ORBES

PHASE II

OHIO RIVER BASIN ENERGY STUDY

August 1980

A MODEL OF MIGRATION IN THE OHIO RIVER BASIN ENERGY STUDY REGION

By

Steven I. Gordon
Christopher Badger

The Ohio State University
Columbus, Ohio 43210

Prepared for

Ohio River Basin Energy Study (ORBES)

Subcontract under Prime Contract EPA R805588

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

CONTENTS

Acknowledgements

We must acknowledge the invaluable assistance of a number of individuals. First, we thank Professor Oscar Fisch of the Department of City and Regional Planning for his advice in the development and execution of the project. We must also thank Dr. Jerome Pickard and Mr. Joseph Cerniglia of the Appalachian Regional Commission for providing us with migration data without which the project would not have gone forward.

Finally, we must thank the ORBES core team and management team for funding the project. Special thanks goes to Professor Gary Fowler of the University of Illinois at Chicago Circle, Department of Geography and Energy Resources Center, for his advice and counsel.

The authors bear all responsibility for any errors contained herin.

TABLES

FIGURES

1.0 Introduction and Purpose

The Ohio River Basin Energy Study (ORBES) has as its purpose the analysis of the environmental, economic, and social impacts of various scenarios of every facility development in the region. Much of this analysis is dependent upon alternative economic growth scenarios which show the energy and economic demand distribution across industries in the region. Similarly, population forecasts have focused on the region as a point and derived alternative projections of population growth.

A remaining question in this type of analysis is the impact of energy scenarios and policies on the internal movements of population and industry within the ORBES region. For any particular regional economic and population forecast, there is implied some level of regional growth. The location of this growth within the region may be influenced by, or may induce, the location and movement of population within the region. The regional forecasts thus provide upper bounds on this growth while the present project focuses on alternative ways in which this growth might be distributed. Broader economic and energy issues within the U.S. undoubtedly are having, and will have, an effect on migration between ORBES and the rest of the nation. However, the ORBES study does not offer projections for the nation as a whole which would enable us to generate and use a model to predict such migration.

The report is divided into several chapters. Chapter 2 reviews other attempts to derive empirical models of migration which relate to the theory behind our model. Chapter 3 discusses the data which was required to derive our migration models. Each data source is described in terms of geography, time, and variable type. Chapter 4 describes the models which were derived and the pros and cons of using each for simulating ORBES impacts. Finally, we use one of these models in Chapter 5 to simulate the migration impacts of the ORBES scenarios under alternative sets of assumptions.

2.0 Literature Review

A number of studies have been undertaken in order to delineate those factors which affect migration. Many approaches have been taken. Because of the nature of our work for ORBES, we will limit our discussion to those models which relate migration to economic growth.

Several major hypotheses have been tested with respect to the relationships between economic growth and migration. These have resulted in a "chicken and egg" controversy over causality. The question remains whether economic growth (or decline) causes migration or whether migration causes economic growth. Among the first to investigate these matters, Borts and Stein (1) contended that migration has tended to narrow wage and income differentials over time and is thus a factor of economic growth and change. A model derived by Muth (2) supported this argument on the basis that total urban employment growth was affected more by migration than migration was affected by employment growth.

On the other hand, several authors have derived models with the underlying assumption that economic growth stimulates migration. Lowry (3) found that economic conditions at the destination greatly influenced the decision to migrate. Miller (4) contended that Lowry and others had incorrectly controlled for conditions at the origin of migration and thus had found those conditions not to be important. Miller concludes that areas with high immigration rates also have high out-migration rates because people who have migrated once will have a higher probability of migrating again.

More recently, Santini (5) has utilized a reformulation of the Lowry model for 49 SMSA's in the North Central U. S. His results support the Lowry findings and contradict those of Muth.

Regardless of which arguments one supports or even whether there is a simultaneous process, the models used to study migration have much in common. Most have adopted a modified "gravity-type" or spatial interaction model in which economic conditions, characteristics of the population at the origin and destination, and distance are the most important variables (11)." The general form of these migration equations can be given as:

$$M_{ij} = f[E_i, E_j, P_i, (1/d_{ij}^n)]$$

where M_{ij} = the migration from region i to region j

$E_{i,j}$ = employment variables at i and j

$P_{i,j}$ = population variables at i and j

d = the distance between i and j

n = a constant.

Most researchers have employed various kinds of regression techniques in an effort to define the relationship of specific variables to migration rates. A number of authors have used employment variables as a measure of employment opportunity that induces migration (3,4,6). The variables used include employment differentials (total or by sector), income differentials, unemployment rates in both the sending and receiving region, and skills of the migrants.

The population variables used include age, sex, education, and race (7,8,9,10).

In theory, migration from an area would be induced by high unemployment and low income. Migrants would tend to be younger and better educated and would be attracted to regions with employment opportunities at higher incomes. All of these effects will be mitigated by distance. The longer the distance, the lower the propensity to migrate because of the associated costs and because less information is available regarding employment opportunities. Education helps overcome this distance factor in that employment for better educated persons is more widely advertised.

The statistical methods used by migration researchers have included ordinary as well as two stage and three stage least squares regression (3,4,11,12). Logarithmic functions have been frequently used to convert the non-linearities in the equations to linear relationships.

Most of these studies focused entirely on migration between major metropolitan regions or on interregional migration with a division of the U. S. into 7-10 regions. The ORBES migration study is unique in that it was undertaken for 43 relatively small regions within the ORBES area.

3.0 Data Description

The ORBES migration model does not seek to advance the state-of-the-art in migration analysis. Rather the developed theories and procedures cited in section 2.0 were utilized to formulate an appropriate model based on migration, employment, distance and demographic data specific to the ORBES region. Before reviewing this data and how it was organized, it is helpful to understand the basic process developed to predict internal migration.

3.1 Overview of Migration Prediction Process

The prediction process developed in this study followed three basic steps:

1) Data was assembled describing the number of persons migrating from 1965 to 1970 between each of 43 regions within the ORBES geographic area. Employment and demographic data describing each of these sub-regions, as well as the distances between them, were also compiled for the same time period. A regression analysis was then conducted to define the relationship between the rate of migration as the dependent variable and the independent variable of employment, distance and demographic characteristics. The result was an equation of the form shown in section 2.0.

2) Using the ORBES I/O Model to predict sector output levels for a given scenario, and using existing data defining the ratio of output to employment for each sector, employment predictions for each scenario were made.

3) Combined with distance and demographic data, these employment predictions were then used as the independent variables in the equation defined in step 1 to predict new migration rates.

The full migration prediction process is described in Figure 1 and discussed in greater detail in section 4.3.

3.2 Migration Data

Ideally, migration data at the county level is necessary in order to obtain the best picture of migration trends and determinants. These data are available from the 1970 Census of Population only through a special tabulation by The Bureau of the Census and was beyond the financial resources and time frame of the present study.

Consequently, a tabulation of the 1965-70 migration data was obtained from The Appalachian Regional Commission (ARC). The ARC originally defined a set of regions which sub-divide the United States and which follow county lines but occasionally cross state boundaries. The Bureau of the Census then tabulated migration data for these ARC regions.

The ARC defined these sub-regions so that each encompasses a single economic area. In this manner localized population movements having little regional significance tend to be ignored, while migration from one economic area to another, usually involving a change of both residence and place of work, is emphasized. These sub-regions do not, however, make complete sense relative to ORBES since some extend beyond the ORBES boundaries. In our analysis, if a portion of an ARC sub-region fell within the ORBES boundary, the entire sub-region was included in the analysis. Although this is not an ideal solution, allocation of portions of regions would have created equal or worse difficulties. Figure 2 shows these sub-regions and Appendix A lists the ORBES counties within each sub-region.

For our analysis, then, only the tabulations pertaining to the 43 ARC sub-regions which fall partially or wholly within the ORBES region were used. The general content of this tabulation is described in Table 1; here one can see that the number of migrants from every sub-region to every other sub-region, is given by age, sex and race. From this data, net migration can be computed for the 43 sub-regions as shown in Table 2. In this table, net migration for a given sub-region is the result of migration between that sub-region and every other sub-region in the U. S. From this data, it is clear the ORBES region as a whole experienced a net loss of population from 1965 to 1970 and that only 15 of the 43 sub-regions showed an increase in population.

Since our analysis is confined to modelling migration internal to the ORBES region, only the tabulations of migration between the 43 sub-regions within ORBES are relevant. These are displayed in Table 3. Note that these migration rates are not broken down by age, sex or race, and that they represent the number of persons migrating from one region to another rather than a net figure. It is this data which was used as the dependent variable in our regression analysis.

A close look at Table 3 reveals several facts about migration within the ORBES region from 1965 to 1970. Regions which included large cities exchanged people with neighboring regions at a high rate. Some of these regions experienced a net loss in the exchange. Region 1 (Pittsburgh) lost population to nearby regions 2 and 3, as well as to region 75, the Canton-Akron area. Region 70, the area just south of Cleveland, also lost people to region 75. Region 71,

(Cincinnati) lost population to surrounding regions, particularly to region 72 which includes Dayton. Those regions which experienced a net gain in population did so as a result of migration from southern rural counties. Region 73 (Columbus) and 72 (Dayton area) drew people from southeastern Ohio (regions 13,14,15); region 152 (Lexington) drew from southeastern Kentucky (regions 22,23,24,28 as well as surrounding regions 151,153). In general there was a net movement of people away from rural regions of Kentucky, West Virginia and southeastern Ohio to major cities. Region 18, for example, experienced a net loss to the regions near Pittsburgh, Wheeling, and the Akron-Canton area.

3.3 Employment, Demographic and Distance Data

The employment and demographic data corresponding to the 1965-1970 migration period were obtained from an array of census materials at the county level and then summed to get totals for the 43 ARC sub-regions. Tables 4 and 5 show what data were collected and their source(s). They included county population, characteristics of the population such as median age and years of schooling completed, female to male ratios, employment by sector and percent unemployment. The actual data is summarized in Tables 6 and 7. The distances between each of the 43 ARC sub-regions was established by measuring from centroid to centroid on a scaled map.

3.4 Data Structure

The data in Table 3, 6 and 7 (with the exception of the net migration figure in Table 6) provided the data base for establishing the relationship between migration on the one hand, and employment, demographic and distance data on the other. A regression analysis was conducted with this data in which gross migration rates were treated as the dependent variable and selected employment, demographic and distance variable were treated as the independent variable. In depth discussion of the regression analysis is given in sections 4.0-4.2.

This regression data was organized in the following manner: For each sub-region i there are 42 data records describing migration from sub-region i to each of the other sub-regions j. The basic structure of any one record, then, is as follows:

Region i data: demographic and employment data describing sub-region i

Region j data: demographic and employment data describing sub-region j

Region i - Region j data: distance between i and j
migrants from i to j

Since there are 43 sub-regions a maximum of 43 times 42 (=1806) data records describing all sub-regions of the ORBES area and all migration between these sub-regions from 1965 to 1970 were possible. The Census Bureau was unable to tabulate migration for some sub-region pairs and thus the actual number of complete records is 1757.

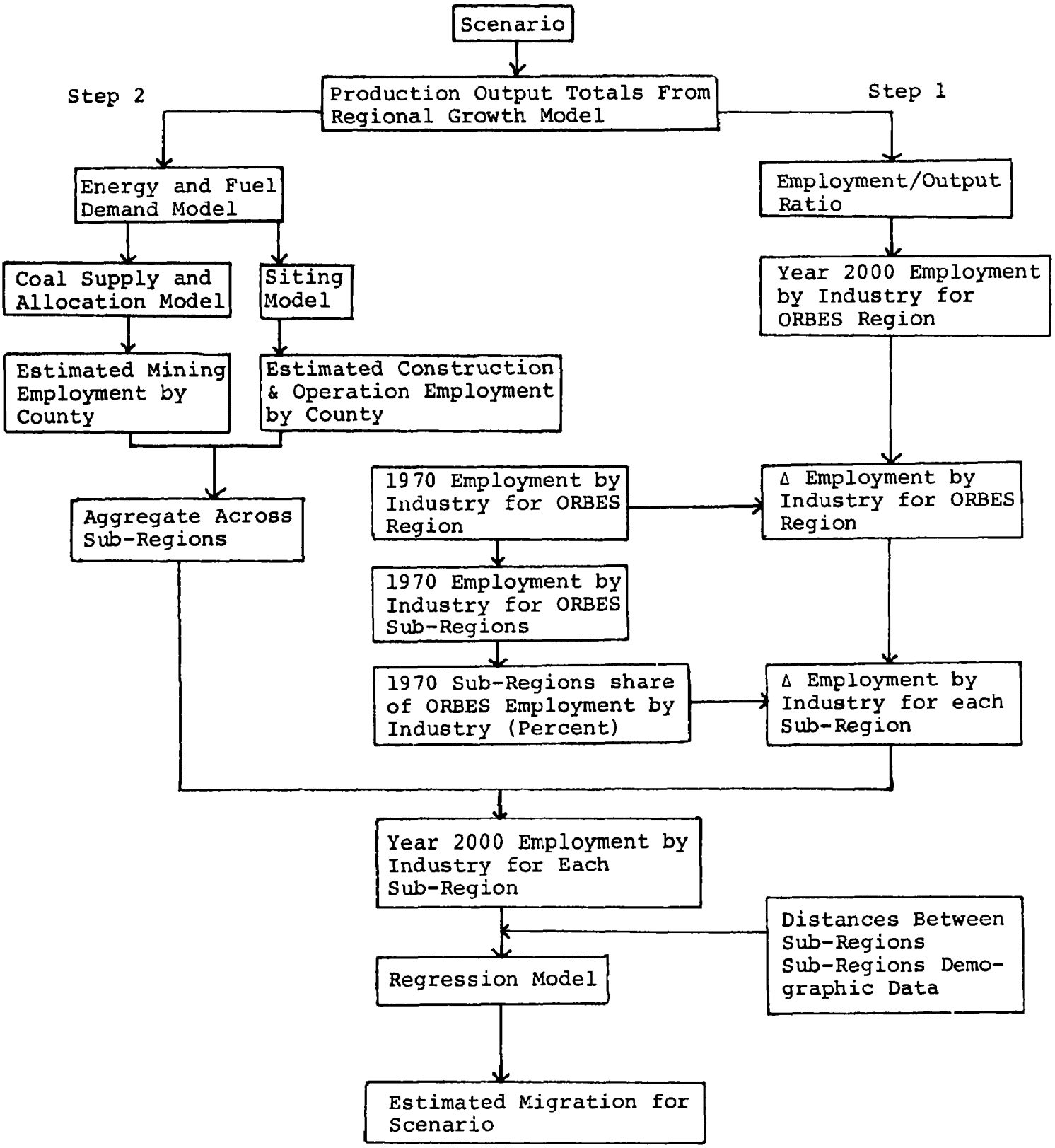
3.5 Employment/Output Ratios

In order to predict migration patterns for each scenario a prediction of employment levels in each sub-region for the major economic sectors is necessary. These predictions were obtained through the use of employment/output ratios which establish the relationship between output and employment levels in a given sector. Such ratios were calculated for a variety of employment sectors for the year 1967.

