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REGIONAL ECONOMIC FORECASTS FOR WATER AND LAND RESOURCES PLANNING.

I. FORECAST SYSTEM

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ACKNOWLEDGEMENT

This report is the fifth in the series on economic forecasts and forecast methods. The focus of this research is on economic forecasts and forecast methods for water and land resources planning in Minnesota. Funding for the research was provided by the Minnesota Energy Agency while financial support of the Minnesota Agricultural Experiment Station made possible the compilation and assessment of the statistical series needed in the study.

ABSTRACT

A regional forecast system for employment, earnings, income and population is presented in this report. Employment is related to earnings in a 25-industry breakdown of the economy and to population and income over the 30-year period from 1970 to 2000. The regional economic forecasts are presented in Part II of this report.

SUMMARY AND CONCLUSIONS

An economic forecast system for deriving state and substate regional forecasts is presented in this report. This system makes use of the 1972 OBERS-E projections prepared by the former Office of Business Economics in the U.S. Department of Commerce for the U.S. Water Resources Council. The OBERS earnings and income projections were used in the building of a baseline series of substate employment forecasts for calibrating the forecast system.

This system is based on a shift-and-share model of the form,

$$emp_i' = (1 + r_i)\ emp_i,$$

or,
$$emp_i' = \left[1 + A + B_i + CH_i\left(\frac{1}{lq_i}\right) + CD_i\ \left(1 - \frac{1}{lq_i}\right)\right] emp_i,$$

where, for example, the forecast employment for the i-th industry, emp_i', is equal to the current employment, emp_i, times an employment multiplier $(1+r_i)$, with r_i being the rate of change in the current year employment. The rate of change coefficient, in turn, is the sum of the three shift-and-share coefficients -- the national-growth coefficient, A, the industry-mix coefficient, B_i, and the two regional-share coefficients, CH_i and CD_i.

Modified and expanded regional-share components of the shift-and-share forecast method were developed to facilitate the preparation of small-area employment and income forecasts. The regional-share component was, first, partitioned into a homothetic effect and a differential effect, with the homothetic effect representing the local consumption impact on a particular industry employment and earnings levels and the differential effect representing the external, or export-market, impact on the same employment and earnings.

CONTENTS

REGIONAL ECONOMIC FORECASTS FOR WATER AND LAND RESOURCES PLANNING. I. FORECAST SYSTEM[1/]

Wilbur R. Maki [2/]

Forecasts of regional employment, income and population are prepared for a variety of public and private purposes. State planning agencies, for example, may have certain responsibilities in the review of state and local capital improvements programs. With increasingly severe limitations on the availability and use of public funds for construction of new facilities, reliable forecasts and forecasting methods are sought by local and state agencies in efforts to better anticipate needs and establish priorities for new public facilities. Private organizations, also, seek the same information as a basis for private investment decisions, particularly in areas of rapid population growth and change.

Most economic forecasts for investment planning pertain to the long-run, oftentimes a 10 to 25-year period (e.g., see ref. 27).[3/] In this report, the long-run (more than five year) outlook is represented by projections of employment, income and population. The short-run (less than five year) outlook is represented by predictions of employment, income and population. Predictions oftentimes deal with prices and income in current dollars while projections deal with both in constant dollars and emphasize, instead changes in real values of income and output.

1/ This is the fifth in a series of reports on regional forecasting, the first being the Interim Report on Forecast Methods prepared for the Minnesota Energy Agency, October, 1978. Two of the earlier reports were published in the University of Minnesota, Department of Agricultural and Applied Economics, Staff Paper Series.

2/ The author gratefully acknowledges the contributions of Mason Chen and Pornsak Chitphakdithai in the preparation of the computer programs and data series cited and/or used in this report.

3/ References are listed alphabetically on page 32.

Data Users and Sources

The immediate users of the forecasts and forecasting methods delineated and proposed in this report are the state and local government agencies involved in water and related land resources planning in Minnesota. The planning period is from the present to the year 2000. For some purposes, however, a 50-year planning period -- from 1970 to 2020 -- is used.

