	12.5
1971	20.4	7.5	13.0
1972	20.4	6.7	13.8
1973	19.6	5.8	13.8
1974	19.9	5.6	14.3
1975	22.3	5.7	16.7
1976	21.7	5.4	16.4
1977	21.0	5.1	16.8
1978	19.9	4.9	17.0
1979	19.4	4.9	16.5
1980	21.0	5.2	17.8
1981	23.5	5.4	18.1
1982	24.1	6.0	18.1
1983	23.1	6.4	16.7
1984	21.3	6.2	17.6
1985	21.5	6.4	18.4

(Source: Secretary of Defense Report to Congress, 1986)

Table 2

Defense and Non-Defense Expenditures

Year	Defense spending as % of Federal Expenditure	Non-Defense spending as % of Federal Expenditure
1970	39.4	60.6
1971	35.4	64.6
1972	32.6	67.4
1973	29.8	70.2
1974	29.0	71.0
1975	25.9	74.1
1976	23.7	76.4
1977	23.4	76.6
1978	23.0	77.0
1979	22.8	77.2
1980	22.7	77.3
1981	23.0	77.0
1982	24.7	75.3
1983	25.4	74.6
1984	25.9	74.1
1985	25.7	74.3

(Source: Secretary of Defense Report to Congress 1986)

Table 3
Regional Categories

Region	State
1	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island
2	Connecticut
3	New York
4	New Jersey
5	Pennsylvania, Ohio
6	Indiana
7	Michigan
8	Illinois
9	Delaware, Maryland, Washington D.C., Virginia, West Virginia
10	North Carolina, South Carolina, Georgia, Florida
11	Kentucky, Tennessee, Alabama, Mississippi
12	Arkansas, Louisiana, Oklahoma
13	Missouri
14	Wisconsin, Minnesota, North Dakota, South Dakota
15	Iowa, Nebraska, Kansas
16	Texas
17	Colorado, New Mexico, Arizona, Utah
18	Montana, Idaho, Wyoming, Nevada, Oregon
19	Washington
20	California

Table 4

Industrial Categories

Input Output Sector	Industry
1	Agriculture
	Mining
3	Construction
4	Manufacturing: Non Durable
	Electric Synchronic
6	Manufacturing: Durable
7	Iron and Steel Forging
8	Iron and Steel Foundries
9	Primary Non Ferrous Metal
10	Fabricated Metal Products
11	General Machine Products
12	Engines and Turbines
13	Ordnance
14	Metalworking Equipment
15	Office and Computing Equipment
16	Electrical Equipment
17	Electrical Components
18	Aircraft and Parts
19	Motor and Parts
20	Aircraft Motor Propulsion
21	Transportation Communication
	and Public Utilities
22	Retail Trade
23	Service
24	Regional Government

Table 5

Aggregate Regional Purchases and Sales

(million of $)

	Defense		Non-Defense		After Conversion	
Region	Purchases	Sales	Purchases	Sales	Purchases	Sales
1	13 [illegible]	7318 80	1140 79	1180 10	[illegible] 3 77	1132 66
	1735 70	241 31	421 56	423 18	11 02	450 13
3	4446 92	5132 4	2784 76	2792 07	2 4	121 93
4	1118 02	1640 63	1292 77	1170 09	126 13	10 02
	7766 42	10 04 03	5021 33	5267 42	62 2	329 14
6	670 53	327 85	1063 70	1141 37	132 7	424 96
7	797 53	4406 4	1513 42	1733 52	101 74	60 22
8	2427 70	3203 66	2341 26	2447 25	57 83	10 28
	3241 86	4761 63	3702 73	3301 89	454 7	11 94
10	749 30	3211 23	3929 70	3764 44	741 22	433 58
11	161 52	667 07	3494 17	3 2 3 94	1 4 1	70 82
12	2939 60	3250 71	2026 00	2 253 52	31 54	26 57
13	59 36	2309 20	1069 3	1032 29	172 53	2 3 18
14	38 41 0	3211 36	2222 21	3079 14	151 53	21 86
15	3333 75	2946	2552 74	2630 0	113 31	130 63
16	5509 64	4509 7	2968 07	3507 31	37 3	34 53
17	6962 32	079 11	3383 30	2736 70	100 95	53 21
18	5953 58	3497 21	2984 31	2040 35	453 07	39 10
19	4775 45	4318 6	1779 15	1683 83	393 93	320 45
20	4346 05	7841 62	8977 09	9015 66	2029 06	1340 01