1967 output levels were provided by the ORBES I/O Model as shown in Table 8 (13). Standard Industrial Codes (SIC) were assigned to each sector in Table 8 and the employment corresponding to these sectors for all counties in the ORBES region was obtained from the 1967 County Business Patterns. The employment for each sector in Table 8 for the entire ORBES region was then obtained by summing across all 423 counties for each SIC code. The employment and output data were then further aggregated into more broadly defined sectors as shown in Table 9. The employment/output ratios were then calculated from these figures and are also shown in Table 9.

When multiplied by the output level projected by the ORBES I/O Model for a given scenario, these employment/output ratios yield the corresponding predicted sector employment for that scenario. Since the result is a sector employment figure for the ORBES region as a whole, it is necessary to break that total down and allocate it to each sub-region. This was done by using the data in Table 7 to calculate the percent of a given sector's total employment contributed by each sub-region in 1970. These same percentages were then used to calculate a sub-region's share in the predicted ORBES total employment for a given sector for the year 2000. The predicted sector employment by sub-region can then be used, along with demographic and distance data, as independent variables in the migration prediction equations.

Figure 1 : Migration Prediction Process



ORBES REGION

FIGURE 2

ARC MIGRATION REGIONS

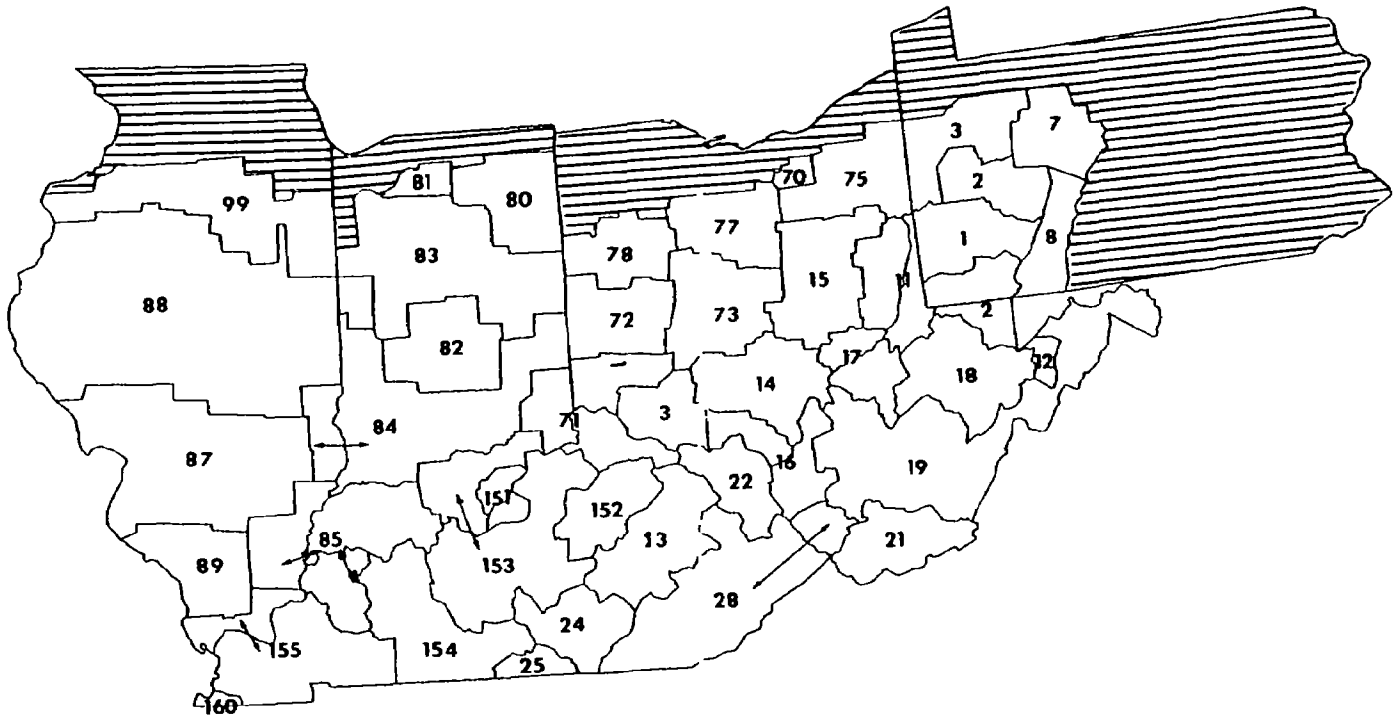


Table 1: Migration Data

Item:	Source:
Total number of persons migrating from sub-region i to sub-region j from 1965 to 1970	Appalachian Regional Commission data derived from U.S. Bureau of the Census migration data
Number of persons migrating from sub-region i to sub-region j from 1965 to 1970, broken down by:	same
Age: 5-17	
18-24	
25-34	
35-55	
over 55	
Sex: male	
female	
Race: white	
other	

Table 2 NET MIGRATION FOR EACH REGION WITHIN ORBES: 1965 TO 1970

FOR REGION	NET NUMBER OF MIGRANTS	BY AGE					BY SEX		BY RACE	
		AGE 5-17	AGE 18-24	AGE 25-34	AGE 35-54	AGE 55	FEMALES	MALES	WHITE	OTHER
1	-57971	-9041	-26357	-3560	-8211	-10802	-29144	-28827	-55237	-2734
2	1001	1142	3188	-2909	-386	-34	763	238	1609	-608
3	-7095	1184	-4707	-1768	-791	-1013	-3424	-3671	-6939	-156
7	-2301	-509	3803	-4122	-921	-552	-2015	-286	-2507	206
8	-14987	-1200	-10189	-1702	-956	-940	-7955	-7032	-14655	-332
11	-13793	-1254	-7807	-1633	-1668	-1431	-6679	-7114	-12904	-889
12	-4072	-800	-2603	-812	-252	395	-3126	-946	-4818	746
13	-481	14	-2659	1563	191	410	-109	-372	-47	-434
14	-103	-339	3091	-2944	-42	131	-1303	1200	-3	-100
15	-6172	-803	-5122	25	-756	484	-2912	-3260	-5609	-563
16	-8779	-1895	-3054	-1374	-1790	-666	-4234	-4545	-8313	-466
17	-1602	199	-1674	17	-179	35	-553	-1049	-1611	9
18	-7120	-1547	-2578	-2270	-418	-307	-3515	-3605	-6895	-225
19	-29826	-5407	-13951	-3664	-4424	-2380	-15462	-14364	-28757	-1069
21	-14974	-2148	-8868	-1237	-1474	-1247	-8071	-6903	-12647	-2327
22	-6153	-827	-3556	-505	-856	-409	-2897	-3256	-5991	-162
23	1347	835	2222	-1654	4	-60	950	397	1504	-157
24	-5974	-1068	-3061	-506	-791	-548	-3140	-2834	-5686	-288
25	-2133	84	-1244	-1373	339	61	-1255	-878	-1648	-485
28	-41249	-7309	-20537	-5999	-4626	-2778	-21108	-20141	-39561	-1688
70	-33577	-6193	-14247	3082	-6430	-9789	-13753	-19824	-39597	6020
71	-11296	-3589	1020	-2286	-2829	-3612	-4691	-6605	-12457	1161
72	7096	1091	1397	6007	96	-1495	3761	3335	4542	2554
73	16406	-922	24315	-4882	-949	-1156	9416	6990	12960	3446
75	2409	3210	-3292	5715	351	-3575	2791	-382	19	2390
77	-1139	1101	-2442	785	-81	-502	-981	-158	-2211	1072
78	-4278	331	-3832	-24	-223	-530	-1589	-2689	-4397	119
79	3256	410	2355	-261	1043	-291	1764	1492	3549	-293
80	3744	1728	-1995	2408	1482	121	1882	1862	2809	935
81	-5165	1824	-6737	1007	69	-1328	-1845	-3320	-6833	1668
82	3487	1386	-613	4909	-161	-2034	2249	1238	241	3246
83	-3194	-3789	11053	-6357	-2504	-1597	-1664	-1530	-3767	513
84	4764	501	8746	-3115	-825	-543	1942	2822	3789	975
85	-10275	-1052	-7259	-238	-1445	-281	-4894	-5381	-9241	-1034
97	-5902	1171	-7030	173	-575	359	-2204	-3698	-6817	915
88	11875	-1725	22598	-7414	-1320	-264	7809	4066	8819	3056
89	6796	1487	5324	-1718	944	759	2801	3995	6258	538
99	6937	4298	-1766	3453	1038	-86	3041	3896	2835	4102
151	-64	643	-2959	2605	615	-968	973	-1037	-701	637
152	10633	32	9415	-226	706	706	5807	4826	10520	113
153	3676	-431	8151	-3621	-787	364	-3118	6794	3136	540
154	1753	831	742	-700	542	338	1086	667	2112	-359
155	-2716	-754	2368	-3689	-1066	425	-2213	-503	-866	-1850
160	-1200	843	-3138	91	611	393	-827	-373	1073	-2273

Table 3 Migration From Each Sub-Region i to Each Sub-Region (j) within ORBES*

REGION	REG1	REG2	REG3	REG7	REG8	REG11	REG12	REG13	REG14	REG15	REG16	REG17	REG18	REG19	REG21	REG22	REG23	REG24	REG25	REG28	REG70
1	.	15982	7596	2862	4942	2552	708	38	170	364	235	221	1003	729	109	130	11	12	13	107	4498
2	20328	.	3900	1892	2261	1962	1202	.	160	136	290	756	2833	1996	879	34	.	6	.	162	1830
3	11649	4181	.	2792	1397	284	120	71	90	173	62	24	239	125	6	.	6	.	17	31	1716
7	3926	1819	2412	.	2767	91	208	.	82	11	37	.	32	83	28	.	.	.	5	.	402
8	3231	1573	736	1897	.	138	744	.	13	77	7	30	113	89	9	.	6	.	.	46	821
11	2553	986	239	70	199	.	265	46	325	1862	328	879	1418	855	286	50	13	7	22	145	1072
12	614	859	82	151	1011	353	.	46	23	32	76	153	1044	388	183	25	.	.	.	27	238
13	34	.	16	11	.	43	7	.	809	106	268	54	20	92	55	172	189	29	.	299	202
14	659	73	120	24	57	494	89	913	.	1077	2372	879	110	587	118	196	64	.	8	209	2360
15	511	146	149	37	36	1988	31	58	1270	.	248	654	382	312	162	46	26	.	6	459	1507
16	467	222	18	10	17	512	84	288	1474	255	.	504	510	4237	1347	1558	97	25	.	1938	1157
17	455	308	63	6	23	993	177	49	650	435	529	.	1258	2067	270	14	29	27	.	156	325
18	1364	1741	84	42	26	1060	956	.	13	38	455	1300	.	2712	636	13	20	.	.	151	735
19	581	847	86	58	63	853	631	10	417	88	2590	1159	2018	.	2981	181	38	.	26	959	1781
21	108	140	62	.	52	196	223	.	29	24	426	254	383	3323	.	67	35	.	6	1641	927
22	122	50	16	.	39	80	66	105	87	17	1438	14	95	317	102	.	745	138	53	1351	186
23	59	.	.	10	.	30	.	353	76	76	123	18	8	90	60	1523	.	878	77	3960	103
24	.	.	.	7	.	.	.	5	.	.	31	14	.	.	.	46	591	.	221	378	13
25	7	16	.	.	.	.	7	.	6	8	7	.	.	34	.	.	19	317	.	141	168
28	68	42	16	.	.	119	107	462	85	69	641	49	181	537	1449	655	1415	295	95	.	741
70	5779	2578	2613	720	1258	1646	325	141	1684	1376	1058	399	1282	3207	1404	148	158	60	169	1351	.
71	1704	332	422	149	153	625	108	10431	1201	739	1338	318	92	1154	286	1082	2751	1046	94	6577	5396
72	1645	278	480	347	83	493	44	1757	2076	698	1354	182	222	644	375	1084	1852	257	357	3814	3631
73	2392	467	476	378	255	2617	161	1774	8169	6477	4689	1180	475	1913	925	1517	165	31	7	3451	9332
75	6819	2398	5063	926	1023	5288	411	286	1354	6623	1072	933	2960	2849	547	262	98	8	176	830	25435
77	657	142	308	52	20	504	100	156	722	1361	820	162	246	409	337	870	107	50	15	815	2570
78	272	55	101	59	62	231	35	75	388	268	222	47	14	111	49	190	194	53	.	662	1233
80	456	160	173	119	144	92	39	139	145	153	171	54	.	222	152	126	253	21	25	2291	909
81	595	121	151	70	94	67	50	16	114	39	43	42	48	549	37	114	60	58	10	683	629
82	910	85	242	68	132	237	31	92	94	215	253	75	26	334	218	201	343	1187	686	2227	1172
83	592	142	215	58	49	74	101	138	95	144	252	27	147	286	259	255	435	646	668	1482	775
84	346	115	175	79	40	46	93	193	50	140	43	50	12	64	31	85	463	209	67	935	389
85	161	12	45	.	10	46	7	10	11	65	93	.	48	77	.	.	54	74	32	254	46
87	214	34	34	12	17	6	13	14	53	104	71	28	.	17	32	12	19	.	.	81	151
88	561	89	302	121	162	117	107	20	118	211	107	82	45	150	33	35	38	125	155	188	752
89	69	.	.	28	16	22	7	7	28	39	9	.	.	15	88	.	.	.	11	107	62
99	447	146	74	47	5	21	180	46	122	197	106	91	30	167	33	31	45	7	80	357	701
151	315	121	96	78	37	18	52	189	93	116	298	146	36	308	87	821	1059	1246	441	2258	632
152	308	32	33	17	61	34	63	243	52	30	285	19	30	135	65	1312	5614	942	196	3735	306
153	293	131	93	48	54	111	212	100	124	103	176	28	118	239	100	390	1041	1200	279	1955	490
154	111	11	55	25	.	54	.	15	28	34	26	.	6	105	.	152	254	530	758	1177	87
155	64	13	15	20	.	24	62	13	.	74	50	.	13	56	50	87	142	152	139	206	371
160	12	.	13	58	29	.	.	.	14	14	13	13	20	6	.	31	16	.	419	36	81

* Example 15982 people migrated from sub-region 2 (REG2) to sub-region 1 (under REGION); 20328 people migrated from sub-region 1 (REGL) to sub-region 2 (under REGION).