The availability of two types of economic and social statistics are implied in the use of different planning periods. In the preparation of the projection series to the year 2000, the historical data base includes annual statistical series. These data series are prepared in the U.S. Department of Commerce by the Bureau of the Census and the Bureau of Economic Analysis (see, ref. 20, 21, 26). The U.S. Bureau of the Census, in cooperation with the designated state planning agency in each state, is responsible for the preparation of the annual population series. This series is required in the administration of general revenue-sharing programs. The Bureau of Economic Analysis, on the other hand, maintains the annual employment and income series as part of its Regional Economic Information System (REIS). Both data sources are used in the preparation of the annual projection series starting from the 1977 base year.

The U.S. Census of Population (for the 1940, 1950, 1960 and 1970 census years) is another source of the employment and population statistics used in the preparation of the projection series for the 1970-2020 period (24, 25). Employment statistics provide detailed industry employment estimates by county of residence (rather than the county of employment). Thus, the employment estimates are directly comparable with the population estimates, which, also, are reported by county of residence.

The two types of statistics are needed in the preparation of the income projections, also. The earnings component of personal income is

derived from payroll data by place of work. A residence adjustment converts the place-of-work series to a place-of-residence series. Property income and transfer payments are reported by place of residence. Thus, total personal income is estimated by place of residence.

The area projection series prepared by the Office of Business Economics, U.S. Department of Commerce, for the Water Resources Council (the so-called OBERS projections) provide a baseline series for comparing the state and sub-state projection series prepared from the 10-year and annual estimates of employment, income and population (27). This projection series is reported by multi-county economic area and a breakdown of the multi-county water resources region (which shows a separate series for each Standard Metropolitan Statistical Area in the water resources region).

In this study, three different multi-county data groupings were identified, namely, the water resources subarea, the metropolitan-centered economic area, and the substate development region (Figure 1.1). Only the substate development region, however, is used extensively in reporting the study findings.

Water Resources Subareas

The 1972 OBERS Projections are reported for each water resources subarea. For those subareas which include a Standard Metropolitan Statistical Area (SMSA), the metropolitan and non-metropolitan portions are reported separately. Four SMSA's were listed for Minnesota in 1972, namely, the five-county Minneapolis-St. Paul Area, the two-county Duluth-Superior Area, the two-county Fargo-Moorhead Area and the one-county Rochester Area. The eight water resources subareas in Minnesota are delineated in Figure 1.1.

