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ESTIMATING INCOME DISTRIBUTION EFFECTS ON REGIONAL INPUT-OUTPUT MULTIPLIERS

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Introduction

Given the well-known increase in the savings to income ratio in cross-section studies of consumption behavior, changes in the distribution among income groups will affect overall multiplier effects at the regional level. However, empirical estimation of income distribution effects on regional I-0 multipliers is rarely done. Renewed efforts in this area are justified by the development of empirical demand estimation techniques and by recent national policy trends that in the short-run are likely to result in redistribution of income from low to high income groups.

This paper investigates the income distribution facet of a regional economy via estimation of household marginal budget shares using the Quadratic Expenditure System (QES) and a regional input-output model developed from survey and secondary sources. Our objective is to estimate the direct, indirect and induced income effects by income group from a delivery to final demand by each of the sectors of the regional economy. Furthermore, following Miyazawa [7] we will demonstrate that changes in the local personal income distribution will affect total income generation from a given change in final demand.

In the following sections, we describe the empirical demand model and regional I-O model used. We next describe how these models are integrated to yield the income distribution effects on regional I-O multiplier effects and some policy implications.

The Regional Input-Output Model

Following Miyazawa [7, p. 3], the income distribution effects on the input-output multipliers can be incorporated as follows: The I-O system balance equation is: $X = AX + F_c + F$ where:

X = column vector of output
A = $n \times n$ matrix of input coefficients
F_c = column vector of consumption demand
F = column vector of other final demand

Then, the well-known solution is: $X = (I-A)^{-1} (F_c + F)$

or, for the closed system with households treated as another processing sector.

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$$X = (I-\hat{A})^{-1} F$$

where: $\hat{A} = (n + 1) \times (n + 1)$ input coefficients matrix. Now, instead of treating households as a processing sector, introduce a disaggregated consumption function and the distribution among k income groups of value added, V_k

$$F_2 = \sum_{k=1}^{r} c_{ik} v_{kj} X_j$$

$$i, j=1, 2, \ldots, \quad k=1, \ldots m,$$

or in matrix terms

$$F_c = CVX$$

where:

$C = n \times r$ matrix of consumption coefficients, $c_{ik} = \frac{C_{ik}}{Y_k}$

$V = r \times n$ matrix of value added ratios, $v_{kj} = \frac{V_{kj}}{X_j}$

and

Y = $k \times 1$ vector of income to each of the k income groups
C_{ik} = consumption of ith good by the kth income group
V_{kj} = value added earned by the kth income group in sector j
Y_k = kth income group's income

By substitution,

$$X = AX + CVX + F$$

Then,

$$X = (I-A-CV)^{-1}F$$

From the income perspective

$$Y = VBCY + VBF \qquad \text{where } B = (I-A)^{-1} \text{ and}$$

where VBCY yields the change in Y from endogenous consumption and VBF represents Y resulting from exogenous forces. Thus solving for Y as a function of final demand

$$Y = [I\text{-}VBC]^{-1} VBF$$
$$Y = KVBF$$

The KVB matrix will yield coefficients that measure the direct, indirect and induced income generated in each income group for a given dollar change in final demand in sector i. Miyazawa [7, p. 9] calls the KVB matrix the matrix multiplier of income formation.

Estimation of the Household Budget Shares

To obtain the C Vectors required for estimation of the matrix "inter-income group coefficients," requires the allocation of total household spending between its composite expenditure categories. As noted by Powell [8], the allocation of a predetermined aggregate, C_o among its m components C_i where:

$$C_o = \sum_{i=1}^{m} C_i$$

may be estimated by ordinary least squares (OLS) if all regressors are common across equations. Thus,

$$C_i = C_o \beta_{oi} + Z \beta_i + e_i \ (i=1, \ldots, m)$$

where C_i and C_o are the $N \times 1$ observation vectors, β_{oi} is the weight of C_o in the ith linear allocation functions; Z is an $(N \times 1)$ observation vector on a variable that is common to every allocation equation and e_i is a $N \times 1$ vector on a stochastic disturbance. Now $(m-1)$ equations are estimated using OLS with the estimation of

$$\beta_{om} = (1 - \sum_{i=1}^{m-1} \beta_{oi})$$

and

$$\beta_m = \sum_{i=1}^{m-1} \beta_i$$

Furthermore, Howe [5] demonstrates that in simple cross section of the QES, quadratic Engel curves may be estimated as:

$$C_i = a_{oi} + a_{li} C_{oi} + a_{2i} C_{oi}^2 \qquad \text{for } i=1, \ldots, M-1$$