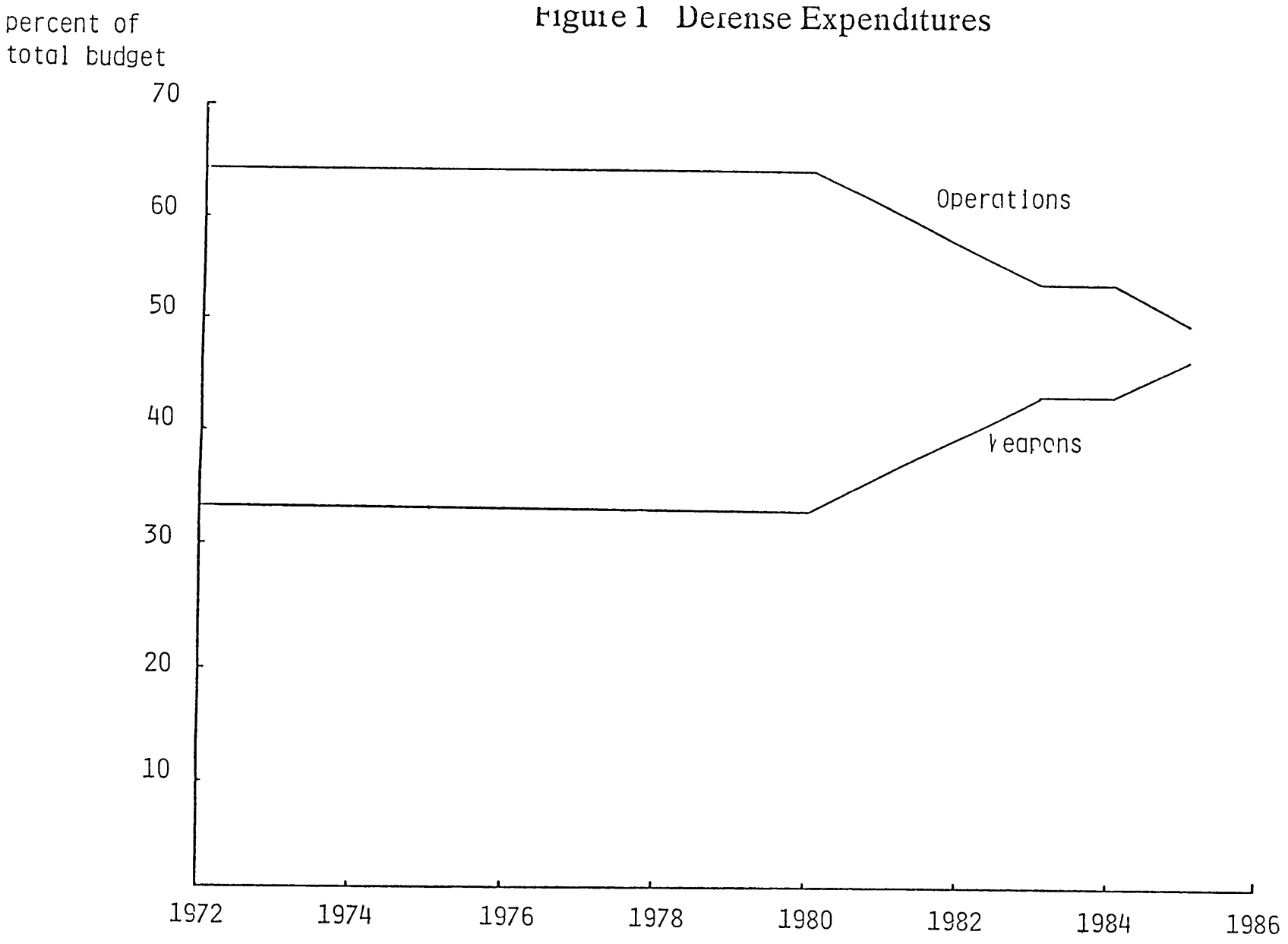
Table 6

Aggregate Industrial Production

(million of)