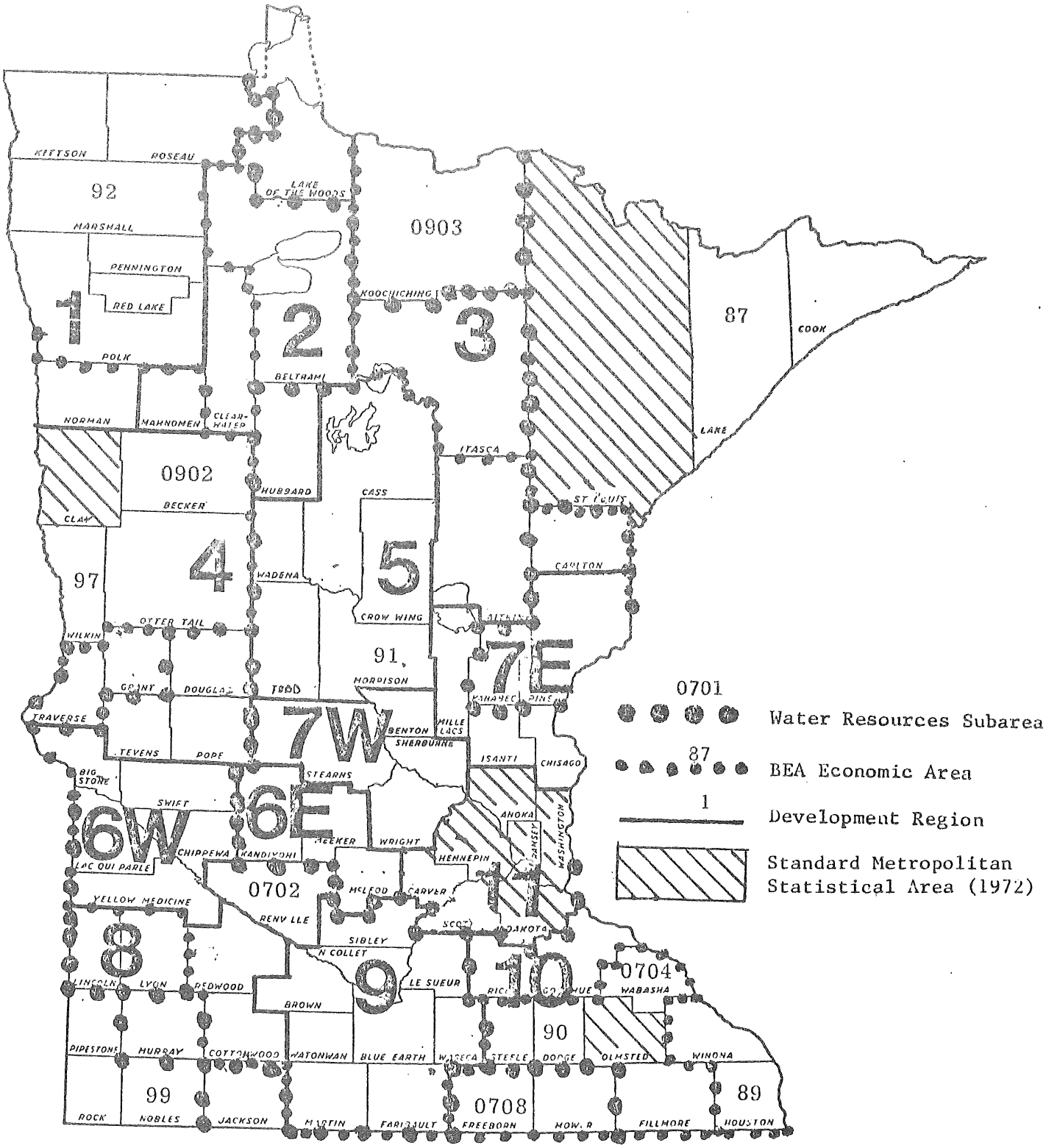

Figure 1.1 Water Resources Subareas, BEA Economic Areas, Development Regions and Standard Metropolitan Statistical Areas in Minnesota, 1975.

To roughly compare the level of economic activity in each water resources subarea, estimated and projected total population levels from the OBERS-E and new baseline series are summarized for each of the eight subareas (which have one or more counties included within the Minnesota state boundaries) in Table 1.1. The annual rates of change in total population are summarized, also, for the 30-year period from 1970 to 2000 for each of these subareas.

Both the OBERS-E and new baseline population projections show widely varying levels and rates of change in total population, with the largest change projected for the Mississippi Headwaters subarea. Differences among regions in the pattern of change during the 30-year period are smaller in the OBERS-E than in the new baseline projections.[4/] All regions are projected to decline from their earlier growth rates in both projection series.

Economic Areas

Each of the 173 Bureau of Economic Analysis (BEA) Economic Areas is identified by its SMSA or designated central city of non-metropolitan status. Seven of these areas have one or more counties lying in Minnesota.

Projected population trends in the seven Economic Areas in Minnesota show contrasting patterns of population growth.[5/] Generally, the area-to-area variability is greater for the economic areas than the water

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4/ The new baseline series were prepared by the Upper Mississippi River Basin Commission from the current state population projections of the State Demographer.

5/ Economic area tabulations are not included in this report. They may be obtained from this department by request.

Table 1.1. Estimated and projected total population in specified water resources subarea, 1970-2000: OBERS-E and New Baseline Series.