Since this is equivalent to Powell's allocation example, ordinary least squares (OLS) is used to estimate the equations. Marginal budget shares are then dependent upon the total level of household expenditures.

$$\frac{C_i}{C_{oi}} = a_{li} + 2\, a_{2i}\, C_{oi} \qquad \text{for } i = 1, \ldots, M$$

Empirical Results

Estimation of the inter-income-group coefficients required estimation of both the consumer demand vectors and regional I-O model. The regional I-O model was constructed using a semi-survey approach that encompassed business and farm surveys and use of tax records. (See Henry, et al., [3]). For purposes of this paper, the data were aggregated to 18 processing sectors.[1] The I-O model emphasizes the farm, trade, and service sectors since manufacturing activity is very limited in this region.

Table 1: Savings and Tax Rates and Income Shares[a]

Nonfarm (289 Households)	Mean Income[b]($)	APS[c]	APT[d]	Shares of total Income
Low Y<6327	4,204	0.000	0.06	.148
Med 6327<Y<10298	8,400	0.027	0.16	.286
High 10298<Y	15,607	0.044	0.19	.556
Farm (214 Households)				
Low Y<7283	4,608	0.001	0.12	.174
Med 7283<Y<11441	9,207	0.031	0.21	.313
High 11441<Y	15,607	0.031	0.25	.513

[a] The income groups are determined by ranking all households by income within the farm and nonfarm group, and then determining the income level that divided each of these farm and nonfarm groups into three subgroups of an equal number of households.

[b] Means and Standard Deviations for the income variable of the entire sample are Y = \$ 9,767, SD = \$5281,
for the nonfarm sample: Y = \$ 9,425, SD = \$5595, and
for the farm sample: Y = \$10,288, SD = \$4812.

[c] Average savings to income ratio (after taxes) computed from survey, data. Data from farm households were not adequate for separate income group savings ratios.

[d] Average effective tax rates at the approximate mean income levels for federal and state income taxes and payroll taxes.

Source: Statistical Abstract of the United States, 1976, pp. 242-243.

[1] Space prohibits listing the I-O matrices. They are available upon request from the authors. The 18 I-O sectors are (1) Ag-Livestock, (2) Ag-Crops, (3) Ag-Services, (4) Coal Mining, (5) Other Mining, (6) Petroleum Refining, (7) Manufacturing, (8) Transportation, (9) Utilities, (10) Construction, (11) Wholesale Trade (WT) Ag Durables (12) WT-Ag Nondurables, (13) Groceries, (14) Eating-Drinking, (15) Clothing, (16) Other Retail Trade, (17) Finance-Insurance-Real Estate, (18) Other Services.

The value added row and consumption column in the standard I-O format are disaggregated into six income groups as shown in Table 1. The V matrix is found by distributing the total income earned in each sector into these six income groups by using the sample shares of total household income received by each group from Table 1. Income earned in each sector includes wages, salaries, proprietor's income and other property-type income that are earned by *residents* of the region.

However, the C matrix of consumption coefficients was formed in two stages. First, the marginal budget shares were estimated using the cross section of the QES.[2] These shares were then adjusted by an import vector to reflect within region purchases only. Location of consumer purchase was determined in the expenditure survey, (See [2]).

The Marginal Budget Shares

For the entire sample, the empirical estimates suggest that the marginal budget shares decrease as income increases in the categories of Food 1, Clothing, Transportation, and Medical Care. The miscellaneous expenditures category is the only category in which the share increases with the income level. Farm, nonfarm differences are apparent in Food 1, Clothing, Transportation, Medical Services, Education and Housing.