Periods indicate missing data

Table 3 (Cont)

REGION	REG 17	REG 27	REG 37	REG 57	REG 77	REG 78	REG 80	REG 81	REG 82	REG 83	REG 84	REG 85	REG 87	REG 88	REG 89	REG 99	REG 151	REG 152	REG 153	REG 154	REG 155	REG 160	REG 161	REG 162	REG 163	REG 164	REG 165	REG 166
1	1119	730	1641	3917	319	184	138	260	506	396	454	241	91	713	27	178	461	151	305	57	65	45	1	1	1	1	1	1
2	175	232	322	1261	284	7	29	23	101	54	212	32	21	109	.	6	18	20	114	.	18	.	2	2	2	2	2	2
3	231	116	233	3452	178	76	56	150	41	273	55	32	135	137	.	152	60	188	109	24	40	20	3	3	3	3	3	3
7	37	171	153	655	53	17	98	41	43	110	86	.	63	114	8	69	62	.	82	.	8	.	7	7	7	7	7	7
8	113	51	80	561	119	8	56	24	7	61	57	.	10	13	5	61	47	.	102	.	14	.	8	8	8	8	8	8
11	174	239	718	2273	245	198	47	176	60	84	94	92	73	82	6	92	.	17	101	.	7	35	11	11	11	11	11	11
12	74	98	166	203	56	18	.	43	24	68	.	18	13	29	5	11	49	7	89	.	7	.	12	12	12	12	12	12
13	13122	1462	841	357	45	54	77	38	103	61	40	21	.	57	.	51	73	185	74	7	27	.	13	13	13	13	13	13
14	1107	1745	6738	1693	832	381	255	88	99	132	102	59	32	154	.	19	95	46	56	38	.	.	14	14	14	14	14	14
15	385	461	3554	6416	1092	215	159	44	107	166	80	142	136	49	84	52	22	20	83	33	6	6	15	15	15	15	15	15
16	665	558	4694	327	316	105	31	15	147	222	69	61	27	115	.	24	122	134	167	51	86	14	16	16	16	16	16	16
17	192	361	589	889	166	101	37	83	24	74	29	18	17	41	10	40	87	68	.	.	22	.	17	17	17	17	17	17
18	123	76	207	856	132	.	35	.	63	64	67	52	42	22	.	12	174	29	43	.	13	.	18	18	18	18	18	18
19	493	123	649	836	124	123	41	79	219	185	28	58	32	70	8	12	157	87	102	38	17	46	19	19	19	19	19	19
21	86	65	306	179	46	.	164	34	58	61	54	69	6	66	10	28	63	59	71	.	26	6	21	21	21	21	21	21
22	720	341	776	80	271	114	78	49	82	103	74	66	35	46	6	7	347	431	155	56	100	.	22	22	22	22	22	22
23	3668	1082	463	52	69	75	77	12	135	253	310	113	41	71	.	74	1347	3651	1774	228	197	.	23	23	23	23	23	23
24	729	92	98	32	.	14	21	5	280	206	112	61	13	27	.	55	408	310	483	236	55	.	24	24	24	24	24	24
25	129	341	36	73	29	54	24	19	485	384	313	85	17	75	.	49	323	65	105	434	103	185	25	25	25	25	25	25
28	3325	1343	1124	161	148	268	484	319	584	257	396	300	63	35	.	75	962	1038	652	356	188	246	28	28	28	28	28	28
70	3414	2381	5341	19578	1612	1180	727	558	1285	628	380	289	187	889	35	325	678	447	439	139	202	115	70	70	70	70	70	70
71	.	12590	6789	3044	1513	1323	850	457	3128	1790	2615	455	299	924	25	276	2233	3181	2032	464	429	104	71	71	71	71	71	71
72	12117	.	8016	2757	1315	4856	1081	667	1203	1922	1926	152	195	794	103	260	969	1032	731	134	168	90	72	72	72	72	72	72
73	6971	9501	.	8321	6499	3864	746	419	1003	985	602	202	255	917	50	281	626	453	470	89	195	149	73	73	73	73	73	73
75	1875	2080	5246	.	2865	1122	581	461	588	815	344	239	178	795	59	179	268	124	562	80	153	89	75	75	75	75	75	75
77	998	883	5075	3258	.	1675	367	260	67	156	123	6	6	131	10	82	174	119	106	34	54	14	77	77	77	77	77	77
78	1066	4432	2457	1117	2028	.	1774	296	179	897	256	49	86	235	56	95	27	66	152	5	57	20	78	78	78	78	78	78
80	965	1050	615	691	281	2411	.	4087	2671	9077	1977	389	227	780	77	560	476	160	320	176	116	81	80	80	80	80	80	80
81	827	224	604	760	267	393	4024	.	1910	4828	2223	638	280	1119	99	814	235	147	326	106	291	294	81	81	81	81	81	81
82	3691	1536	1392	528	255	419	2367	2944	.	14255	16612	3335	481	2561	183	574	2157	397	2178	1136	461	369	82	82	82	82	82	82
83	1989	1726	1073	628	341	777	8147	5902	14472	.	9402	1653	356	2938	99	1129	956	410	1220	247	140	153	83	83	83	83	83	83
84	4247	1644	418	370	269	238	2478	3133	17696	9341	.	4622	939	4398	269	595	2342	346	3043	487	317	84	84	84	84	84	84	84
85	291	100	136	212	214	60	239	379	2531	927	2833	.	1798	1149	1339	469	989	358	1079	2443	1962	51	85	85	85	85	85	85
87	152	409	303	120	68	92	167	222	522	444	1722	2052	.	10093	4013	2470	154	105	182	135	691	272	87	87	87	87	87	87
88	1135	782	1006	703	122	144	653	1081	1671	2690	4524	1551	15263	.	2795	19596	649	345	515	309	1265	342	88	88	88	88	88	88
89	18	25	52	77	.	8	66	150	70	100	252	1476	4378	4168	.	1875	31	45	7	78	1157	55	89	89	89	89	89	89
99	342	386	221	412	133	124	390	769	649	970	851	1077	2515	16266	1132	.	244	85	428	168	669	234	99	99	99	99	99	99
151	2460	1207	520	632	139	203	375	317	1875	880	1673	1779	268	921	82	271	.	3258	14239	3685	1281	95	151	151	151	151	151	151
152	3791	774	640	358	133	126	160	105	347	428	329	603	134	218	32	94	4782	.	4114	1315	1050	84	152	152	152	152	152	152
153	2285	408	558	446	65	150	409	417	1952	1274	2559	1065	144	423	113	236	14596	2278	.	2075	743	204	153	153	153	153	153	153
154	480	146	280	170	107	72	41	126	982	344	428	2471	184	214	58	219	3871	747	2989	.	1574	170	154	154	154	154	154	154
155	328	92	36	504	80	38	84	223	366	279	152	2617	859	984	635	770	1367	626	464	1503	.	1313	155	155	155	155	155	155
160	61	19	35	102	17	.	45	210	132	126	131	69	295	291	93	54	121	79	122	143	1231	.	160	160	160	160	160	160

Table 4: Employment and Demographic Data

Item	Source
Total County Population	1970 Characteristics of the Population, U.S. Bureau of the Census, for Ohio, Indiana, Illinois, Kentucky, Pennsylvania, West Virginia (see footnote*)
County Population Density	1970 Characteristics of the Population*
Female/Male Ratio, County	1970 Characteristics of the Population*
Median Age, County	1970 U.S. Bureau of the Census Summary Topes, Fourth Count
Median Years of Schooling completed, County (persons 25 yrs. and older)	1970 U.S. Bureau of the Census Summary Topes, Fourth Count
Median Family Income, County	1970 Characteristics of the Population*
Percent Unemployment, County	1970 Characteristics of the Population*
Total Employment, County, 1965 and 1970	County Business Pattern: 1965, 1970
County Employment by Sector: 1965, 1970	County Business Patterns: 1965, 1970
agricultural services	"
mining	
contract construction	
manufacturing	"
transportation and other public utilities	"
wholesale trade	
retail trade	
finance, insurance, real estate	"
services	
unclassified establishments	"
Distance in miles from centroid of sub-region i to centroid of sub-region j	Measured from U.S. Geological Survey Maps.

* See Table 7 for specific references.

Table 5: Characteristics of the Population Data

Item	Table Number
Total Population, County	Table 9
Population Density, County	Table 9
Female/Male Ratio, County	Table 34
Median Family Income, County	Table 124
Percent Unemployment, County	Table 121

State	Volume No.	Part No.
Ohio	1	37
Indiana	1	16
Illinois	1	15
Kentucky	1	19
West Virginia	1	50
Pennsylvania	1	40

All references from U.S. Bureau of the Census, 1970 Census of Population and Housing, Characteristics of the Population.

Table 6: Regional Summary Characteristics

Region	Density	1970 Population	1965-70 Net Migration	1970 Total Employment
1	821.48	2401362	-17178	749856
2	120.58	562908	7218	107677
3	129.55	340292	1967	86973
7	59.68	156084	405	39185
8	169.45	262822	-5675	62488
11	209.96	411334	-7688	111330
12	18.04	8607	-1543	1829
13	86.84	169960	802	16126
14	59.76	238026	1566	38193
15	69.39	321028	-2728	71845
16	134.50	321536	-2035	67933
17	74.48	172597	-155	43631
18	68.09	245445	-4161	53269
19	56.34	461921	-12696	104372
21	80.52	238532	-4435	44050
22	87.93	151971	-4557	27526
23	47.67	204987	2671	27676
24	38.58	96361	-5093	11268
25	33.32	26666	-1275	2657
28	56.43	475565	-28284	65765
70	195.09	82717	-7747	14624
71	1031.26	1646764	4349	504250
72	348.58	1089278	10079	325439
73	267.13	1174893	27248	352021
75	528.82	1784006	15003	542330
77	119.45	373357	1174	110637
78	113.37	288937	-1616	80499
80	126.64	469021	5347	160413
81	70.39	54266	-686	9588
82	319.76	1138284	8192	365443
83	114.47	961573	4198	258039
84	79.31	758484	6355	179998
85	86.46	510761	-7705	134667
87	76.82	902941	-4894	180154
88	66.81	1672517	7426	430367
89	64.64	217115	3071	40713
99	60.01	423475	-1293	98171
151	808.12	826553	1785	286078
152	117.37	325239	11815	88418
153	54.16	449389	-680	62397
154	54.13	302612	2592	68916
155	49.10	311100	-304	59192
160	49.67	10183	-834	2236

Table 6 : (Cont'd)

Region	Median	Median Years of Schooling	Female/Male Ratio	Median Family Income	Percent Unemployment
1	27	11	107.07	9368.8	4.2848
2	32	10	105.36	7507.4	4.9762
3	32	9	104.75	8425.0	4.2307
7	42	11	106.96	7826.7	6.1391
8	22	11	106.44	8098.5	4.9058
11	32	11	106.12	8273.8	4.1372
12	27	9	101.66	5320.0	5.6891
13	27	11	103.05	7658.8	4.3549
14	22	11	101.72	7114.4	6.8158
15	27	11	105.32	7890.9	4.9886
16	27	10	105.77	7037.7	6.1722
17	27	9	103.30	6907.0	4.2621
18	32	8	105.82	6102.0	2.1767
19	32	9	103.46	6360.9	5.6962
21	32	10	108.21	6246.7	6.0027
22	27	8	102.36	5682.0	5.3180
23	27	10	101.54	5306.6	5.3316
24	27	8	103.48	4742.5	4.6612
25	27	7	101.64	3942.0	4.8306
28	27	7	103.05	4138.6	7.1904
70	27	8	102.20	11178.0	3.2336
71	54	19	211.58	17924.4	7.9252
72	27	11	104.97	10204.6	5.8109
73	27	11	103.83	9183.5	4.8904
75	27	11	105.22	10313.9	4.8317
77	27	11	103.80	9191.9	3.7125
78	27	11	103.81	9250.0	3.5079
80	27	11	105.54	9938.4	2.9154
81	27	10	104.01	8738.5	3.6634
82	27	11	103.03	10421.7	3.8318
83	27	10	104.43	9310.0	4.6136
84	27	11	106.20	8416.0	4.9628
85	27	10	104.73	7701.3	5.1787
87	32	10	106.16	7958.5	12.2903
88	32	10	106.43	8825.3	9.3776
89	27	11	102.85	7559.0	9.4622
99	32	10	103.57	9577.8	6.7640
151	32	10	107.97	9766.7	4.0303
152	32	10	105.41	7535.4	3.4861
153	27	9	101.71	6998.0	5.1107
154	27	8	104.13	6215.8	4.4667
155	32	8	102.63	6184.7	6.5633
160	27	8	115.46	5546.0	6.4542