Resources Subarea No.	Title	Estimated 1/ 1970	Estimated 1/ 1975	Projected 1980 OBERS	Projected 1980 New	Projected 1985 OBERS	Projected 1985 New	Projected 1990 OBERS	Projected 1990 New	Projected 2000 OBERS	Projected 2000 New	Annual Change 1970-1975	Annual Change 1970-2000 Base-line	Annual Change 1970-2000 New Base-line
		(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(pct.)	(pct.)	(pct.)
Upper Mississippi:														
1.	Mississippi Headwaters 2/	2,386	2,472	2,812	2,608	2,872	2,749	3,076	2,898	3,399	3,122	0.7	1.2	0.9
2.	Minnesota 3/	435	442	434	497	445	458	455	464	470	468	0.3	0.3	0.2
3.	St. Croix 4/	73	81	79	88	81	97	83	105	86	120	2.1	0.6	1.7
4.	Black-Root 5/	524	544	585	567	606	594	627	619	661	657	0.8	.08	0.8
8.	Iowa-Skunk-Wapsipinicon	1,663	1,684	1,741	1,724	1,768	1,767	1,796	1,812	1,832	1,901	0.2	0.3	0.4
10.	Des Moines 3/	758	776	793	794	809	819	825	841	852	867	0.4	0.4	0.5
Souris-Red-Rainy:														
2.	Red	541	559	591	567	512	579	505	586	491	594	0.7	-0.3	0.3
3.	Rainy	21	22	22	22	22	22	21	23	21	22	-0.2	0	0

1/ U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Inforamtion System, 1977.

2/ OBERS-E projections from: U.S. Water Resources Council, 1972 OBERS Projections, Regional Economic Activity in the U.S., Series E Population, U.S. Government Printing Office, Washington, D.C., 20240, April 1974.

3/ Chisago (MN), St. Croix (WI) and Scott (MN) counties were transferred from adjacent subareas to Mississippi Headwaters (0701) Subarea.

4/ Murray (MN) and Jackson (MN) counties were transferred from Minnesota River subarea to Des Moines River (0702) Subarea.

5/ Chisago (MN), St. Croix (WI) and Pierce (WI) counties were transferred to adjacent regions from St. Crois River Subarea.

6/ Monroe (WI) county was transferred to Rock River Subarea.

resources planning regions and subregions. However, each economic area includes both rapidly-growing and slowly-growing counties, with the metropolitan areas generally growing more rapidly than the non-metropolitan areas.

Because of the disregard of state boundaries in the delineation of economic areas, and the lack of a public planning unit with the BEA Economic Area as its territory, use of the economic area is infrequent in state and local government studies. Disregard of state boundaries becomes a major limitation in extensive use of the economic area delineation in state and substate water and land resources planning.

Substate Development Region

The substate development region differs from the preceding regional delineations in two important aspects: this region conforms with state boundaries and its also involves local governments in its organization and policy. Hence, the economic forecasts and related database prepared for the substate development region are more directly related to substate decision making than the corresponding information based on either the Water Resources Subarea or the BEA Economic Area.

Summary data for 13 substate development regions in Minnesota show wide differences in the level of, and rates of growth in, total population in both the OBERS-E and the new baseline projections (Table 1.2). These differences are associated with a vastly different economic base in the slow-growing as compared with the fast-growing region. Strongly agricultural and mining regions (Minnesota regions 1, 2, 3 and 4), for example, are slow-growing as compared with strongly manufacturing, trade, and service regions (Minnesota regions 10 and 11), which are fast-growing.

The region-to-region comparison of projected population show widely

Table 1.2. Estimated and projected total population in specified development region, Minnesota, OBERS-E and New Baseline Series, 1970-2000.

No.	Title	Estimated [1] 1970	Estimated [1] 1975	Projected Baseline SEries [2] 1980 OBERS	1980 New	1985 OBERS	1985 New	1990 OBERS	1990 New	2000 OBERS	2000 New	Annual Change 1970-1975	Annual Change 1970-2000 OBERS	Annual Change 1970-2000 New
		(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(thou.)	(pct.)	(pct.)	(pct.)
1.	Northwest	95	97	87	96	85	98	83	99	80	98	0.1	-0.6	0.1
2.	Headwaters	55	58	54	66	54	64	53	67	52	73	1.9	-0.2	1.0
3.	Arrowhead	330	331	328	330	329	332	329	332	329	325	-0.1	-0.0	-0.1
4.	West Central	186	192	180	196	180	202	178	207	178	213	0.6	-0.2	0.5
5.	Region Five	114	199	112	122	116	128	122	132	122	140	1.8	0.2	0.7
6E.	Six East	98	101	95	104	97	109	102	112	102	119	0.8	0.1	0.6
6W.	Upper Minnesota Valley	62	61	61	60	62	60	65	60	65	57	-0.2	0.2	0.2
7E.	East Central	77	85	84	94	86	105	91	117	91	142	3.4	0.6	0.6
7W.	Central Minnesota	177	189	179	206	184	227	194	248	194	288	2.6	0.4	1.7
8.	Southwest	142	141	132	141	143	143	158	144	158	139	-0.2	0.4	-0.1
9.	Region Nine	219	223	217	228	221	234	233	239	233	243	-0.1	0.2	0.3
10.	Southeastern	384	397	426	410	441	427	479	442	479	460	-0.3	0.7	0.6
11.	Metropolitan Council	1,879	1,928	2,157	2,028	2,330	2,122	2,816	2,222	2,816	2,356	0.4	1.4	0.8
	Minnesota	3,815	3,923	4,119	4,077	4,331	4,252	4,552	4,422	4,901	4,653	0.6	0.8	0.7