[2] Since the regressors are identical across equations, these estimates are the equivalent of single equation OLS estimates. Note that the equations are estimated in expenditure-share form to control for heteroscedastic disturbances. The expenditure data were obtained by personal interview with a sample of farms stratified by size in Western North Dakota and nonfarm residents in the same twelve county region. The region of study included North Dakota State Planning regions 1, 7, and 8. A complete description of the survey methodology and sample characteristics is available in Henry, M. [2] *Socioeconomic Monitoring Study for Western North Dakota: Part II Economic Characteristics and Structure of Western North Dakota.* REAP Report No. 79.10 (Bismark, N.D.: Regional Environmental Assessment Program). The expenditure categories on the expenditure questionnaire included 103 different questions including data on type of expenditure and location of the purchase. The expenditure categories were aggregated to ten groups as shown in Table 2. Food 1 is food purchased for home consumption. Food 2 is purchases of food and drink away from home. Business expenses were netted out of household expenses for the farm households in the sample. Housing expenditures were comprised of rent, mortgage payments, and property taxes on housing. Inputed rental value of owner occupied housing was not considered for two reasons. First, there is the sticky problem of farm housing as a production expense and as household consumption. Second, our focus is on estimation of the composition of expenditures by farm and nonfarm households in our regions as their income changes. Of course, marginal budget shares will vary across households with different ages of mortgages. We have not attempted to measure this except to the extent that there are significant differences in age of mortgage and rental patterns (and thus marginal budget shares) between farm and nonfarm households. The results in Table 2 support this hypothesis and are also available with mean expenditure levels in Martin and Henry [6].

Table 2: Household Budget Shares, Bismarck, N.D. Region, 1975-76

Commodity Composition of Expenditures[a]	All Households		Farm Households		Nonfarm Households	
	n=503		n=214		n=289	
	MSB	ABS	MBS	ABS	MBS	ABS
1. Food purchased for off-premise consumption, PCE category:3	.18 .15 .11	.20	.15	.19	.15	.20
2. Purchased meals and beverages, PCE category:4	.04	.04	.03	.04	.05	.04
3. Clothing, PCE categories:11, 14, 15, and 19.	.08 .07 .05	.07	.13 .08 .04	.08	.05	.06
4. Durables, PCE categories:29, 30, 31, 32, 33, 68, 86, and 87.	.07	.05	.07	.08	.06	.05
5. Transportation, Autos, gas-oil, rail, air, etc. PCE categories:65, 66, 67, 70, 71, 72-81.	.17 .14 .12	.13	.18 .14 .09	.12	.17 .15 .13	.13
6. Medical: Drugs, Physicians, etc. PCE categories:45-51	.10 .08 .05	.09	.13 .09 .04	.10	.10 .08 .06	.09
7. Miscellaneous Retail Trade and Services, PCE categories:7, 12, 17, 18, 21, 22, 34, 35, 42, 43, 56-62, 69, 83-85, 88-97, 102-104.	.18 .27 .37	.23	.17 .29 .41	.25	.13 .26 .40	.21
8. Education: PCE categories:99-101	.04	.03	.06	.04	.03	.02
9. Housing: PCE categories:24-27	.07	.07	.02	.03	.16 .11 .06	.11
10. Utilities: PCE categories:37-41	.06	.10	.06	.10	.06	.09

[a] See Table B, Input-output Commodity Composition of Personal Consumption Expenditures, 1972, Bureau of Economic Analysis, U.S. Dept. of Commerce, April 1979.

MBS is the QES marginal budget share for Y=$5000, Y=9747, Y=$15,000.

ABS is the average budget share. See Martin and Henry [4] for more information on expenditures.

All coefficients reported were significant at least at the .05 level. For commodities 2, 4, 8, 9, and 10, the coefficients on the C^2 variable, a_{2i}, were not statistically different from zero at the $\alpha=.05$ level. However, the C^2 variable was included in the estimated equations to satisfy the need to have identical regressors across all equations. See the appendix to this paper for results.