Table 7 · 1970 Regional Employment by Sector

REGION	AGRI	MINING	CON	MFG	UTL	WHL	RTL	FIN	SER	UNCL
1	942	8876	37808	290851	46457	49825	136471	39888	137593	1145
2	213	10738	6966	38721	7238	4533	21494	3462	13865	334
3	133	1276	2927	42856	5241	3137	14657	3169	13123	155
7	80	1793	1354	19938	2678	1555	5784	872	4877	63
8	57	4640	2609	24710	4507	2792	10835	1917	10255	166
11	144	5677	4219	45781	6214	4153	18822	3806	15354	88
12	0	0	0	398	250	60	243	35	84	0
13	47	112	1295	4476	1095	582	5386	882	2078	69
14	65	567	1693	14900	2632	1551	9238	1618	5654	42
15	56	3624	2657	32986	4167	3207	12761	2303	9262	95
16	260	497	4024	26735	4591	4063	13977	3223	10056	151
17	43	901	3028	18379	2625	2265	7331	1443	6072	118
18	28	6242	2789	16479	5101	2519	9391	1773	8476	39
19	77	10821	7269	24494	9991	7066	18894	5095	16559	202
21	14	15088	1628	4830	2401	2705	8251	1864	7114	60
22	0	441	2136	11353	1549	1417	4671	1120	4242	127
23	31	213	981	9144	1490	1386	6775	902	4057	7
24	24	124	623	4628	646	560	2633	482	1251	22
25	19	10	101	627	60	143	644	82	370	-1
28	46	20100	2808	7451	3230	3424	13291	2338	11572	311
70	76	60	679	6166	495	682	3208	984	2252	22
71	676	369	24037	206028	30823	38321	88538	29202	84414	803
72	457	621	14637	154256	14735	15632	61875	12431	52182	471
73	762	840	17335	120174	21012	22282	75806	27124	65800	738
75	890	1639	22682	270943	29602	26811	95973	19138	74362	833
77	133	797	3659	59056	5669	3906	19613	3737	13619	174
78	240	93	3987	40114	3320	4586	14701	3084	10107	36
80	317	225	6682	74735	8924	11320	29187	8308	20272	260
81	16	0	416	4051	494	444	2279	373	1475	0
82	609	630	20500	132942	23318	31875	69808	28800	56095	607
83	440	234	9263	138476	9743	8963	51096	10171	28071	274
84	297	2490	9015	81121	9129	8699	38550	7434	21741	308
85	115	5988	6085	52561	7033	7614	25384	5078	21206	204
87	409	4986	4676	67821	11765	7770	37676	8578	30705	348
88	891	1635	22417	151434	25493	26762	94245	26881	77084	565
89	30	2772	1917	14058	2687	1756	9250	1772	5682	42
99	307	738	5521	39601	5225	4877	22915	3303	13920	61
151	478	467	13660	121092	17160	20866	49637	16269	45910	471
152	838	141	6558	29366	5041	5250	17635	5376	16824	166
153	99	263	3014	21223	3495	3580	14672	2565	8291	68
154	134	3181	4626	28079	3219	3412	13899	2695	8794	103
155	246	979	3387	20896	3709	4135	12318	3015	8990	144
160	0	0	61	753	73	353	592	95	304	5

Key

AGRI	Agriculture	FIN	Finances and Real Estate
MINING.	Mining	SER	Services
CON·	Construction	UNCL	Unclassified
MFG	Manufacturing		
UTI	Utilities		
WHL:	Wholesale		
RTL.	Retail		

Table 8 : 1967 Regional Production, Non-Energy Sectors (Gilmore, 1979)

SIC CODE ASSIGNMENT	SECTOR DESCRIPTION	TOTAL OUTPUT (millions of '67 dollars)
15,16,17	CONSTRUCTION	8714
20-29	MANUFACTURING	
201	meat products	1795
20 excl. 201	food excluding meat products	8741
23 excl. 239	apparel and misc. textile products	769
239	misc. fabricated textile products	1508
24	logging and misc. wood products	1601
261,264,266,27	misc. paper products and publications	2828
262	paper mills	342
263	paperboard mills	173
265	paperboard containers	685
281	industrial organic/inorganic chemicals	2153
287,289	agricultural and misc. chemicals	2403
282	plastic and synthetic resins	1119
295	paving and asphalts	134
30	rubber and misc. plastic products	2492
32	glass, stone, and clay products	2933
331	blast and basic steel products	8820
332	iron and steel foundries and forging	1398
33 excl. 331, 332, 336	other primary metal manufacturing	516
336	nonferrous forge, cost, and rolling	2595
34	fabricated metal containers	4954
35	industrial and farm machinery	7815
36	electrical equipment and components	7800
371	truck, bus and auto manufacturing	3930
37 excl. 371	misc. transportation equipment	2609
39	misc. manufacturing	1568
	TOTAL MANUFACTURING OUTPUT	71688
41,42,44,45,48	TRANSPORTATION	
41,48	misc. transportation and communication	2766
42,421,4211	motor freight transportation	2039

Table 8 : (cont'd)

SIC CODE ASSIGNMENT	SECTOR DESCRIPTION	TOTAL OUTPUT (millions of '67 dollars)
44	water transportation	236
45	air transportation	152
	TOTAL TRANSPORTATION OUTPUT	5193
50-51	WHOLESALE TRADE	6050
52-59	RETAIL TRADE	10289
60-67	FINANCE	4132
60-64,6,67	finance and insurance	4132
65	real estate	7828
	TOTAL FINANCE OUTPUT	11960
70,72,73,75,80,82,86	SERVICES	
70,79	hotels, lodging and amusements	2388
72,73 excl. 731	misc. business and personal services	3063
731	advertising	980
75	auto repair	1325
80,82	medical and educational services	3638
86	nonprofit organizations	1389
	TOTAL SERVICES OUTPUT	12783

Table 9 : 1967 Employment/Output Ratios
(No. of Employees/Millions of 1967 Dollars)

SIC CODE RANGE	SECTOR CATEGORY	TOTAL ORBES EMPLOYMENT	TOTAL ORBES OUTPUT (millions of 1967 dollars)	EMPLOYMENT/ OUTPUT RATIO
15,17	CONSTRUCTION	319,205	8714	36.631282
20-39	MANUFACTURING	2,270,693	71688	31.674659
41-48	TRANSPORTATION	246,917	5193	47.548045
50-51	WHOLESALE TRADE	337,979	6050	55.864297
52-59	RETAIL TRADE	1,059,762	10289	102.99951
60-68	FINANCE	273,924	11960	22.903344
70-86	SERVICES	749,594	12783	58.639912

4.0 Derivation of Migration Models

Given the basic data and theoretical approach described in sections 2.0 and 3.0, two migration models were derived. The first utilized employment by sector along with the other population and distance variables as the independent explanatory variables for migration. In using this model for future projections, some major problems arose because of the nature of the data base. Thus, a second model was derived which substituted unemployment estimates for the employment variables. Each of these models is discussed in turn below.

4.1 Employment Based Migration Model

The first model tested in this study utilized a migration equation with the following general form:

Eq. 1

$$M_{ij} = f\,(TE_i, TE_j, El_i - El0_i, El_j - El0_j, D_{ij}, A_i, A_j, ED_i, ED_j, FMR_i, FMR_j)$$

where: M_{ij} = total number migrants from i to j

TE_i (TE_j) = total employment in sub-region i (j)

$El_i - El0_i$ ($El_j - El0_j$) = employment in sub-region i (j) for each of ten sectors.

- El: agricultural services
- E2: mining
- E3: contract construction
- E4: manufacturing
- E5: transportation
- E6: wholesale trade
- E7: retail trade
- E8: finance, insurance, real estate
- E9: services
- El0: unclassified establishments

D_{ij} = distance in miles between centroids of i and j

A_i (A_j) = median age of i (j)

ED_i (ED_j) = median years of schooling completed in i (j)

FMR_i (FMR_j) = female to male ratio in i (j)

The actual equations were derived using linear regression analysis, assuming a non-linear relationship between the dependent variable, migration, and all independant variables. A logarithmic transformation of the ARC migration data and the employment/demographic/distance data gave excellent empirical results, yielding a migration equation with a coefficient of determination (R^2) of 0.968. This means that almost 97% of the migration changes were explained by the independent variables chosen. The actual equation derived was:

Eq. 2

$$\begin{aligned}\log_{10} M_{ij} = {} & 0.47205030 \log_{10} TE_i + 0.59835792 \log_{10} TE_j \\ & -0.6525517 \log_{10} E3_i - 0.17851250 \log_{10} E4_i \\ & -0.31055967 \log_{10} E5_i - 0.92875838 \log_{10} E6_i \\ & -0.40063660 \log_{10} E7_i + 0.66509703 \log_{10} E10_i \\ & -0.08943625 \log_{10} E3_j - 0.16063457 \log_{10} E4_j \\ & -1.10771851 \log_{10} E6_j + 1.02603079 \log_{10} E8_j \\ & +0.43420710 \log_{10} E10_j - 1.93003811 \log_{10} D_{ij} \\ & +0.84364045 \log_{10} A_i - 1.43443765 \log_{10} Ed_i \\ & +2.37172640 \log_{10} FMR_i + 1.58257969 \log_{10} A_j \\ & -1.03546675 \log_{10} ED_j - 2.21746006 \log_{10} FMR_j\end{aligned}$$

and M_{ij} = anti-log ($\log_{10} M_{ij}$).

In this model, then, estimates of future migration between sub-regions were obtained by estimating total employment, TE, for each sub-region as well as employment for individual sectors, E1-E10.

It is unclear what effect, if any, such phenomena as the post World War II baby boom will have on future levels of employment; it has not been studied in the migration literature and no data are currently available with which to model its impact on employment in the future. Thus demographic characteristics such as median age, years of schooling completed, and female/male ratio were assumed constant overtime and taken from the original 1970 data file.

As we discuss in detail in section 4.3, this model did not work well in projecting migration to the year 2000. The reasons for this appear to be related to the state of the economy in 1970, particularly in the mining sector. Thus, we derived an alternative empirical migration model.

4.2 Unemployment Based Migration Model

The second migration model shows the relationship between unemployment rates, the population and distance variables, and migration. The general equation is as follows:

Eq. 3

$$M_{ij} = f(UNEMP_i, UNEMP_j, TE_i, TE_j, MFI_i, MFI_j, D_{ij})$$

where: M_{ij} = total number migrants from sub-region i to j

$UNEMP_i$ ($UNEMP_j$) = percent unemployment in i (j)

TE_i (TE_j) = total employment in i (j)

MFI_i (MFI_j) = median family income in i (j)

D_{ij} = distance in miles between centroids of i and j

The specific regression results are shown as Table 10. Here, we see that again we have obtained a very high R^2 indicating good empirical results. The major problem posed by this equation is one of estimating future unemployment rates. Although we cannot do so with a high degree of accuracy, we found that the ORBES scenarios gave us enough information to make estimates suitable for comparing scenario by scenario differences in migration impacts.

4.3 Application of the Migration Equations to ORBES

Our application of the first migration equation, that based on employment, involved a number of steps. These are illustrated in Figure 1. We began with output estimates taken from the regional I/O model for the year 2000. Our employment/output ratios were then used to derive the year 2000 ORBES employment estimates by industry. This can be thought of as the first constraint on our model. Constraints on minimum county level employment in mining, construction and utilities were also derived using information from the coal supply and allocation model and the power plant siting model.

The next steps involved summing the constraints to sub-regional and regional levels. The base year (1970) employment totals were used to calculate the change in employment by sector (Δ employment) for the region. For those industries which were not constrained in their subregional location by the ORBES scenarios (i.e. everything but mining, construction, and utilities) we allocated the new employment in proportion to the share of employment present in 1970. Thus, we implicitly assumed no shift occured in the location of employment in these industries.

For mining, construction, and utilities, we allocated employment to the sub-regions based on the shares as constrained by the aggregated sub-regional totals. This completed the employment data needed for the year 2000 in order to run the regression model.

Next, we read in the remaining regression model data on distances and demographic characteristics and obtained an estimate of migration between 1970 and 2000.

Using this process, we estimated migration in ORBES for each scenario. Unfortunately, we found a grave inconsistency in model results. In those regions with high projected increases in mining employment, the model was predicting heavy out-migration. This is the opposite of what we would expect. In fact, we would expect those sub-regions to have lower out-migration, net migration near zero, or net in-migration relative to the base period. Looking back at our original data we discovered that the reason for the discrepancy was the unemployment level in mining in 1970. At that time, a large number of miners were out of work because of depressed market conditions. Thus, those regions with high mining employment also had a large number of unemployed which in turn brought about net out-migration.

The model we derived based on employment thus predicted that as the proportion of mining employment increased, so did net out-migration. However, the market conditions assumed by our scenarios in the year 2000 are not those that existed in 1970. As a result, we were forced to derive a second migration model linked to unemployment rates in order to avoid this problem. Although this unemployment based model is not as well linked to the ORBES I/O work it was the only way we could see to get around the empirical problems caused by the employment based model.

The unemployment based equation was found to be a much more consistent estimator of migration trends in the region. Table 11 shows the actual vs. estimated net migration for the region in 1970. Here, one can see that the model projects the direction and order of

magnitude of migration correctly for most of the migration regions. However, there are a significant number of regions for which an incorrect estimate is made. The reason for this discrepancy is related to the non-linear form of the equation. Although the linearly transformed equation gives a regression estimate with an R^2 of .95, the logarithmic form of the equation means the transformation back to non-linear form expands the errors of the model exponentially. This is not a problem unique to our migration model but instead is one common to all similar models reported in the literature.

Another problem with the unemployment model lies in the prediction of unemployment and income for each subregion. Here, we had to make estimates of changes based on projected mining and other employment changes. These estimates are made rather arbitrarily since we have no regional unemployment and income model. However, they should still be accurate enough to allow the comparison of migration impacts of various scenarios.

Given these problems, we do not have very great confidence in the numeric predictions from our migration model. However, we do believe that the general direction and magnitude of migration predicted is adequate for a comparison of the migration impacts of various economic and other conditions related to the ORBES scenarios. Our final chapter makes these comparisons.