[1] U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System, 1977.

[2] OBERS-E Baseline Series is based on population forecasts in: U.S. Water Resources Council, 1972 OBERS Projections, Regional Economic Activity in the U.S., Series E Population, U.S. Government Printing Office, Washington, D.C., April 1974. New Baseline Series is based on current state population projections used by Upper Mississippi River Basin Commission.

varying patterns of economic growth and decline, especially in the OBERS-E baseline series. The wide variations in projected growth result in part from the contrasting patterns of economic opportunity in employment, social services and amenities. The reduced spread in population growth rates in the New Baseline Series is due to the perceived improvements in the quality of life in formerly declining regions.

Study Purposes and Plan

The primary purpose of this study was to develop alternate series of employment forecasts for Minnesota and its substate regions and to provide a forecast data base and a forecast method for reproducing the regional forecast series. This objective stemmed from the expressed need for a readily available and quickly updated economic forecast series for Minnesota substate regions.

The study purposes are pursued, in part, in the following two chapters of this report. First, data sources, analytical framework, model implementation and forecast validation are discussed with reference to the development and use of a modified shift-and-share model. The integration of this model into a regional economic forecasting system is explained in the second of the two chapters. Industry employment is related to the total earnings of the employed labor force in each industry and the total employment is related to total population. The total earnings, together with property income and transfer payments,make up the total personal income payments of the total resident population.

In Part II of this report, a baseline forecast series is presented for later use in calibrating the modified shift-and-share model. Included in this series are State and substate regional projections of the employed work force and its total earnings which are based on current population

projections prepared by the Office of State Demographer. Alternate economic projections prepared by the regional forecasting system (which includes the modified shift-and-share model) are presented. Finally, implications of the economic forecast for water and land resources planning in Minnesota are considered in Part II of this report.

The shift-and-share method was used in this study to prepare the regional employment forecasts from the 1972 OBERS projections of earnings, income, employment and population.[6/] This forecast method is widely used

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6/ In the shift-and-share forecast method, total change in employment is partitioned into the three effects for each of the 25 industry groups in the form,

$$emp'_i = (1 + A + B_i + C_i)emp_i$$

where,

emp'_i = total employment in i-th industry in region, year (t+1)

emp_i = total employment in i-th industry in region, year (t)

$Aemp_i$ = national-growth effect of i-th industry in region, year (t) to year (t+1)

$B_i emp_i$ = industry-mix effect of i-th industry in region, year (t) to year (t+1)

$C_i emp_i$ = regional-share effect of i-th industry in region, year (t) to year (t+1)

The three coefficients are derived as follows:

$$A = \frac{EMP'}{EMP} - 1$$

$$B_i = \frac{EMPN'_i}{EMPN_i} - \frac{EMPN'}{EMPN}$$

$$C_i = \frac{emp'_i}{emp'} - \frac{EMP'_i}{EMP_i}$$

where,

EMP'_i = total earnings in i-th industry in nation, year (t+1)

EMP_i = total earnings in i-th industry in nation, year (t)

$EMPN'$ = $\sum_i EMP'_i$, total employment in all industries in the nation, year (t+1)

$EMPN$ = $\sum_i EMP_i$, total employment in all industries in the nation, year (t)

All U.S. employment is given; only the forecast industry employment, emp'_i, must be derived for each industry and region.

in water and land resources planning, specifically in the geographical disaggregation of the sources of employment and income change. In this study, the shift-and-share method was used, first, to disaggregate the 1972 OBERS earnings projections to the county level and, finally, to derive the sources of employment change for the new substate regional series which were compiled from corresponding county-level data.