The consumption coefficients in Table 3 differ in several substantial ways from standard I-O consumption coefficients. First, they are marginal coefficients rather than averages. As Tiebout [9] has argued marginal coefficients are appropriate when added income is associated with additions to household income of current residents rather than with new residents in the region. New residents might be expected to replicate the regional "average" household consumption coefficients.

Second, since most manufactured goods and processed agriculture commodities are imported into the region, household spending is assigned mostly to the trade and service sectors. The consumer dollar spent in most trade sectors (except Eating and Drinking) will then result in large import leakages via the trade sectors as the cost-of-goods purchased in most trade sectors are imported from outside manufacturing. I-O models usually assign consumer spending to the manufacturing sector and various trade and transportation margins within the consumption vector.

However, the most striking feature of our model is the disaggregation of the consumption vector into its income group and farm, nonfarm status components. The QES results suggest that there are demand differences between income groups and farm-nonfarm status in our region.

The Matrix Multiplier of Income Formation

By combining the household budget analysis with the regional I-O model, we form the matrix, M1 = KVB where K, V, and B are defined as before. In our case M will be a 18 × 6 matrix with M_{ij} showing the total income received by the jth income group for every dollar of delivery to final demand by sector i.

Table 3: The Consumption Coefficients, C, and Value Added Coefficients, V, for Six Income Groups in Western North Dakota

	Consumption Coefficients						Value Added Coefficients					
Sector	C1	C2	C3	C4	C5	C6	V1	V2	V3	V4	V5	V6
1	0	0	0	0	0	0	.032	.058	.005	0	0	0
2	0	0	0	0	0	0	.019	.035	.057	0	0	0
3	0	0	0	0	0	0	0	0	0	.051	.103	.193
4	0	0	0	0	0	0	0	0	0	.029	.058	.109
5	0	0	0	0	0	0	0	0	0	.011	.022	.041
6	0	0	0	0	0	0	0	0	0	.002	.004	.008
7	0	0	0	0	0	0	0	0	0	.054	.109	.204
8	.067	.052	.033	.063	.056	.048	0	0	0	.045	.090	.169
9	.051	.051	.051	.051	.051	.051	0	0	0	.025	.051	.096
10	.062	.062	.062	.053	.053	.053	0	0	0	.023	.046	.087
11	0	0	0	0	0	0	0	0	0	.014	.028	.053
12	0	0	0	0	0	0	0	0	0	.048	.095	.178
13	.149	.149	.149	.188	.149	.099	0	0	0	.020	.040	.076
14	.022	.022	.022	.037	.037	.037	0	0	0	.048	.095	.178
15	.090	.055	.028	.035	.035	.035	0	0	0	.032	.064	.121
16	.261	.261	.261	.234	.234	.234	0	0	0	.023	.046	.086
17	.019	.019	.019	.152	.105	.057	0	0	0	.047	.093	.176
18	.137	.137	.137	.100	.100	.100	0	0	0	.112	.224	.421

To assess the impact on the region of changing the income distribution, we compute an M matrix for three alternative V matrices of income distribution. M1 is found using the current income distribution as shown in Table 1. A redistribution of income from low to high groups is assumed in computing M2. This represents a 10 percentage point reduction in the low income share, no change in the middle income group and a 10% point increase in the high income shares. After adjusting the V matrix, the M2 matrix is found as before as $M2 = K_2V_2B$ where $V_2 = V$ adjusted for the low to high redistribution, $K_2 =$ K adjusted for the low to high redistribution.

Finally, a redistribution from high to low groups is computed by reducing the high income share by 10% points and increasing the low income share by 10% points. Thus, $M3 = K_3V_3B$ with K_3 and V_3 representing adjustments in the K and V matrices to reflect the redistribution from high to low income households. Table 4 lists the M1, M2 and M3 matrices. Each coefficient in these matrices represent the total income received by the jth income group for a $1000 delivery to final demand by sector i. Row totals yield the total income received by all income groups together for a $1000 delivery to final demand by that row sector. The important export sectors are (1) Ag-Livestock, (2) Ag-Crops, (4) Coal Mining, (5) Other Mining, and (9) Utilities (electric generation).