Table 10

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOTALMIG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	7	9699.08351808	1385.58335973	5799.78	0.0001	0.958676	21.3893
ERROR	1750	418.07963251	0.23890265		STD DEV		TOTALMIG MEAN
UNCORRECTED TOTAL	1757	10117.16315059			0.48877668		2.28514984

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE IV SS	F VALUE	PR > F
PCUNEMP1	1	8754.76280087	36645.73	0.0001	1	0.75009576	3.14	0.0766
PCUNEMPJ	1	154.75174642	647.76	0.0001	1	0.74962585	3.14	0.0767
MFII	1	303.87398867	1271.96	0.0001	1	0.64295063	2.69	0.1011
MFIJ	1	18.66008841	78.11	0.0001	1	17.38007199	72.75	0.0001
TOTEI	1	57.49502624	240.66	0.0001	1	18.24870064	76.39	0.0001
TOTEJ	1	40.70256952	170.37	0.0001	1	15.08975823	63.16	0.0001
DISTANCE	1	368.83729795	1543.88	0.0001	1	368.83729795	1543.88	0.0001

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
PCUNEMP1	0.15719813	1.77	0.0766	0.08871550
PCUNEMPJ	0.15827303	1.77	0.0767	0.08935012
MFII	0.18323816	1.64	0.1011	0.11169599
MFIJ	0.45011305	8.53	0.0001	0.11139353
TOTEI	0.21218852	8.74	0.0001	0.02427819
TOTEJ	0.19240299	7.95	0.0001	0.02420924
DISTANCE	-1.85650032	-39.29	0.0001	0.04724851

Table 11: Actual and Estimated Migration For 1970

REGION	ACTUAL	ESTIMATE
1	-17178	2078
2	7218	-1129
3	1967	-162
7	405	-443
8	-5675	-97
11	-7688	161
12	-1543	-732
13	802	-422
14	1566	-962
15	-2728	-813
16	-2035	-549
17	-155	-1072
18	-4161	-2118
19	-12696	-1703
21	-4435	-1148
22	-4557	-2562
23	2671	-4451
24	-5093	-1880
25	-1275	-870
28	-28284	-4557
70	-7747	3028
71	4349	3469
72	10079	4208
73	27248	1088
75	15003	2704
77	1174	911
78	-1616	784
80	5347	1550
81	-686	274
82	8192	4418
83	4198	197
84	6355	-1219
85	-7705	-213
87	-4894	-387
88	7426	57
89	3070	44
99	-1293	726
151	1785	4247
152	11815	1787
153	-680	-1274
154	2592	-1369
155	-304	-1348
160	-834	-251

5.0 Migration Impacts of the ORBES Scenarios

Given our migration model, we proceeded to simulate the migration impacts of various changes or shifts in regional employment and the impact of scenario differences. The regional employment shifts were based on the 1965-70 rates shown in Table 12.

In order to estimate unemployment and median family income, we utilized changes in employment as an indicator. We simulated migration using several rate differences and decision criteria but only report some representative ones here.

In the first simulation we used 1965-70 shifts in manufacturing employment as our indicator for change. Scenario 1 (Business As Usual or BAU) was used as our backdrop relative to total regional employment calculated using our employment/output ratios. Then we calculated the total sub-region employment in the year 2000 if manufacturing continued to shift from one part of the region to another at 1965-70 rates. The manufacturing employment in the year 2000 was calculated and used as an indicator of unemployment changes. Unemployment levels were initially set to 5.5%. Arbitrarily, we said that if manufacturing employment increased by over 1000 then unemployment would be reduced to 2.5% and median family income would increase to $10,000 (1970 dollars). If manufacturing employment decreased, then unemployment shifted to 6.5% and median family income dropped to $9,000. All other sectors were assumed stationary for this simulation run. The results of the simulation are shown in Figure 3.

A shift in manufacturing employment at the 1965-70 rate appears to result in a shift of population away from most of the major population areas to smaller urban areas and to rural regions. The exceptions to this are the Indianapolis, Indiana and Lexington, Kentucky regions which are still forecast to have net inmigrants. This finding seems consistent with recent urban-rural migration trends, reports of older industries in urban areas closing and of new industries in less populated areas opening. Examples include the closing of Youngstown Sheet and Tube and U.S. Steel in Youngstown, the building of a new Volkswagen assembly plant in New Stanton, Pennsylvania and the plans for a major steel facility in Conneaut, Ohio. Should this trend continue, the implication for ORBES is that changes in population related to energy growth will be reinforced by changes in the location of manufacturing concerns. Thus the combined impacts may in fact be larger than anticipated. However, these impacts may be more easily ameliorated than otherwise might be the case because growth in some areas will be stable.

A second simulation, using the same methods for determining unemployment and income levels, was conducted for the construction industry. Figure 4 shows the migration forecast. There are several differences from the manufacturing simulation. The Cincinnati area is expected to have net inmigration rather than net outmigration. Similarly Portsmouth, Ohio, Central Illinois, Northwestern Pennsylvania, Southern West Virginia, and the area south of South Bend, Indiana, will all have a reversal in migration. This implies that, historically, construction unrelated to manufacturing has been occuring in these areas and has induced inmigration.

Figures 5 and 6 show similar distributions using services and finance sectors respectively as the forecasting variables. Here again, there are minor differences but no major changes. Table 13 summarizes the differences between figures 3,4,5 and 6.

What these results indicate is that a general shift of population away from major metropolitan areas to rural areas has been occurring in the recent past in conjunction with shifts in employment. If these shifts continue this same pattern of internal migration will result in the future and may have some affect on the direct population impacts of coal mines and power plants.

Another set of simulations was made to compare the net migration impacts of various scenarios. Although the model predicts gross migration, net figures are reported in order to simplify the results for discussion. Scenarios 1, 4, and 5 were selected because of their differences in terms of economic assumptions. Essentially these model runs assumed that all sectors except mining would shift at the 1965-70 rate. Mining employment was projected based on scenario projections of the amount and location of new mining employment by county. For these runs, unemployment rates were initially set high at 7.5% to be consistent with higher levels in mining areas. These were then summed to the subregional level. If mining employment increased by over 1000, unemployment levels dropped to 2.5 and income increased to $10,000. The result of these simulations show the impacts of scenario-based mining projections on subregional migration. The results of these runs are given as Figures 7, 8, and 9, and Table 14 summarizes their differences. Here, one can see that the migration model is insensitive to scenario differences in mining at this geographic scale with only region 8 in Pennsylvania falling into a different net migration class in scenario 5 vs. 1 and 4. The reasons for this are because mining is concentrated in the same portions of the ORBES region regardless of scenario and all scenarios produce significant increases in mining employment. Comparing these figures to Figure 3, one can see a significant shift in population toward mining subregions brought about by these assumptions. This is consistent with what one would expect to occur when these relatively rural, low population areas require major increases in labor force.

Although there are no major scenario differences in migration impacts according to our model, there are significant shifts in population predicted as a result of potential shifts in employment in the major sectors such as manufacturing and mining. These shifts, in turn, imply changes in the distribution of point and non-point sources of air and water pollution. Current ORBES efforts do not allow the estimation of the impacts of these shifts on pollutant levels but future research efforts could do so.

In summary, the migration model which we operationalized demonstrates several trends that are of relevance to the ORBES assessment. First, the continuation of internal migration trends into the future may result in a shift of pollutant sources away from many major metropolitan areas to more rural areas. These trends would particularly exacerbate the air pollution problems associated with the location of power plants in the study region. It is important to note that in many cases population is predicted to shift to the same areas where utilities have scheduled plant additions and where the ORBES siting model has allocated "conjured" plants.

The second result of importance to the ORBES analysis is the predicted shift of population toward the mining regions of ORBES. Although the predicted net migration at the scale of our 43 regions is low, net migration at the county or community scale can be expected to be quite high. This implies in turn, potential problems associated with the provision of public and health services.

Finally, the combination of these trends points to the potential for synergistic impacts on the physical, social, and economic environment as people, power plants, mines, and industries concentrate in previously low population areas of the region. Our results thus point to a number of secondary impact analyses which could be performed in order to assess the magnitude of those synergistic effects.

Table 12

PERCENT CHANGE IN EMPLOYMENT WITHIN EACH REGION FROM 1965 TO 1970 FOR VARIOUS SECTORS

REGION	MINING	CONSTRUCTION	MANUFACTURING	WHOLESALE	RETAIL	FINANCIAL	COMBINED WHOLESALE RETAIL FINANCIAL	SERVICES
1	0.1	-0.2	-1.3	-0.1	-0.1	-0.5	-0.7	-0.8
2	-0.2	0.8	-0.1	-0.0	-0.1	-0.2	-0.2	-0.0
3	-0.1	0.1	-0.2	-0.1	-0.1	-0.0	-0.2	0.0
7	-0.5	-0.1	0.1	-0.0	-0.1	-0.1	-0.2	-0.0
8	0.0	0.2	-0.1	-0.0	-0.1	-0.1	-0.2	-0.0
11	1.0	-1.2	-0.3	-0.2	-0.0	-0.1	-0.3	-0.1
12	-0.3	0.0	-0.0	-0.0	-0.0	0.0	-0.0	-0.0
13	0.1	0.1	0.0	-0.0	0.0	0.0	0.1	0.0
14	-0.3	0.0	0.1	0.0	-0.0	0.1	0.0	0.0
15	0.7	0.1	0.1	-0.0	-0.1	0.1	0.0	0.0
16	-0.3	-0.1	-0.1	-0.2	-0.1	-0.1	-0.4	0.0
17	-0.1	0.3	0.0	0.0	-0.1	0.0	-0.0	0.0
18	-0.6	0.3	-0.0	-0.1	-0.1	-0.0	-0.3	-0.1
19	-0.1	0.8	-0.3	0.0	-0.2	-0.0	-0.1	-0.1
21	2.6	0.0	0.0	-0.1	-0.1	-0.0	-0.2	-0.0
22	-0.1	-0.0	0.0	0.1	-0.0	0.0	0.1	0.1
23	-0.1	-0.1	0.1	0.1	0.1	0.0	0.1	-0.0
24	-0.0	0.0	0.1	-0.0	0.0	0.0	0.0	-0.0
25	-0.0	0.0	-0.0	0.0	-0.0	0.0	0.0	0.0
28	-0.2	-0.0	0.1	0.1	0.0	0.0	0.1	0.2
70	-0.0	0.0	0.1	0.1	0.0	0.0	0.1	-0.0
71	0.0	0.6	0.2	0.7	-0.0	-0.2	0.5	0.2
72	0.1	-0.8	0.3	-0.3	0.4	0.2	0.3	0.1
73	-0.1	-0.2	0.1	-0.0	0.6	0.6	1.2	0.5
75	-0.2	-0.1	-0.1	0.1	0.2	0.1	0.4	-0.2
77	-0.0	0.0	0.1	-0.0	0.1	-0.0	0.0	-0.0
78	-0.0	0.2	0.2	0.1	-0.1	-0.0	-0.0	-0.0
80	0.1	0.1	0.2	0.0	0.1	0.1	0.2	0.1
81	-0.0	0.0	0.0	0.0	-0.0	0.0	0.0	-0.0
82	0.1	0.4	-0.1	0.4	0.3	0.1	0.7	0.2
83	-0.0	-0.3	-0.3	-0.3	-0.1	-0.2	-0.6	-0.1
84	-0.1	0.5	-0.1	-0.1	-0.1	0.0	-0.1	0.1
85	-2.1	-0.7	0.1	-0.0	-0.1	-0.1	-0.2	0.1
87	0.8	-0.5	-0.2	-0.3	-0.2	-0.1	-0.6	0.3
88	-0.3	-0.3	-0.0	-0.3	-0.3	0.1	-0.6	-0.1
89	0.1	-0.1	0.1	-0.0	0.0	0.0	0.0	-0.0
99	-0.1	0.5	-0.0	-0.0	0.1	0.0	0.1	0.0
151	0.0	-0.8	0.7	0.1	0.2	0.0	0.3	-0.1
152	0.0	-0.0	0.3	0.1	-0.0	0.1	0.2	-0.1
153	0.0	0.1	0.2	0.1	0.0	0.0	0.2	0.0
154	0.6	0.3	0.2	0.2	0.0	0.1	0.3	0.1
155	-0.0	-0.1	0.1	0.1	-0.1	0.0	-0.0	0.1
160	0.0	-0.0	0.0	-0.0	0.0	-0.0	-0.0	-0.0