Industry	Durable	Non-durable	Petroleum Products	% Change in Production
1	1,230.0	6,01.2	1707.1	17.80
	311.3	2,324.3	133.1	3.9
3	401.1	3,32.7	20.6	8.34
4	9,33.6	9433.1	1161.4	3.7
5	34.1	2006.7	103.1	4.03
6	3,31.2	3,260.8	3130.6	11.3
7	4,10.7	10,37.6	427.4	10.43
8	600.7	4,39.4	27.3	2.16
9	3,234.3	893.3	443.3	10.93
10	429.6	3,13.3	73.6	1.41
11	1,131.0	3,09.2	131.3	10.13
12	428.0	200.0	70.3	3.2
13	1,23.1	3.1	143.4	2.17
14	120.0	83.7	70.7	14.06
15	1,19.2	13,3.4	133.7	1.13
16	1037.6	3,16.7	3,0.8	3.27
17	1,73,.7	364.3	2.8.7	12.22
18	6,334.9	33.7	1336.2	24.61
19	879.8	2,966.1	972.9	17.32
20	41,38.0	2,3.0	834.0	4.3
21	6049.1	3431.3	101.4	1.03
22	1,3.7.1	698.9	37.7	1.2
23	9,299.6	10663.7	1,27.2	7.3
24	91.3	628.7	143.7	13.31

Figure 1 Defense Expenditures



Operations= personnel, retirement pay, operations and maintanence

Weapons= research-development-testing and evaluation, procurement

Source Modified from Secretary of Defense report to Congress, 1985, p 279

Figure 2 Primary Defense Contracts
(millions of dollars)

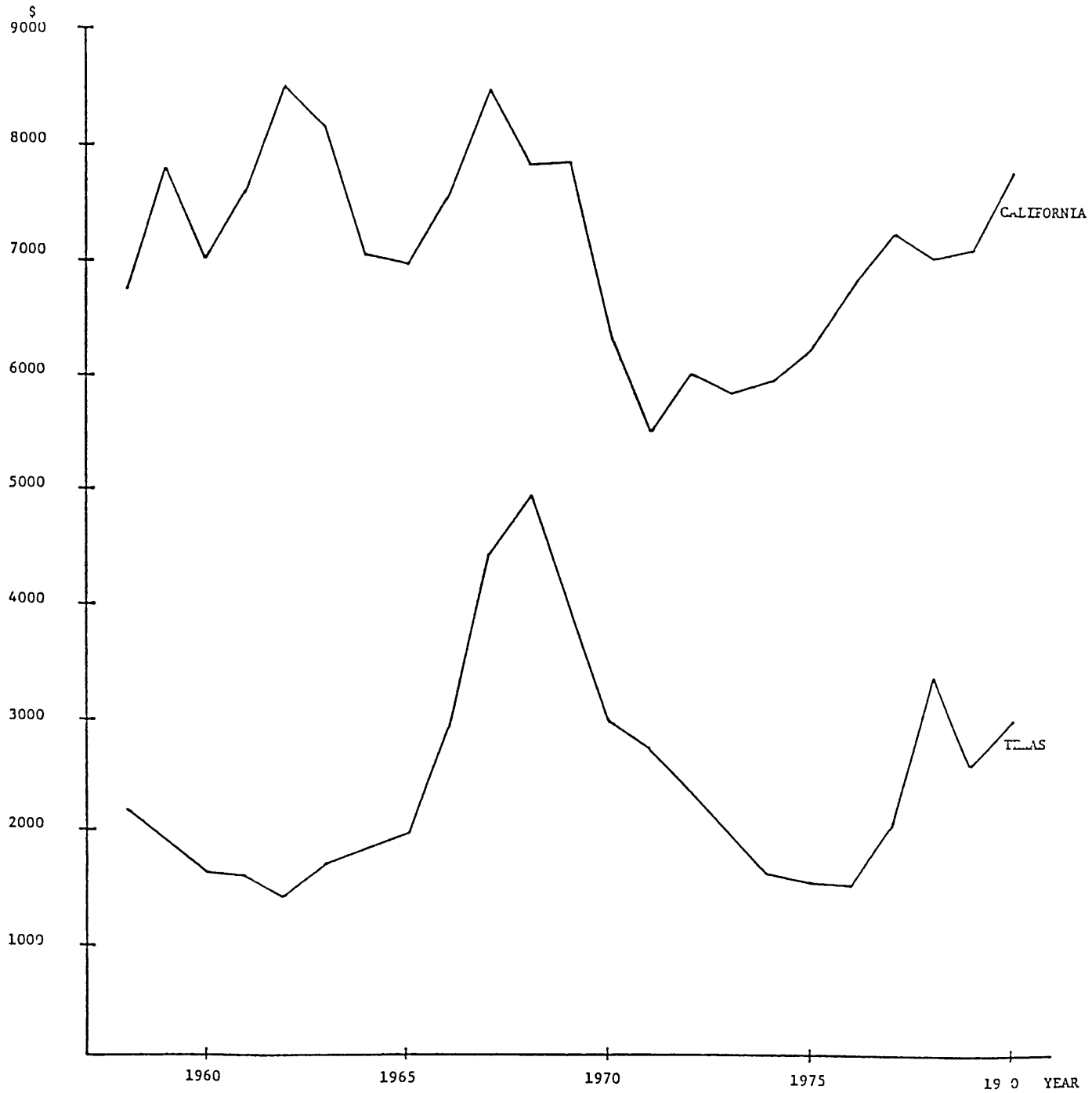
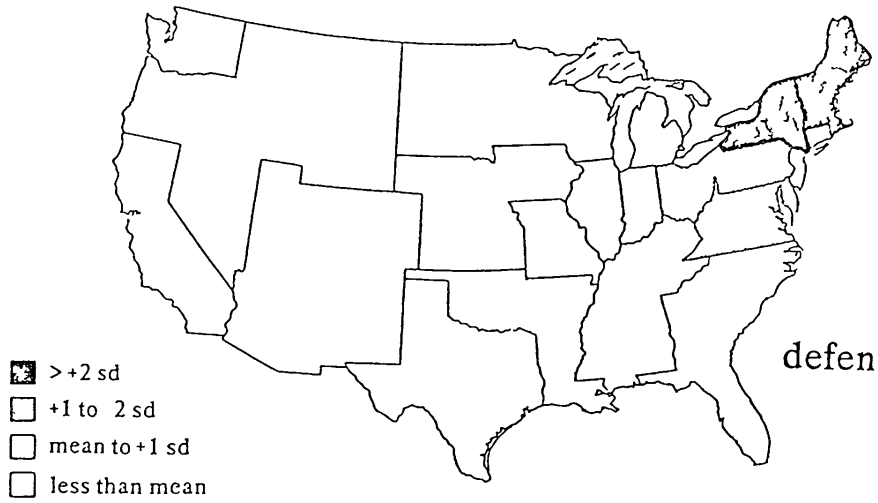
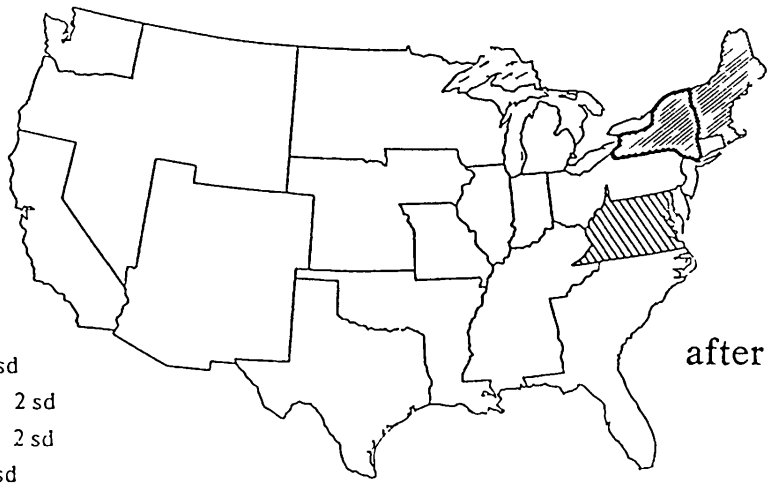