Looking first at the matrix multiplier of income formation based on the 1975-76 sample income distribution, matrix M1, we find three facets of the results to be of interest. First, final demand by the export sectors sales have significant nonfarm income effects but the reverse is generally not true. Thus, the economic base notion of exogenously determined farm income affecting "nonbasic" income without feedbacks is illustrated. Second, the farm sectors tend to have larger total income effects than the other important export sectors. Finally, the nonfarm households income distribution seems to be more skewed to the high group than the farm household income distribution. Generally, the ratio of income received by the high group to the low group is about 4:1 between nonfarm households and only 3:1 between farm households.

Table 4: Matrix Multipler of Income Formation, M1, M2 and M3.[a]

	Farm			Nonfarm			
Income Group	**Low**	**Mid**	**High**	**Low**	**Mid**	**High**	**Total**
I Sector				**M1**			**Total**
1 AGLVST	33.631	60.498	99.155	46.687	93.374	175.39	508.74
2 AGCRPS	20.424	36.739	60.215	35.545	71.09	133.53	357.55
3 AGSVCS	.40038	.72022	1.1804	87.581	175.16	329.02	594.06
4 COAL	.15847	.28507	.46722	47.752	95.504	179.39	323.56
5 OTHMIN	.10096	.1816	.29764	25.814	51.628	96.978	175
6 PETROL	.046665	.083944	.13578	12.479	24.959	46.882	84.589
7 MANUF	.25445	.45771	.75017	78.651	157.3	295.47	532.89
8 TRAN	.26134	.47011	.7705	73.348	146.7	275.55	497.1
9 UTIL	.18434	.33159	.54348	49.582	99.163	186.27	336.07

10 CONST	.22011	.39595	.64896	65.669	131.34	246.7	444.98
11 WTAGDUR	.083303	.14985	.2456	25.232	50.465	94.792	170.97
12 WTAGND	.24877	.4475	.73344	77.035	154.07	289.4	521.94
13 GROC	3.7377	6.7236	11.02	48.896	97.793	183.69	351.86
14 EATDRNK	.39326	.70742	1.1594	85.209	170.42	320.11	578
15 CLOTH	.15546	.27966	.45835	48.007	96.014	180.35	329.26
16 OTHRTRD	.17235	.31004	.50815	40.814	81.628	153.33	276.76
17 FIRE	.23005	.41382	.67824	70.717	141.43	265.67	479.14
18 SVCS	.52007	.93553	1.5333	160.98	321.96	604.76	1090.7

I Sector			M2				Total
1 AGLVST	14.298	60.477	118.44	14.985	92.405	204.79	505.4
2 AGCRPS	8.6822	36.723	71.922	11.414	70.384	155.99	355.11
3 AGSVCS	.16132	.68234	1.3363	28.173	173.73	385.03	589.11
4 COAL	.062513	.26442	.51785	15.361	94.724	209.93	320.86
5 OTHMIN	.040295	.17044	.3338	8.3039	51.207	113.49	173.54
6 PETROL	.01857	.078546	.15383	4.0144	24.755	54.863	83.884
7 MANUF	.10017	.42369	.82978	25.3	156.02	345.77	528.44
8 TRAN	.10364	.43839	.85856	23.595	145.5	322.46	492.95
9 UTIL	.073326	.31015	.60741	15.949	98.354	217.97	333.27
10 CONST	.086896	.36755	.71983	21.124	130.27	288.7	441.26
11 WTAGDUR	.032847	.13894	.2721	8.1167	50.053	110.93	169.54
12 WTAGND	.09792	.41418	.81115	24.781	152.81	338.67	517.59
13 GROC	1.5846	6.7024	13.126	15.725	96.973	214.91	349.02
14 EATDRNK	.15853	.67056	1.3133	27.41	169.03	374.6	573.18
15 CLOTH	.061208	.25889	.50703	15.443	95.231	211.05	322.55
16 OTHRTRD	.069126	.29238	.57262	13.129	80.961	179.43	274.45
17 FIRE	.090604	.38323	.75054	22.748	140.28	310.89	475.14
18 SVCS	.20472	.8659	1.6958	51.783	319.33	707.7	1081.6