FIGURE 3

ØRBES REGIØN

SCENARIØ NØ. 1 : MANUFACTURING SHIFT

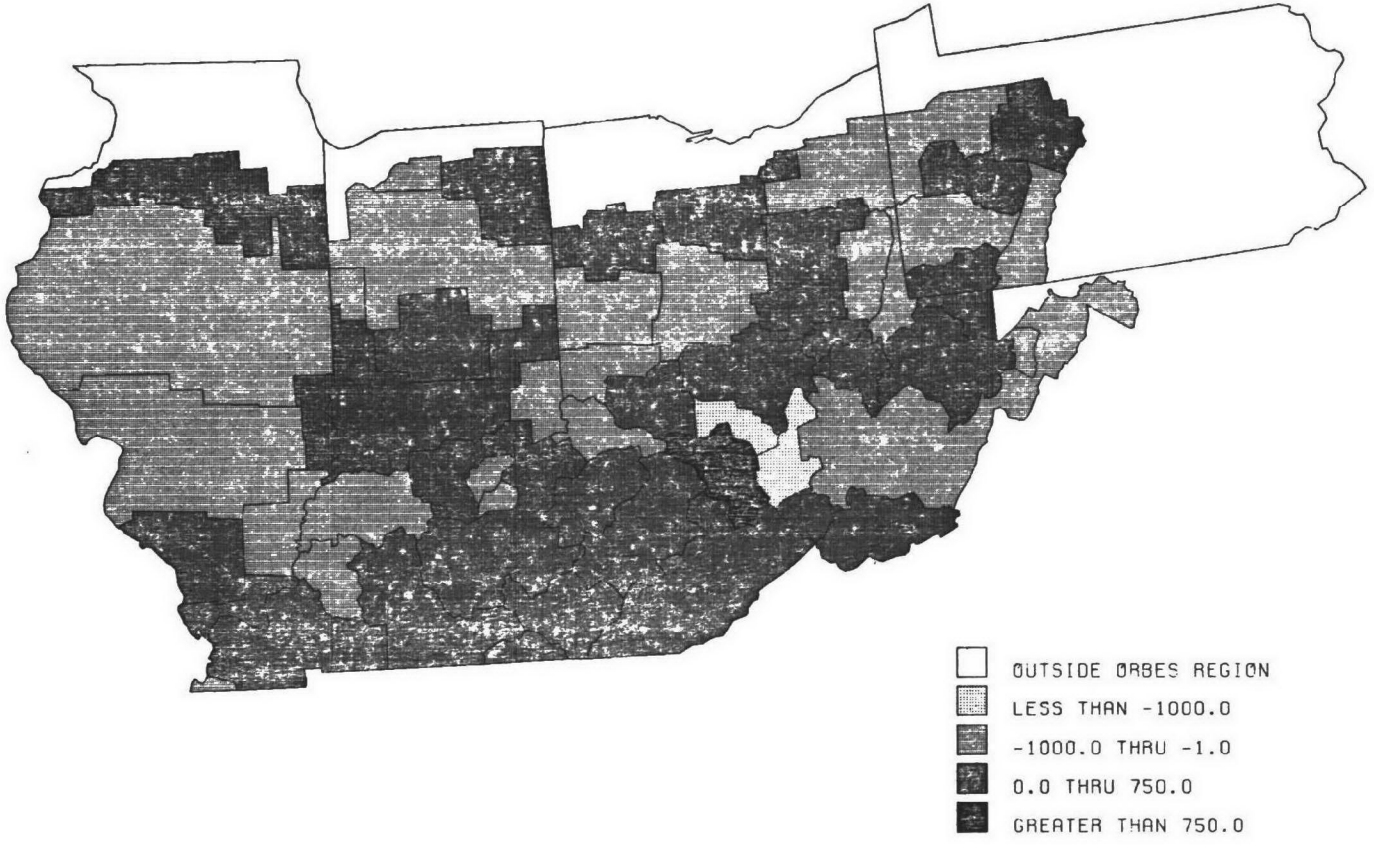


FIGURE 4

ORBES REGION

SCENARIO NO. 1 : CONSTRUCTION SHIFT

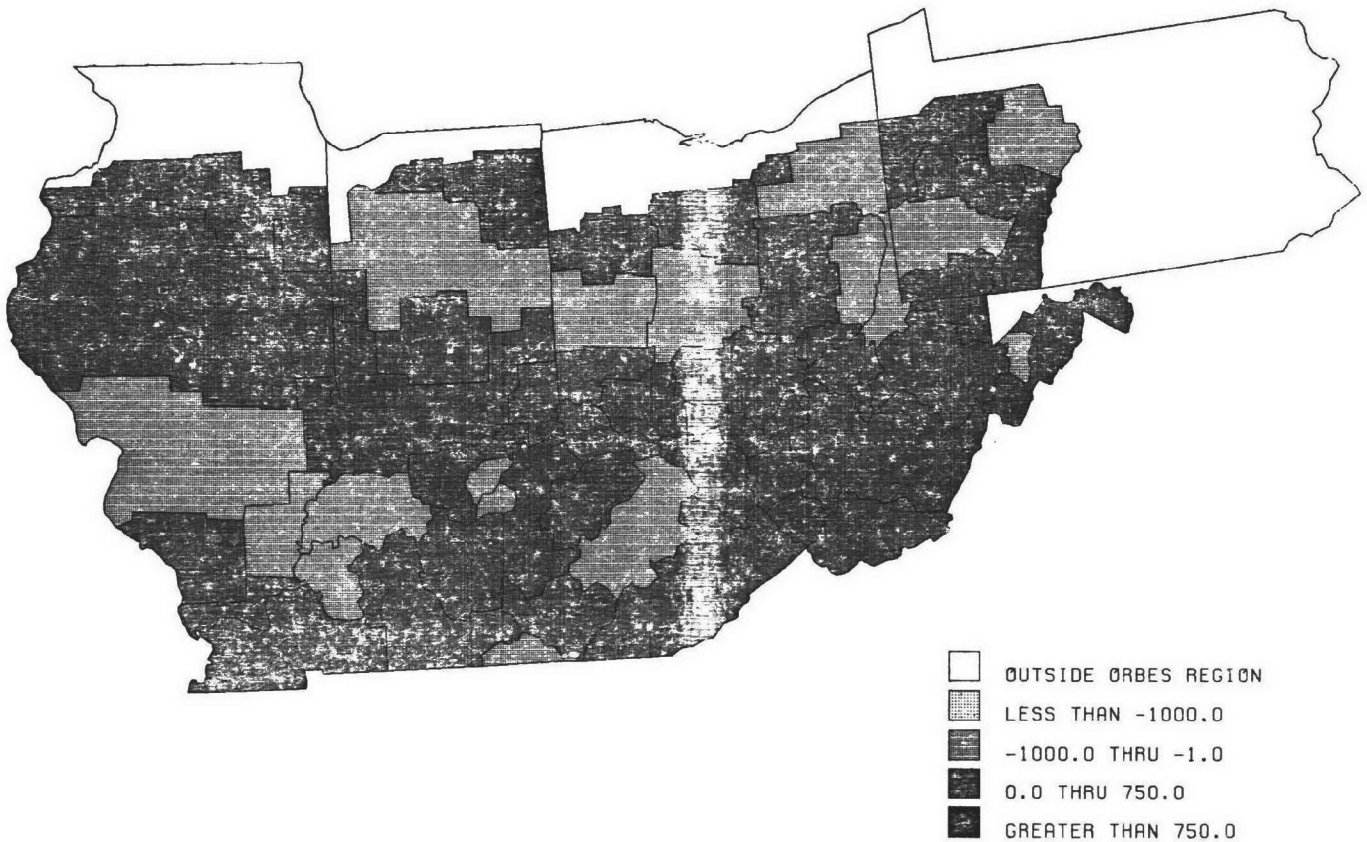


FIGURE 5

ØRBES REGIØN

SCENARIØ NØ. 1 : SERVICE SHIFT

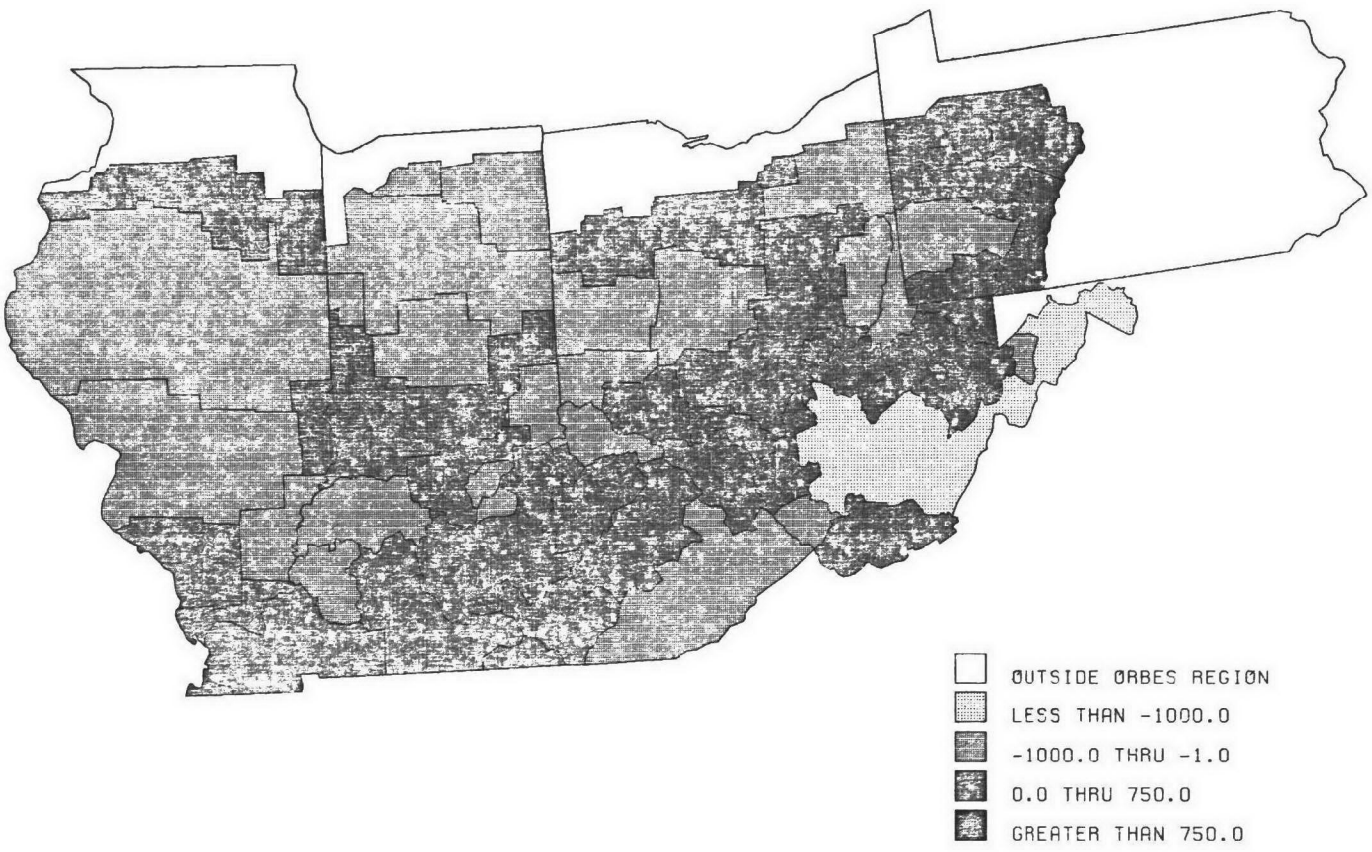


FIGURE 6

ORBES REGION

SCENARIO NO. 1 : FINANCIAL SHIFT

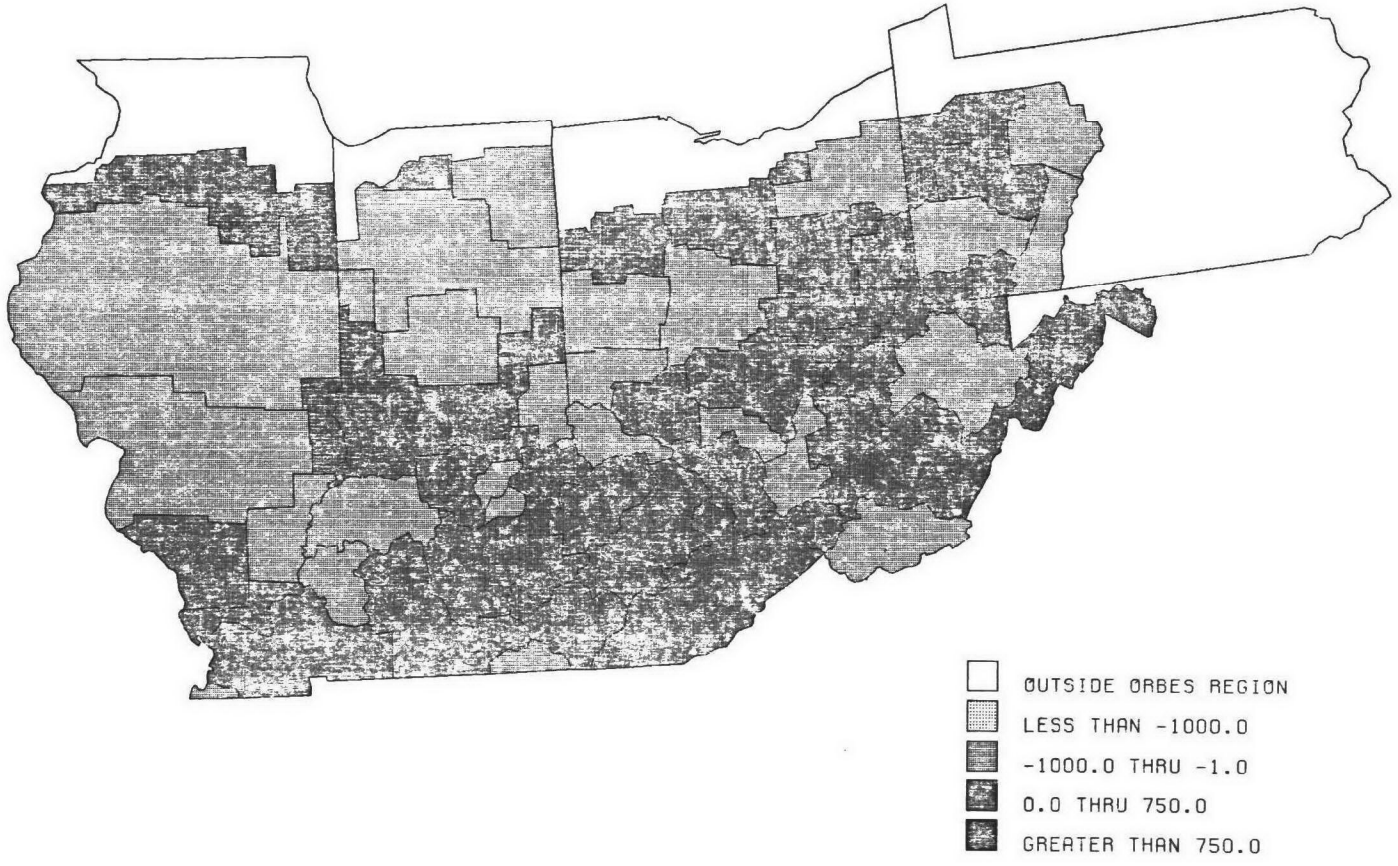


Table 13: Sub-Region Net Migration Impacts for Scenario 1

A Summary of Figures 3,4,5, and 6

		Shifts Due To:			
OBS	REGION	Manufacturing	Construction	Services	Finances
1	1	2	2	2	2
2	2	3	3	3	3
3	3	2	3	3	3
4	7	3	2	3	2
5	8	2	3	3	2
6	11	2	2	2	3
7	12	2	2	2	3
8	13	3	3	3	3
9	14	3	3	3	3
10	15	3	3	3	3
11	16	1	3	3	2
12	17	3	3	3	3
13	18	3	3	3	2
14	19	2	3	1	3
15	21	3	3	3	2
16	22	4	3	3	3
17	23	3	2	3	3
18	24	3	3	3	3
19	25	3	2	3	2
20	28	3	3	2	3
21	70	3	3	3	3
22	71	2	3	2	2
23	72	2	2	2	2
24	73	2	2	2	2
25	75	2	2	2	2
26	77	3	3	3	3
27	78	3	3	3	3
28	80	3	3	2	2
29	81	2	3	2	3
30	82	3	3	2	2
31	83	2	2	2	2
32	84	3	3	3	3
33	85	2	2	2	2
34	87	2	2	2	2
35	88	2	3	2	2
36	89	3	3	3	3
37	99	3	3	3	3
38	151	2	2	2	2
39	152	3	3	3	3
40	153	3	3	3	3
41	154	3	3	3	3
42	155	3	3	3	3
43	160	2	3	3	2