The county is the primary statistical reporting unit in the study procedure. All statistical series used in this study are compiled and reported by county. The individual county series are re-compiled into various multi-county groupings for analysis and planning.

While the new baseline series is based on a conventional shift-and-share model, the modified shift-and-share model is used for the alternate development series. The baseline series used in calibrating the new forecast model is then used to prepare the alternate economic forecast for the state or individual substate regions.

The modified shift-and-share method represents a new application of several forecast methods. These include certain economic and demographic variables and relationships, such as total personal consumption expenditures per capita, industry gross output per worker, industry location quotients and employment shares, and the annual rate of change in each of these parameters and, also, total population. Regional variables are linked, thus, to a wide range of national economic indicators. In addition, a new series of substate economic economic indicators is presented as data output of the regional forecasting system.

FORECASTING MODEL

An economic forecasting model for state and substate planning is presented in this chapter. The design of an expanded shift-and-share model is discussed, first, as an introduction to a closer examination of its implementation and verification. Finally, data sources, analytical framework, model implementation and forecast validation are discussed with reference to economic forecast needs in water and related resources planning in Minnesota.

Data Sources

Two principal data sources are available for each substate region in Minnesota -- the U.S. Census of Population and the Regional Economic Information System (REIS). The latter is maintained by the Bureau of Economic Analysis and the Bureau of the Census in the U.S. Department of Commerce, Washington, D.C.[7/] These two sources are supplemented by periodic and occasional reports from the U.S. Department of Commerce and the Minnesota Department of Employment Security. Various industry classification lists are used in compiling employment and earnings from the two data sources. The 25-industry classification system used in this study differs from other frequently used classification systems in the level of industry detail and the aggregation of these industry groups as shown in Table 2.1.

Employment is reported in terms of both persons and jobs. The U.S. Census of Population reports employed persons by place of residence with

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7/ The REIS data series are acquired on computer tapes directly from the Bureau of Economic Analysis, U.S. Department of Commerce, Washington, D.C.

Table 2.1. Standard Industry Classification for Regional Employment, Income and Population Forecasting System: Basic Version, Model II.

No.	Title	Employment and Earnings 1/ 46-industry	36-insustry	39-industry	85-industry	Standard Industry Classificatio Code (1972 ec
1.	Agr., for., fish.	1,2	1,2	1-3	1-4	01,07-08
2.	Mining	3,4,5	3	4-6	5-10	10-14
3.	Construction	7	4	7	11,12	15-17
4.	Food and kind. prod. mfg.	8	5	8	14,17	20
5.	Textile mill prod. mfg.	10	6	pt. 19	19,20	22
6.	Apparel & other fabric prod. mfg.	11	7	pt. 19	21,22	23
7.	Lumber prod. & furn. mfg.	12,13	8	9	23-26	24,25
8.	Paper & allied prod., mfg.	14	9	10	27,28	26
9.	Printing & publishing	15	10	11	29,30	27
10.	Chem. & allied prod. mfg.	16	11	12	31-34	28
11.	Petro. refining 7 rel. prod.	17	12	13	35,36	29
12.	Primary metals mfg.	21	13	15	42,43	33
13.	Fabr. metals & ordn.	22	14	16	13,44-47	34
14.	Mach., exc. electr.	23	15	17	48-58	35
15.	Electr. mach. & supplies	24	16	18	59-64	36
16.	Motor veh. & supplies	25	17	pt. 19	65	371
17.	Trans. eq., exc. mot. veh.	26	18	pt. 19	66,67	37, exc. 371
18.	Misc. mfg.	9, 18-20, 27, 28	19	14, pt. 19	18, 37-41, 68-71	21,30-32,38,
19.	Trans., comm., util.	29-33	20-24	20-26	73-81	41,42,44-49
20.	Trade	34-37	25-28	27,28	82,83	50-59
21.	Fin., ins., real est.	38	29	29	84,85	60-67
22.	Services	39-43	30-34	pt. 20, pt. 21, 30-33, 36	87-89	70-89
23.	Fed. civ. govt.	44	pt. 34, pt. 35	34, 37	pt. 91	91, exc. 9190
24.	State and local govt.	45	pt. 34, pt. 35	35, 38	pt. 92	92, 93
25.	Military	46	pt. 36	39	--	91, 90