I Sector			M3				Total
1 AGLVST	52.978	60.519	79.854	79.057	94.359	145.36	512.13
2 AGCRPS	32.176	36.755	48.498	60.163	71.807	110.62	360.02
3 AGSVCS	.6642	.75873	1.0011	147.97	176.62	272.08	599.1
4 COAL	.26793	.30607	.40385	80.68	96.296	148.35	326.3
5 OTHMIN	.16891	.19296	.2546	43.615	52.057	80.196	176.48
6 PETROL	.078288	.589432	.118	21.085	25.166	38.769	85.306
7 MANUF	.43095	.49229	.64958	132.89	158.61	244.34	537.4
8 TRAN	.43977	.50237	.66287	123.93	147.91	227.87	501.31
9 UTIL	.30936	.3534	.4663	83.772	99.986	154.03	338.92
10 CONST	.3719	.43483	.56056	110.95	132.43	204.01	448.75
11 WTAGDUR	.14089	.16094	.21236	42.632	50.883	78.388	172.42
12 WTAGND	.42139	.48137	.63516	130.16	155.35	239.32	526.37
13 GROC	5.9047	6.7452	8.9002	82.633	98.627	151.94	354.75
14 EATDRNK	.65207	.74489	.98287	143.97	171.83	264.72	582.9
15 CLOTH	.26329	.30077	.39686	81.111	96.81	149.14	328.02
16 OTHRTRD	.28712	.32799	.43277	68.958	82.305	126.79	279.11
17 FIRE	.38948	.44491	.58706	119.48	142.61	219.69	483.2
18 SVCS	.88093	1.0063	1.3278	271.98	324.63	500.1	1099.9

[a] M1 = KVB, where V represents the sample income distribution.

M2 = $K\bar{V}B$, where $\bar{V}$ assumes a 10% point redistribution from the low to high income groups relative to the sample distribution.

M3 = $K\bar{V}B$, where $\bar{V}$ assumes a 10% point redistribution from the high to low income groups relative to the sample distribution.

Each element M_{ij} represents the change in income received by household group j for every $1000 delivery to final demand by sector i.

These three facets of the results hold for each of the three matrices of income formation. If we now turn to a comparison of M1, M2 and M3, it is apparent that redistribution of income from low to high groups has two effects. First, total regional income generated by a given final demand sale is less when income is assumed to be redistributed from low to high groups. Accordingly, for an income redistribution program to promote income growth in a given region, final demand sales must rise enough to offset the regional income dampening effect of the redistribution effect. The other effect is to skew the household income distribution more to the high group. Of course, this is mostly a result of the initial change in the direct value added coefficients.

Looking now at Table 5, we note that the overall negative income impact from a low to high redistribution is small for a given sector. For every $1000 delivery to final demand by Ag-Livestock (sector 1) regional income declines by only $3.34. This considers a rather substantial redistribution of income from low to high income households as can be seen from reading a row in Table 5.

Similar conclusions regarding overall income impacts can be drawn from the redistribution from high to low income households. The economic base of the region of analysis is agriculture and mining with a sparse interindustry transactions matrix. We would expect the income redistribution effects on total income to be substantially larger in more industrialized regions.

Conclusions

By integrating a regional I-O model with household budget analysis, we are able to address some issues of regional income formation that may be of increasing importance. National policy that redistributes income from low to high income households is shown to have a negative effect on the regional economy. Of course, the magnitude of this negative effect will vary with the region of study. However, if: (1) low income households spend a higher proportion of their income than high income households; and (2) low income households spend larger proportions of their income locally, e.g., travel less outside the region, buy fewer imports per dollar of income, *etc.,* then a redistribution of income from low to high income households is likely to result in lower regional incomes *from a given level of final demand* (other than consumption). Beyond this total regional income effect, there are, of course, potential equity problems with a policy that increases the share of income going to high income groups and reduces it for low income households.