Code: Net Migrants

1: more than -1000
2: -1000 thru -1
3: 0 thru 750
4: greater than 750

FIGURE 7

ORBES REGION

SCENARIO NO. 1 : NET MIGRATION

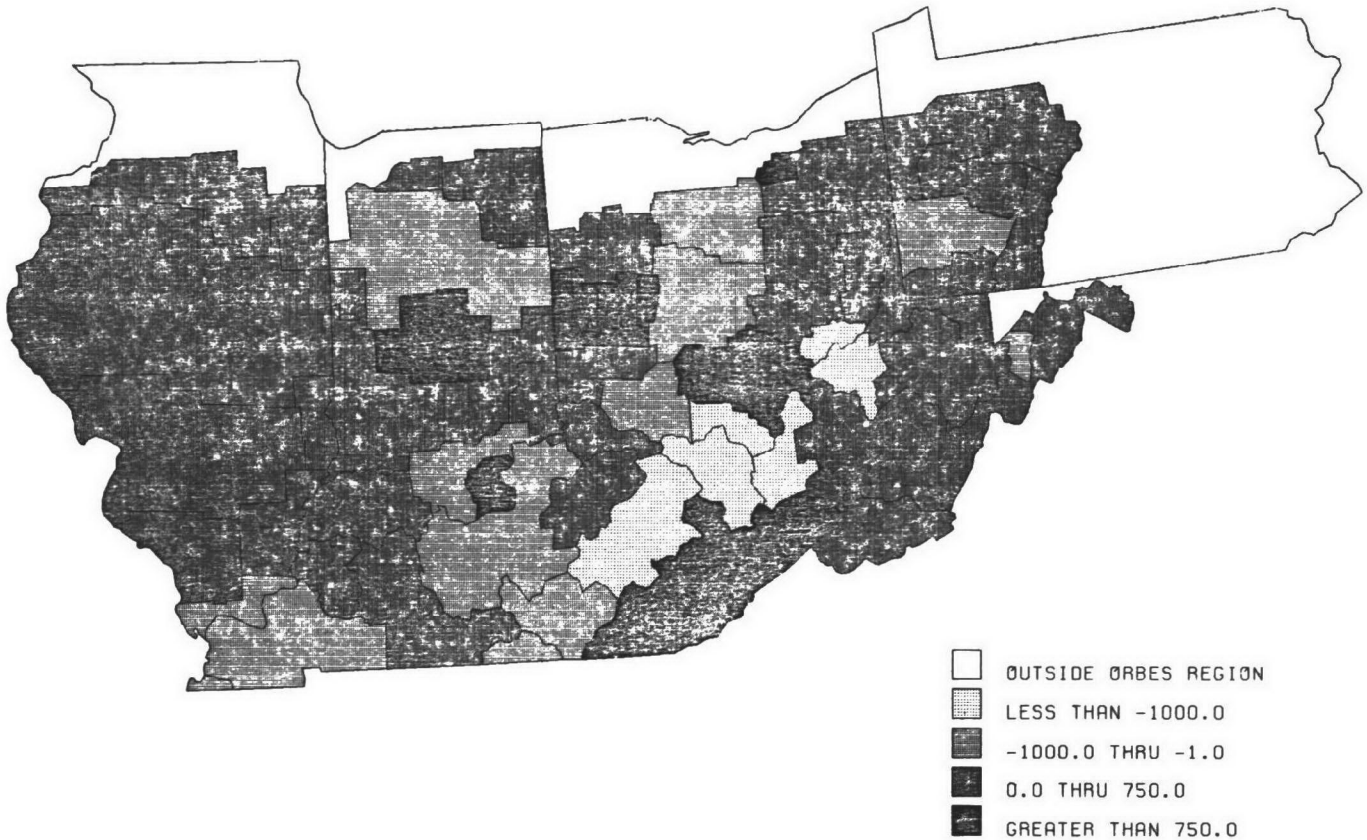


FIGURE 8

ØRBES REGIØN

SCENARIØ NØ. 4 : NET MIGRATIØN

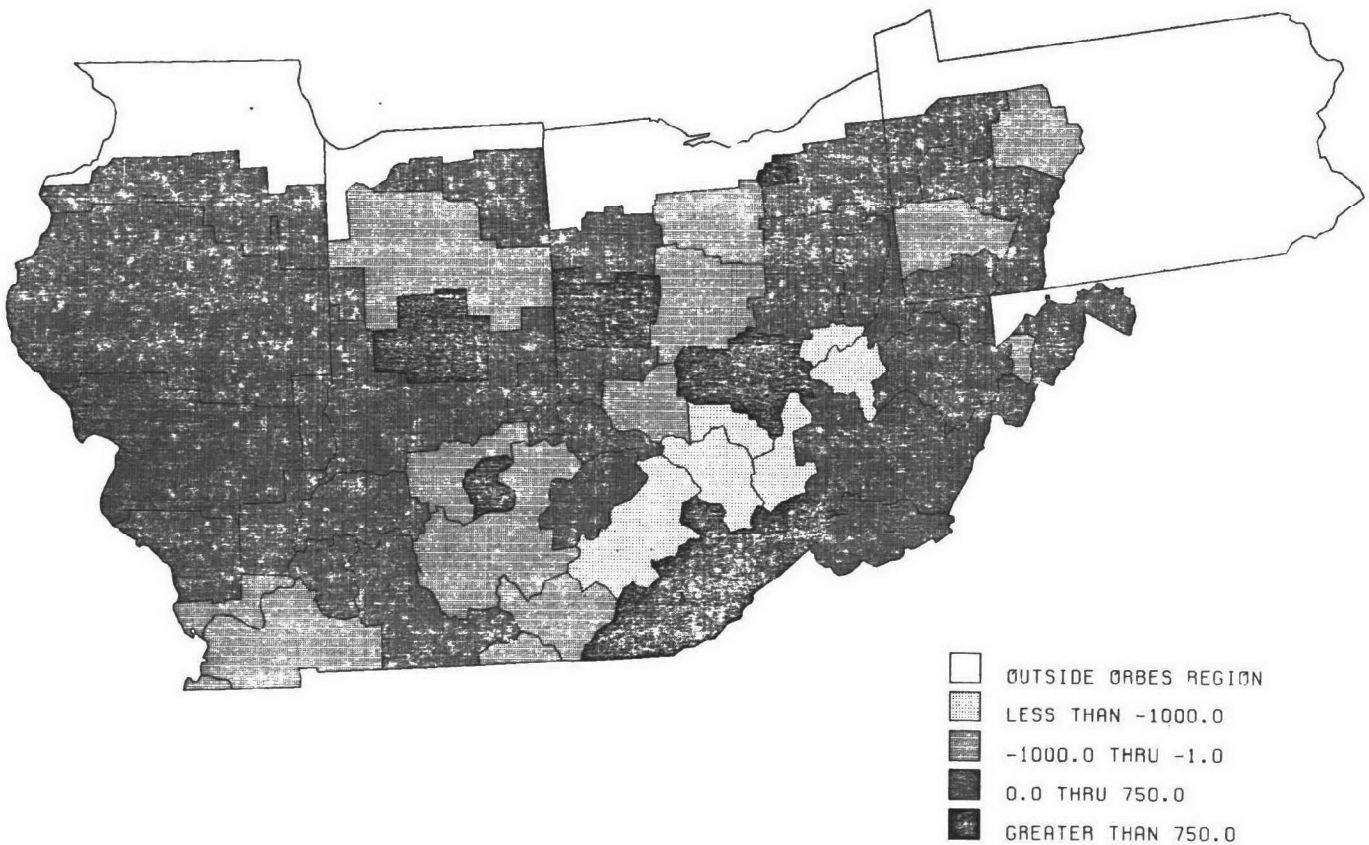


FIGURE 9

ØRBES REGIØN

SCENARIØ NØ. 5 : NET MIGRATIØN

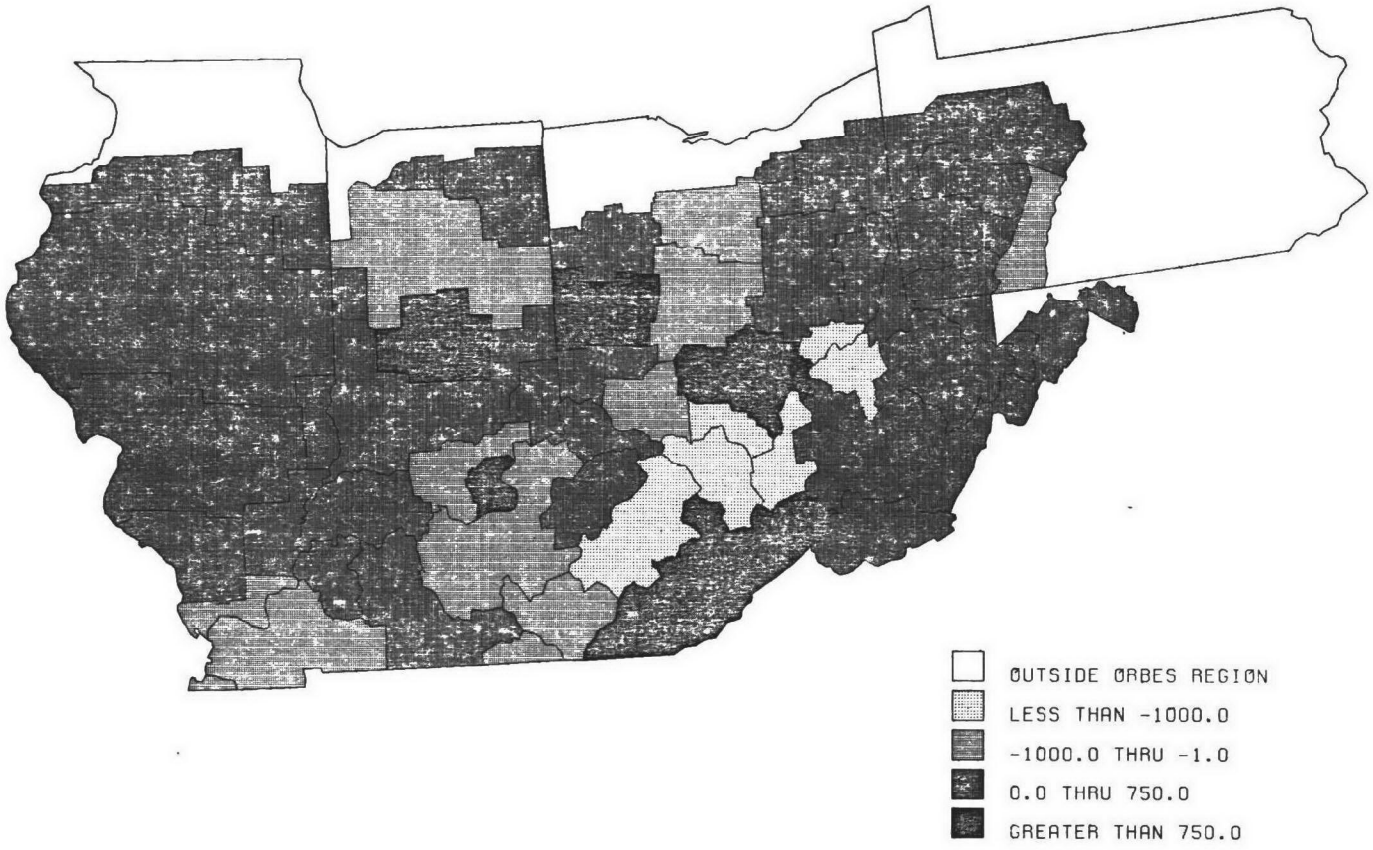


Table 14: Sub-Region Net Migration Impacts for Scenarios 1, 4, and 5
A Summary of Figures 7, 8, and 9

REGION	Scenario ONE	FOUR	FIVE
1	2	2	3
2	3	3	3
3	3	3	3
7	3	2	3
8	3	3	2
11	3	3	3
12	2	2	3
13	2	2	2
14	4	4	4
15	3	3	3
16	1	1	1
17	1	1	1
18	3	3	3
19	3	3	3
21	3	3	3
22	1	1	1
23	1	1	1
24	2	2	2
25	2	2	2
28	4	4	4
70	4	4	3
71	3	3	3
72	4	4	4
73	2	2	2
75	3	3	3
77	2	2	2
78	3	3	3
80	3	3	3
81	3	3	3
82	4	4	4
83	2	2	2
84	3	3	3
85	3	3	3
87	3	3	3
88	3	3	3
89	3	3	3
99	3	3	3
151	4	4	4
152	3	3	3
153	2	2	2
154	3	3	3
155	2	2	2
160	2	2	2

Code: Net Migrants

1: more than -1000
2: -1000 thru -1
3: 0 thru 750
4: greater than 750

References

1) Borts, G.H. and Stein, J.L., Economic Growth in a Free Market, (New York: Columbia University Press, 1964).

2) Muth, R.F., "Differential Growth Among Large U.S. Cities," in Papers in Quantitative Economics, edited by J.P. Quirk and A.M. Zarley (Lawrence: The University Press of Kansas, 1968) pp. 311-355. Also see: "Migration: Chicken or Egg," Southern Econ. J., Jan. 1971, 37(3), pp. 295-306.

3) Lowry, I.S., Migration and Metropolitan Growth: Two Analytical Models (San Francisco: Chandler Publishing Company, 1960).

4) Miller, E., "Is Out-Migration Affected by Economic Conditions?" Southern Econ. J., Jan. 1973, 39(3), pp. 396-405.

5) Santini, Danilo J., "Lowry versus Muth: The Chicken or Egg Question Reexamined." Mimeographed.