Figure 3 New York Interregional Sales Linkages
(all industries)



>+2 sd
+1 to 2 sd
mean to +1 sd
less than mean



< 2 sd
1 to 2 sd
+1 to 2 sd
>+2 sd

Figure 4 New York Interregional Purchase Linkages
(all industries)

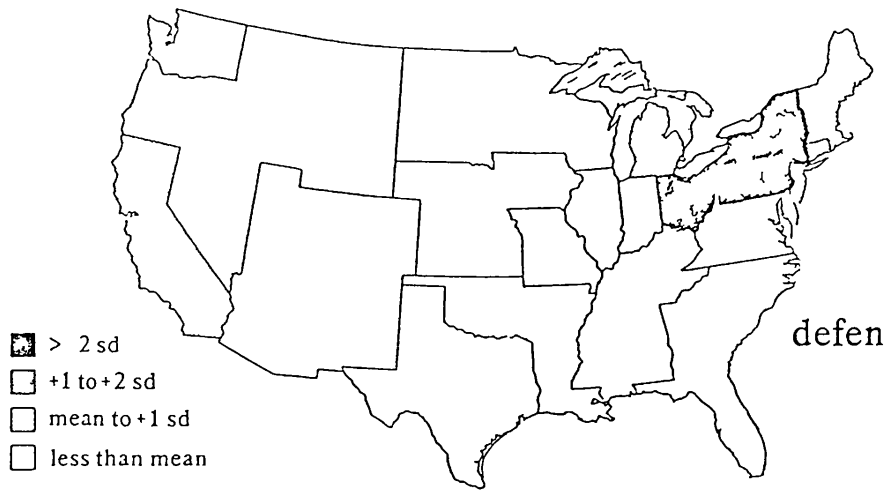
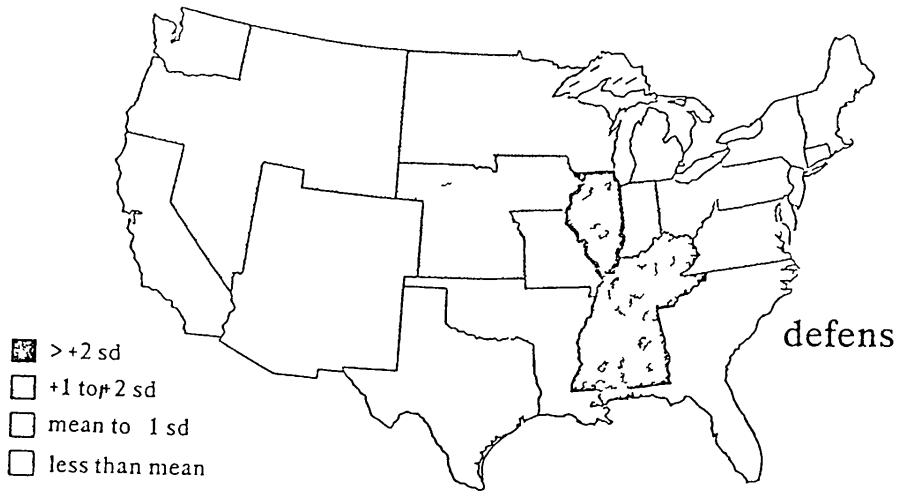


Figure 5 Illinois Interregional Sales Linkages
(all industries)



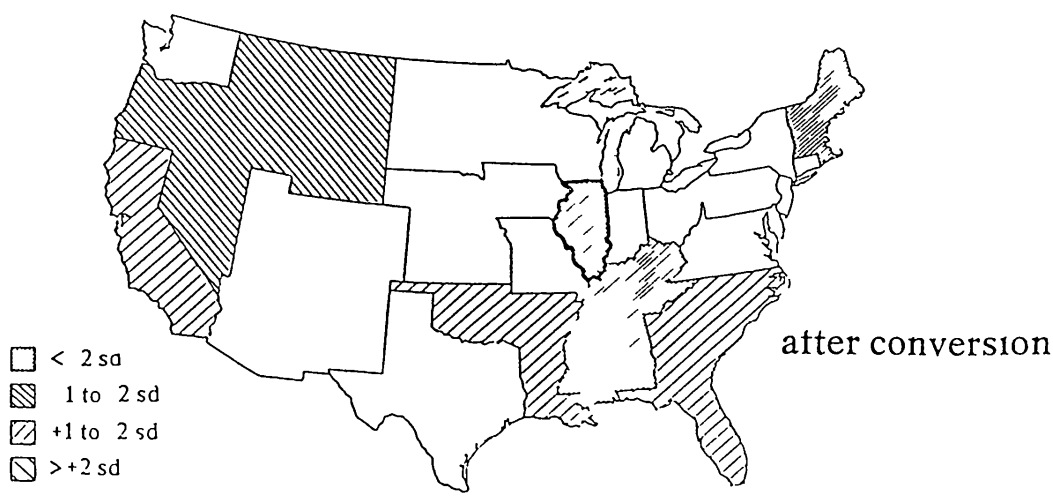
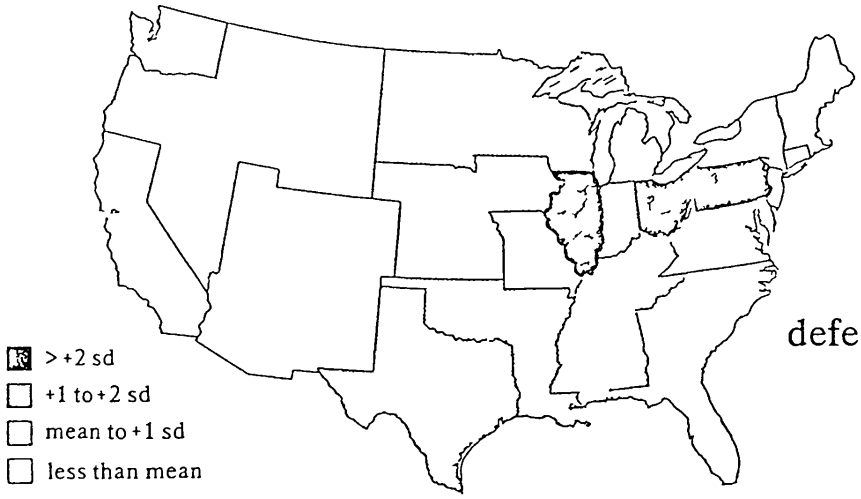
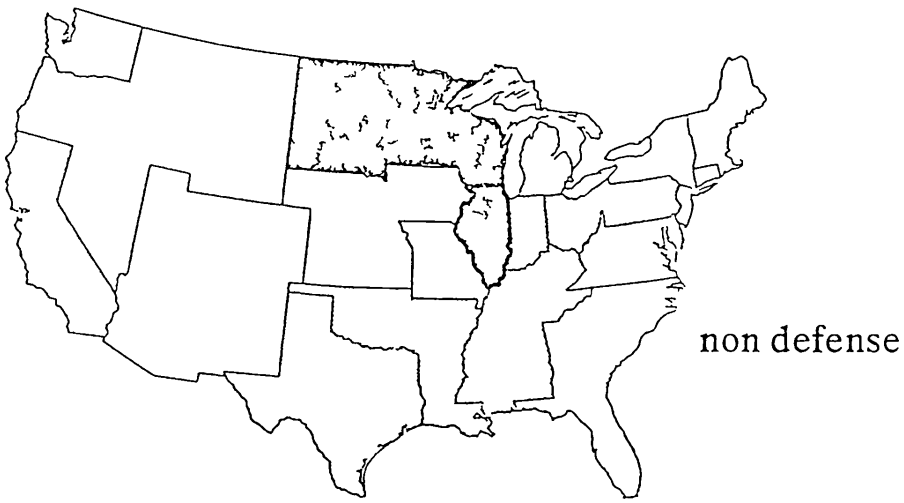