Of course, the standard input-output model is a "demand-side" model since equilibrium income depends on a given level of final demand expenditures for the goods and services produced in the region. "Supply-side" economics tells us that an increase in economic incentives to produce via less taxation, income redistribution and government regulation will increase the supply of goods and services relative to the supply forthcoming with past policy. For the regional economy this means that exports of goods and services and local investment should rise although we might expect government nondefense purchases to fall.

The debate over the relative merits of supply-side and demand-side macro policy is not so much one of flaws in logic. Rather, the magnitude of the impact on economic activities of alternate policies is the crux of the issue. The matrix multiplier of income formation allows the regional analyst to participate in this debate both from the "equity" and regional income growth perspectives.

Table 5: Income Change Associated With Income Redistribution[a]

	Farm			Nonfarm			
Income Group	Low	Mid	High	Low	Mid	High	Total
I SECTOR			DIFHIB				THIB
1 AGLVST	−19.333	−.020784	19.288	−31.702	−.96883	29.398	−3.3385
2 AGCRPS	−11.741	−.015733	11.707	−24.131	−.70558	22.453	−2.434
3 AGSVCS	−.23906	−.037884	.15591	−59.408	−1.4298	56.007	−4.9515
4 COAL	−.09596	−.020655	.050625	−32.391	−.77921	30.538	−2.6985
5 OTHMIN	−.06066	−.011166	.036152	−17.51	−.42133	16.508	−1.4591
6 PETROL	−.028095	−.005398	.016247	−8.4651	−.20367	7.9807	−.70533
7 MANUF	−.15428	−.03402	.079606	−53.35	−1.2834	50.298	−4.4444
8 TRAN	−.1577	−.031727	.08806	−49.754	−1.197	46.907	−4.1453
9 UTIL	−.11101	−.021447	.063938	−33.632	−.8092	31.708	−2.8023
10 CONST	−.13322	−.028405	.070873	−44.545	−1.0716	41.996	−3.711
11 WTAGDUR	−.050455	−.010914	.0265	−17.116	−.41174	16.136	−1.4259
12 WTAGND	−.15085	−.033321	.077712	−52.255	−1.257	49.265	−4.3532
13 GROC	−2.1531	−.021213	2.1066	−33.171	−.82	31.221	−2.838
14 EATDRNK	−.23473	−.036859	.15382	−57.799	−1.3911	54.491	−4.8175
15 CLOTH	−.094257	−.020765	.04868	−32.564	−.78335	30.701	−2.7128
16 OTHRTRD	−.10323	−.017654	.064478	−27.685	−.66623	26.1	−2.3072
17 FIRE	−.13944	−.030588	.072304	−47.969	−1.1539	45.224	−3.9962
18 SVCS	−.31535	−.06963	.16252	−109.19	−2.6268	102.95	−9.0966
I SECTOR			DIFLOWB				TLOWB
1 AGLVST	19.347	.021211	−19.3	32.371	.98503	−30.028	3.3956
2 AGCRPS	11.752	.016043	−11.717	24.618	.71738	−22.912	2.4748
3 AGSVCS	.26382	.038514	−.17928	60.394	1.4538	−56.936	5.0345
4 COAL	.10946	.020998	−.06337	32.929	.79227	−31.044	2.7437
5 OTHMIN	.067957	.011352	−.043042	17.801	.42839	−16.782	1.4835
6 PETROL	.031623	.0054877	−.019578	8.6056	.20709	−8.1131	.71715
7 MANUF	.17651	.034585	−.1006	54.236	1.3049	−51.132	4.5189
8 TRAN	.17843	.032254	−.10764	50.579	1.2171	−47.685	4.2148
9 UTIL	.12503	.021803	−.077172	34.19	.82276	−32.234	2.8492
10 CONST	.15178	.028877	−.0884	45.284	1.0896	−42.693	3.7732
11 WTAGDUR	.057588	.011095	−.033235	17.4	.41864	−16.404	1.4498
12 WTAGND	.17262	.033874	−.098273	53.122	1.2781	−50.082	4.4261
13 GROC	2.167	.021574	−2.1197	33.737	.83374	−31.754	2.8856
14 EATDRNK	.25881	.037471	−.17657	58.759	1.4144	−55.395	4.8982
15 CLOTH	.10783	.02111	−.061493	33.104	.79648	−31.21	2.7583
16 OTHRTRD	.11477	.017948	−.075372	28.144	.67739	−26.533	2.3458
17 FIRE	.15943	.031096	−.091179	48.765	1.1733	−45.974	4.0631
18 SVCS	.36086	.070786	−.20549	111.01	2.6708	−104.65	9.249

[a]DIFHIB = M2-M1 or the income change associated with the redistribution of income from low to high groups per $1000 delivery to final demand by sector I.