6) Perloff, H.S., Dunn, E.S. Jr., Lampard, E.E. and Muth, R.F., Regions, Resources, and Economic Growth (Baltimore: Johns Hopkins Press, 1960).

7) Gallaway, L.E., "Age and Labor Mobility in The United States, 1957-1960", Social Security Administration Office, Office of Research and Statistics Research Report No. 28., Washington, D.C.: U.S.G.P.O., 1969.

8) Schwartz, A., "Interpreting the Effect of Distance on Migration", J. Polit. Econ., Sept./Oct., 1973, 81(5), pp. 1153-1169

9) Suval, E.M. and Hamilton, C.H., "Some New Evidence on Educational Selectivity in Migration to and from the South", Social Forces, May 1965, 43(4), pp. 536-547.

10) Kain, J.F. and Persky, J.J., "The North's Stake in Southern Rural Poverty", in J.F. Kain and J.R. Meyer (eds.), Essays in Regional Economics (Cambridge: Harvard University Press, 1971), pp. 243-278.

11) Greenwood, Michael J., "Research on Internal Migration in The United States: A Survey", Journal of Economic Literature, 13: pp. 397-433.

12) _____. "A Simultaneous - Equations Model of Urban Growth and Migration", Journal of the American Statistical Association, Dec. 1975, No. 352, pp. 797-810.

13. Gilmore, Douglas, Input/Output Model for ORBES, Dept. of Economics, University of Illinois at Urbana-Champaign, 1979.

Appendix A

COUNTY NAMES AND FIPS CODES* FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
1	42003	ALLEGHENY
1	42007	BEAVER
1	42125	WASHINGTON
1	42129	WESTMORELAND
2	42005	ARMSTRONG
2	42019	BUTLER
2	42051	FAYETTE
2	42059	GREEN
2	42063	INDIANA
2	54061	MONONGALIA
2	54077	PRESTON
3	42031	CLARION
3	42053	FOREST
3	42073	LAWRENCE
3	42085	MERCER
3	42121	VENANGO
7	42033	CLEARFIELD
7	42047	ELK
7	42065	JEFFERSON
8	42021	CAMBRIA
8	42111	SOMERSET
11	39013	BELMONT
11	39067	HARRISON
11	39081	JEFFERSON
11	39111	MONROE
11	54009	BROOKE
11	54029	HANCOCK
11	54051	MARSHALL
11	54069	OHIO
11	54095	TYLER
11	54103	WETZEL
12	54023	GRANT
13	39001	ADAMS
13	39015	BROWN
13	39025	CLERMONT
13	39071	HIGHLAND
14	39009	ATHENS
14	39053	GALLIA
14	39073	HOCKING
14	39079	JACKSON
14	39105	MEIGS
14	39131	PIKE
14	39141	ROSS
14	39163	VINTON
15	39019	CARROLL
15	39031	COSHOCTON
15	39059	GUERNSEY
15	39075	HOLMES
15	39115	MORGAN
15	39119	MUSKINGUM
15	39121	NOBLE
15	39127	PERRY
15	39157	TUSCARAWAS
16	39087	LAWRENCE

Appendix (Con't)

COUNTY NAMES AND FIPS CODES FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
16	39145	SCIOTO
16	54011	CABELL
16	54043	LINCOLN
16	54053	MASON
16	54099	WAYNE
17	39167	WASHINGTON
17	54013	CALHOUN
17	54073	PLEASANTS
17	54085	RITCHIE
17	54105	WIRT
17	54107	WOOD
18	54001	BARBOUR
18	54017	DODDIDGE
18	54021	GILMMER
18	54033	HARRISON
18	54041	LEWIS
18	54049	MARION
18	54083	RANDOLPH
18	54091	TAYLOR
18	54093	TUCKER
18	54097	UPSHUR
19	54005	BOONE
19	54007	BRAXTON
19	54015	CLAY
19	54019	FAYETTE
19	54025	GREENBRIER
19	54035	JACKSON
19	54039	KANAWHA
19	54067	NICHOLAS
19	54075	POCAHONTAS
19	54079	PUTNAM
19	54087	ROANE
19	54101	WEBSTER
21	54047	MCDOWELL
21	54055	MERCER
21	54063	MONRE
21	54081	RALEIGH
21	54089	SUMMERS
21	54109	WYOMING
22	21019	BOYD
22	21043	CARTER
22	21063	ELLIOTT
22	21089	GREENUP
22	21115	JOHNSON
22	21127	LAWRENCE
22	21135	LEWIS
23	21011	BATH
23	21049	CLARK
23	21065	ESTILL
23	21069	FLEMING
23	21079	GARRARD
23	21109	JACKSON
23	21129	LEE
23	21137	LINCOLN

Appendix (Con't)

COUNTY NAMES AND FIPS CODES FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
23	21151	MADISON
23	21165	MENIFEE
23	21173	MONTGOMERY
23	21197	POWELL
23	21203	ROCKCASTLE
23	21205	ROWAN
23	21237	WOLFE
24	21001	ADAIR
24	21045	CASEY
24	21087	GREEN
24	21199	PULASKI
24	21207	RUSSELL
24	21231	WAYNE
25	21053	CLINTON
25	21057	CUMBERLAND
25	21171	MONROE
28	21013	BELL
28	21025	BREATHITT
28	21051	CLAY
28	21071	FLOYD
28	21095	HARLAN
28	21119	KNOTT
28	21121	KNOX
28	21125	LAUREL
28	21131	LESLIE
28	21133	LETCHER
28	21147	MCCREARY
28	21153	MAGOFFIN
28	21159	MARTIN
28	21175	MORGAN
28	21189	OWSLEY
28	21193	PERRY
28	21195	PIKE
28	21235	WHITLEY
28	54045	LOGAN
28	54059	MINGO
70	39103	MEDINA
71	18029	DEARBORN
71	18047	FRANKLIN
71	18115	OHIO
71	18137	RIPLEY
71	18155	SWITZERLAND
71	21015	BOONE
71	21023	BRACKEN
71	21037	CAMPBELL
71	21077	GALLLATIN
71	21081	GRANT
71	21117	KENTON
71	21161	MASON
71	21191	PENDLETON
71	39017	BUTLER
71	39027	CLINTON
71	39061	HAMILTON
71	39165	WARREN

Appendix (Con't)

COUNTY NAMES AND FIPS CODES FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
72	39021	CHAMPAIGN
72	39023	CLARK
72	39037	DARKE
72	39057	GREENE
72	39109	MIAMI
72	39113	MONTGOMERY
72	39135	PREBLE
73	39041	DELAWARE
73	39045	FAIRFIELD
73	39047	FAYETTE
73	39049	FRANKLIN
73	39089	LICKING
73	39097	MADISON
73	39129	PICKAWAY
73	39159	UNION
75	39029	COLUMBIANA
75	39099	MAHONING
75	39133	PORTAGE
75	39151	STARK
75	39153	SUMMIT
75	39155	TRUMBULL
75	39169	WAYNE
77	39005	ASHLAND
77	39033	CRAWFORD
77	39083	KNOX
77	39101	MARION
77	39117	MORROW
77	39139	RICHLAND
77	39175	WYANDOT
78	39003	ALLEN
78	39011	AUGLAIZE
78	39065	HARDIN
78	39091	LOGAN
78	39107	MERCER
78	39149	SHELBY
80	18001	ADAMS
80	18003	ALLEN
80	18069	HUNTINGTON
80	18085	KOSCIUSKO
80	18113	NOBLE
80	18179	WELLS
80	18183	WHITLEY
81	18099	MARSHALL
81	18149	STARKE
82	18011	BOONE
82	18057	HAMILTON
82	18059	HANCOCK
82	18063	HENDRICKS
82	18081	JOHNSON
82	18097	MARION
82	18109	MORGAN
82	18133	PUTNAM
82	18145	SHELBY
83	18007	BENTON

Appendix (Con't)

COUNTY NAMES AND FIPS CODES FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
83	18009	BLACKFORD
83	18015	CARROLL
83	18017	CASS
83	18023	CLINTON
83	18035	DELAWARE
83	18049	FULTON
83	18053	GRANT
83	18065	HENRY
83	18067	HOWARD
83	18073	JASPER
83	18075	JAY
83	18095	MADISON
83	18103	MIAMI
83	18107	MONTGOMERY
83	18131	PULASKI
83	18135	RANDOLPH
83	18157	TIPPECANOE
83	18159	TIPTON
83	18169	WABASH
83	18181	WHITE
84	17023	CLARK
84	17033	CRAWFORD
84	17101	LAWRENCE
84	18005	BARTHOLOMEW
84	18013	BROWN
84	18021	CLAY
84	18027	DAVIESS
84	18031	DECATUR
84	18041	FAYETTE
84	18055	GREENE
84	18071	JACKSON
84	18079	JENNINGS
84	18083	KNOX
84	18093	LAWRENCE
84	18101	MARTIN
84	18105	MONROE
84	18119	OWEN
84	18121	PARKE
84	18139	RUSH
84	18153	SULLIVAN
84	18161	UNION
84	18165	VERMILLION
84	18167	VIGO
84	18177	WAYNE
85	17047	EDWARDS
85	17059	GALLATIN
85	17065	HAMILTON
85	17165	SALINE
85	17185	WABASH
85	17193	WHITE
85	18037	DUBOIS
85	18051	GIBSON
85	18123	PERRY
85	18125	PIKE

COUNTY NAMES AND FIPS CODES FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
85	18129	POSEY
85	18147	SPENCER
85	18163	VANDERBURGH
85	18173	WARRICK
85	21101	HENDERSON
85	21107	HOPKINS
85	21225	UNION
85	21233	WEBSTER
87	17005	BOND
87	17013	CALHOUN
87	17025	CLAY
87	17027	CLINTON
87	17049	EFFINGHAM
87	17051	FAYETTE
87	17061	GREENE
87	17079	JASPER
87	17081	JEFFERSON
87	17083	JERSEY
87	17117	MACOUPIN
87	17119	MADISON
87	17121	MARION
87	17133	MONROE
87	17135	MONTGOMERY
87	17159	RICHLAND
87	17163	ST CLAIR
87	17189	WASHINGTON
87	17191	WAYNE
88	17001	ADAMS
88	17009	BROWN
88	17017	CASS
88	17019	CHAMPAIGN
88	17021	CHRISTIAN
88	17029	COLES
88	17035	CUMBERLAND
88	17039	DE WITT
88	17041	DOUGLAS
88	17045	EDGAR
88	17053	FORD
88	17057	FULTON
88	17067	HANCOCK
88	17071	HENDERSON
88	17095	KNOX
88	17107	LOGAN
88	17109	MCDONOUGH
88	17113	MCLEAN
88	17115	MACON
88	17123	MARSHALL
88	17125	MASON
88	17129	MENARD
88	17137	MORGAN
88	17139	MOULTRIE
88	17143	PEORIA
88	17147	PIATT
88	17149	PIKE

Appendix (Con't)

COUNTY NAMES AND FIPS CODES FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
88	17167	SANGAMON
88	17169	SCHUYLER
88	17171	SCOTT
88	17173	SHELBY
88	17175	STARK
88	17179	TAZEWELL
88	17183	VERMILION
88	17187	WARREN
88	17203	WOODFORD
88	18045	FOUNTAIN
88	18171	WARREN
89	17055	FRANKLIN
89	17077	JACKSON
89	17087	JOHNSON
89	17145	PERRY
89	17157	RANDOLPH
89	17181	UNION
89	17199	WILLIAMSON
99	17011	BUREAU
99	17063	GRUNDY
99	17073	HENRY
99	17075	IROQUOIS
99	17091	KANKAKEE
99	17099	LA SALLE
99	17105	LIVINGSTON
99	17131	MERCER
99	17155	PUTNAM
151	18019	CLARK
151	18043	FLOYD
151	21111	JEFFERSON
152	21005	ANDERSON
152	21017	BOURBON
152	21067	FAYETTE
152	21073	FRANKLIN
152	21097	HARRISON
152	21113	JESSAMINE
152	21167	MERCER
152	21181	NICHOLAS
152	21201	ROBERTSON
152	21209	SCOTT
152	21239	WOODFORD
153	18025	CRAWFORD
153	18061	HARRISON
153	18077	JEFFERSON
153	18117	ORANGE
153	18143	SCOTT
153	18175	WASHINGTON
153	21021	BOYLE
153	21027	BRECKINRIDGE
153	21029	BULLITT
153	21041	CARROLL
153	21085	GRAYSON
153	21093	HARDIN
153	21099	HART

COUNTY NAMES AND FIPS CODES FOR EACH MIGRATION REGION

REGION	FIPS	COUNTY
153	21103	HENRY
153	21123	LARUE
153	21155	MARION
153	21163	MEADE
153	21179	NELSON
153	21185	OLDHAM
153	21187	OWEN
153	21211	SHELBY
153	21215	SPENCER
153	21217	TAYLOR
153	21223	TRIMBLE
153	21229	WASHINGTON
154	21003	ALLEN
154	21009	BARREN
154	21031	BUTLER
154	21059	DAVIESS
154	21061	EDMONSON
154	21091	HANCOCK
154	21141	LOGAN
154	21149	MCLEAN
154	21169	METCALFE
154	21177	MUHLENBERG
154	21183	OHIO
154	21213	SIMPSON
154	21227	WARREN
155	17003	ALEXANDER
155	17069	HARDIN
155	17127	MASSAC
155	17151	POPE
155	17153	PULASKI
155	21007	BALLARD
155	21033	CALDWELL
155	21035	CALLOWAY
155	21039	CARLISLE
155	21047	CHRISTIAN
155	21055	CRITTENDEN
155	21083	GRAVES
155	21105	HICKMAN
155	21139	LIVINGSTON
155	21143	LYON
155	21145	MCCRACKEN
155	21157	MARSHALL
155	21219	TODD
155	21221	TRIGG
160	21075	FULTON

*FIPS codes uniquely identify counties; The first two digits are associated with the state and the last three identify particular counties within that state. The FIPS code prefixes for states included in the ORBES region are: Illinois - 17; Indiana - 18; Kentucky - 21; Ohio - 39; Pennsylvania - 42; West Virginia - 54.