Figure 6 Illinois Interregional Purchase Linkages
(all industries)





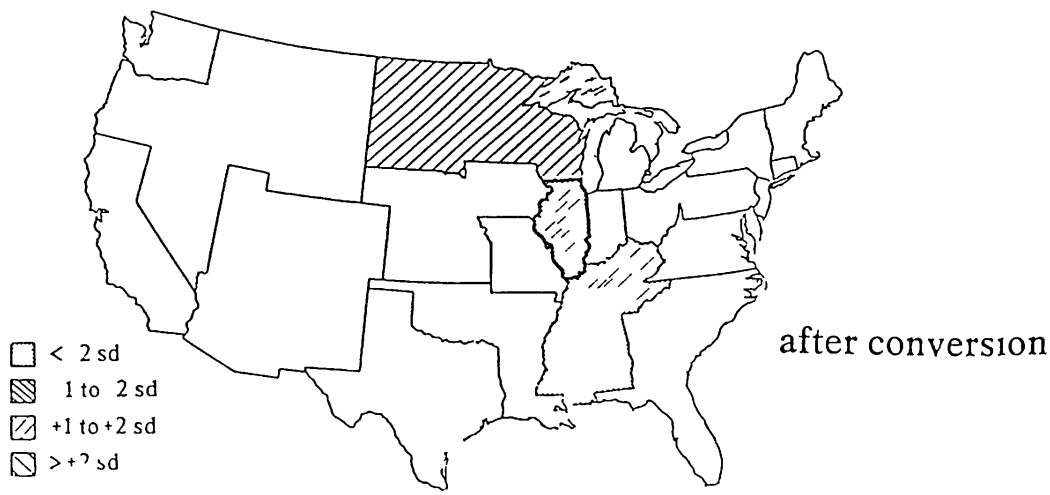


Figure 7 California Interregional Sales Linkages
(all industries)