DIFLOWB = M3-M or the income change associated with the redistribution of income from high to low groups per $1000 delivery to final demand by sector I.

REFERENCES

1. Artle, Roland. *Studies in the Structure of the Stockholm Economy (Berkeley),* 1965.

2. Henry M. *Socioeconomic Monitoring Study for Western North Dakota: Part II Economic Characteristics and Structure of Western North Dakota* (Bismark, N.D.: Regional Environmental Assessment Program, 1979.

3. Henry, M., A. Leholm, G. Schaible, and J. Haskin. "A Semi-Survey Approach to Building Regional Input-Output Models." *North Central Journal of Agricultural Economics.* 2:1(1980):17-23.

4. Henry, Mark S. and T. L. Martin. "Estimating Income Distribution Effects on Regional Input-output Multipliers." Paper presented at the Southern Regional Science Association, May 31, 1982.

5. Howe, H. J. *Estimation of the Linear and Quadratic Expenditure System: A Cross-Section Case for Columbia* (unpublished Ph.D. Dissertation, University of Pennsylvania, 1974).

6. Martin, Thomas L. and M. S. Henry, "Rural Area Consumer Demand and Regional Input-Output Analysis." *American Journal of Agricultural Economics.* 64:4(1982):752-755.

7. Miyazawa, K. *Input-Output Analysis and the Structure of Income Distribution.* Lecture notes in Economics and Mathematical Systems, ed., M. Beckman and H. Kunzi, (New York: Springer Verlag, 1976).

8. Powell, Alan. "Aitken Estimators as a Tool in Allocating Predetermined Aggregates." *American Statistical Association Journal.* September, 1969.

9. Tiebout, C. M. "An Empirical Regional Input-Output Projection Model: The State of Washington, 1980" *Review of Economics and Statistics, 51 (1969):334-340.*

Appendix: Household Expenditure Equations

	a_{1i}	(X10^5) a_{2i}	C_o	$a_{1i} + 2a_{2i} (C_o)$ MBS
Food 1	.22	−.35	5,000	.185
	(8.29)	(−3.57)	9,747	.152
			15,000	.115
Food 2	.03	+.04	5,000	.034
	(2.43)	(.84)	9,747	.038
			15,000	.042
Clothing	.10	−.17	5,000	.083
	(6.26)	(−2.83)	9,747	.067
			15,000	.049
Durables	.04	.14	5,000	.054
	(1.48)	(1.57)	9,747	.067
			15,000	.082
Transportation	.19	−.24	5,000	.166
	(7.42)	(2.50)	9,747	.143
			15,000	.118
Medical	.13	−.26	5,000	.104
	(6.63)	(−3.40)	9,747	.079
			15,000	.052
Miscellaneous	.09	.93	5,000	.183
	(2.07)	(5.39)	9,747	.271
			15,000	.369
Education	.05	−.01	5,000	.049
	(2.85)	(−.15)	9,747	.048
			15,000	.047
Housing	.10	−.14	5,000	.086
	(3.48)	(−2.35)	9,747	.073
			15,000	.058
Utilities	.05	+.06	5,000	.056
	(2.36)	(.79)	9,747	.062
			15,000	.068
Σa_{1i}	1.00			ΣMBS 1.00
Σa_{2i}		0.00		1.00
				1.00

t-values are in parentheses; for the two tailed test for: $a_{1i} = 0$ and $a_{2i} = 0$, with $\alpha = .05$, the critical value for t is: 1.96 for n = 500; 1.97 for n = 200-300.