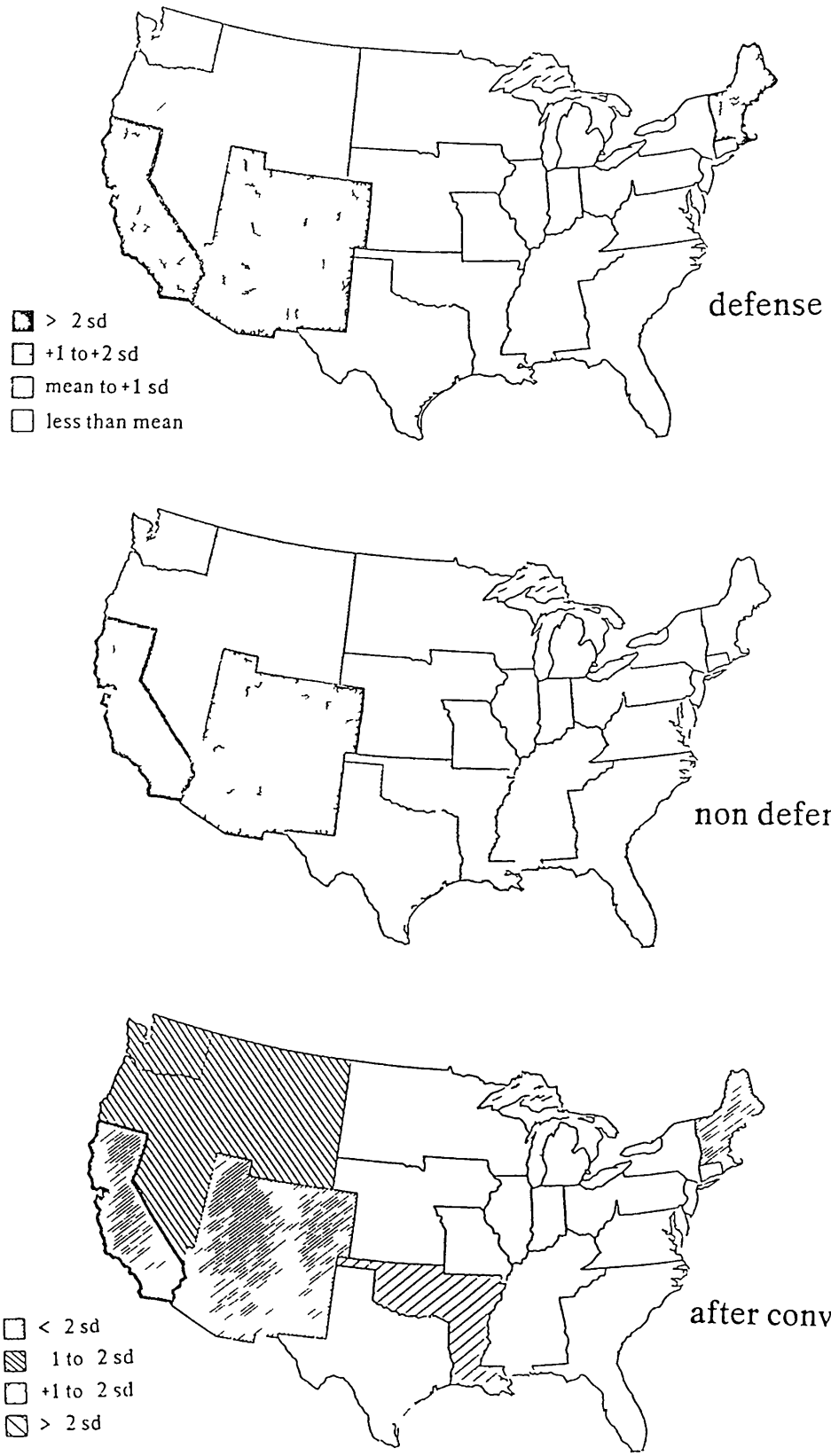
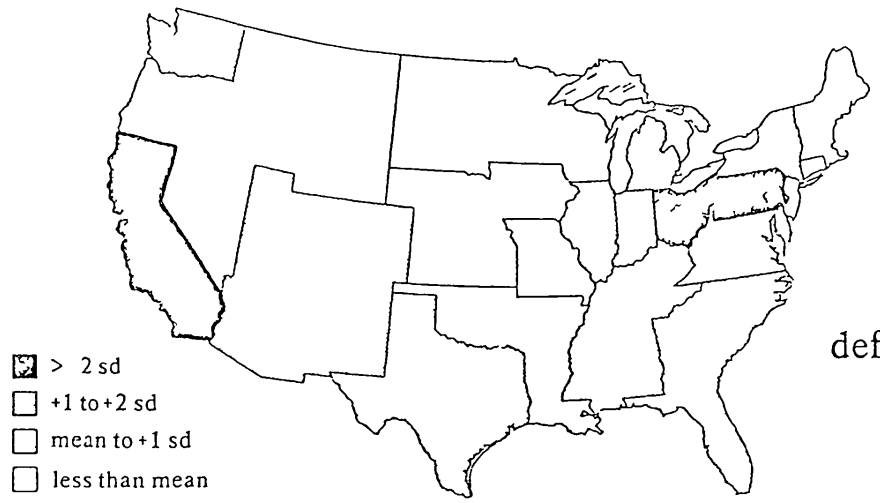
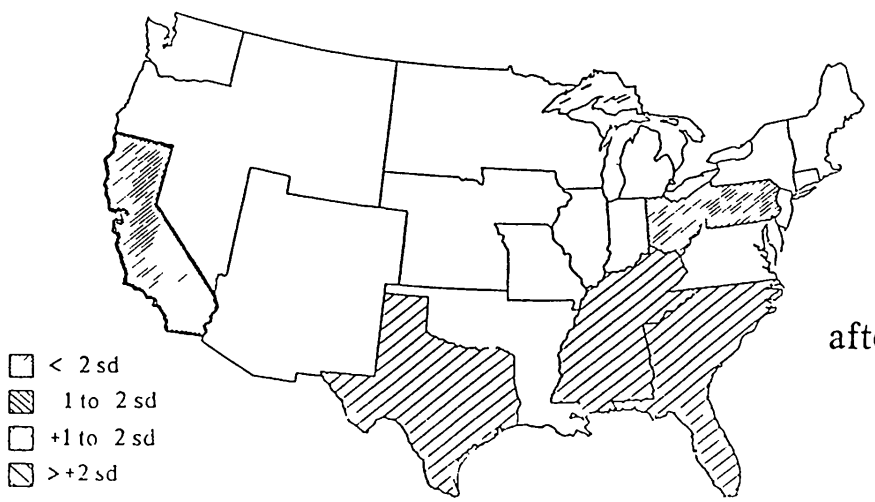


Figure 8 California Interregional Purchase Linkages
(all industries)



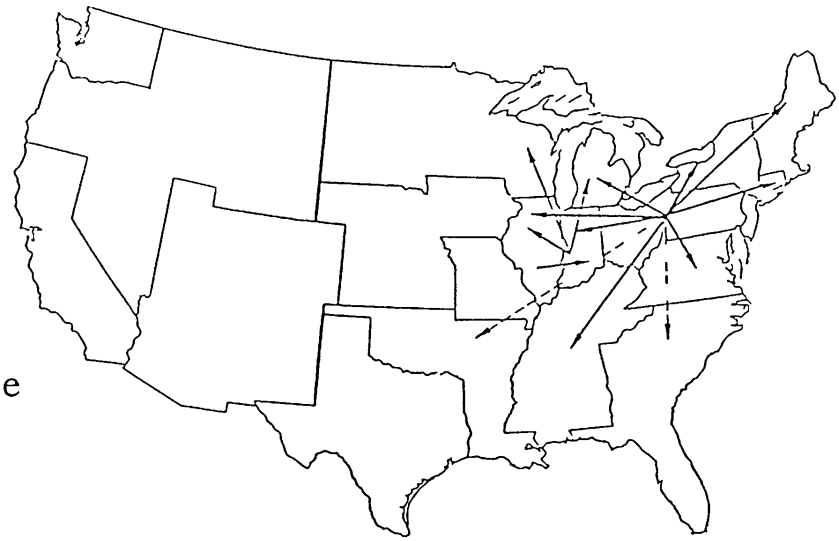
defense

non defense



after conversion

Figure 9 Iron and Steel Forging



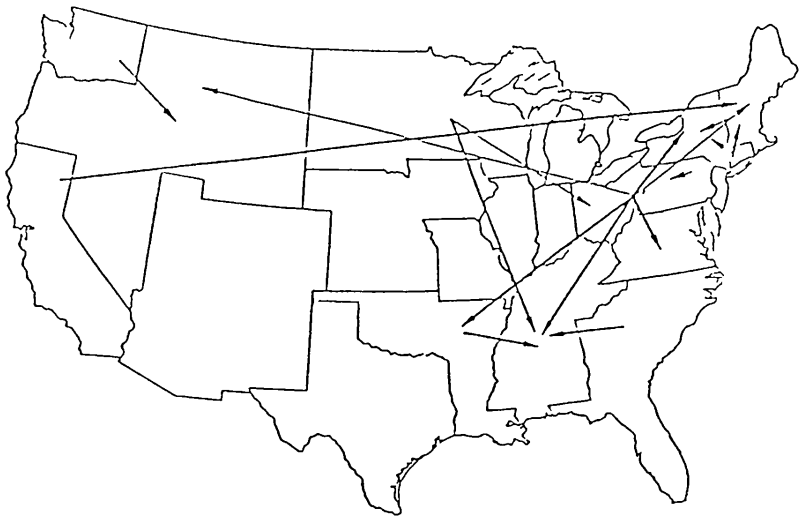
defense

non-defense

after conversion

Figure 10 Electrical Equipment

defense



non defense

after conversion