1/ Alternate industry classifications, namely, an expanded OBERS series (46-industry), a U.S. Census of Population [illegible] Agency series (39-industry), and a U.S. Department of Commerce

the major source of earned income being shown by the industry of employment. The Minnesota Department of Employment Security, on the other hand, reports the number of jobs, by industry. Employment is reported by place of work. The number of employed persons is not reported in the monthly, quarterly and annual employment statistics published by this agency.

The person-count of industry employment is used in the decenniel censuses of population. The 1940, 1950, 1960 and 1970 employment series have been collated in a 36-industry breakdown of total employment by the U.S. Department of Commerce (24). This series expands the earlier industry employment series prepared by the U.S. Department of Commerce for the U.S. Water Resources Council (27). It also expands the 28-industry employment series prepared by the U.S. Office of Business Economics (now the Bureau of Economic Analysis) in a shift-and-share analysis of county employment trends for the 1940 to 1960 period (22).

The estimated employed work force presented in this report is based on the annual REIS series cited earlier.[8/] This series is comparable with the U.S. Bureau of Labor Statistics employed work force projections to 1985 and the income projections prepared for the U.S. Water Resources Council.

Total earnings are reported for the 25-industry employed work force in this study. Estimated total earnings for 1970 and 1975 are obtained annually from the Regional Economic Information System while

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8/ Estimated employment refers to reported employment estimates for a given historical period, such as the calendar years 1940, 1950, 1960 and 1970. Projected employment refers to post-1970 employment derived as a forecast, i.e., by use of a forecasting method. In this report, all 1980, 1990 and 2000 state and substate employment is projected using the shift-and-share method. All data in this report are identified as being estimated or projected, with the data source being identified, also.

projected total earnings are obtained from the 1972 OBERS-E projections. The total earnings projections are used in this report to derive an employed work force projection series for the U.S., the State of Minnesota and the 13 substate regions. The alternate baseline series cited earlier is essentially a population-adjusted OBERS-E projection series. The OBERS-E projections are available for each water resources subarea and economic area in the United States, including the portion of the subarea in a single-county or multi-county Standard Metropolitan Statistical Area.

Analytical Framework

An analytical framework for small-area employment forecasting is presented which builds on several of the forecasting methods cited in the review of literature. This framework extends the conventional shift-and-share analysis by incorporating the location quotient and economic base approaches in a new allocation-type employment forecasting model. This procedure makes use of U.S. industry employment trends and projections. It is supplemented by an "excess" employment technique which identifies an "export-producing" and a "residentiary" component for each industry in terms of its total employment.

So-called export-producing employment is engaged in producing goods and in "excess" of the region's requirements. In this study, "excess" employment is determined statistically as that employment in a given industry which is in excess of the national average for this industry. The ratio of total employment to excess employment is a measure of a region's economic base. The larger the ratio, the larger the total employment supported by each "export-producing" worker and, also, the larger

the inter-industry linkages and, hence, the smaller the region's dependency on imports.

The proposed regional economic forecasting model is identical to the conventional shift-and-share model, except for the reformulation of the regional-share coefficient, C_i. In the reformulation,

$$C_i = CH_i * hemp_i + CD_i * demp_i \qquad (2.1)$$

CH_i = homothetic regional-share coefficient for i-th industry in region

CD_i = differential region-share coefficient for i-th industry in region

$hemp_i$ = homothetic component of total i-th industry employment in region

$demp_i$ = differential component of total i-th industry employment in region

The homothetic and differential components of the regional share effect are based on the use of industry share-and-shife coefficients as follows:

$$CD_i = ISC_i \left[\frac{(1+e_i\,pchpcpce)(1+pchpcepi)(1+pchpcpi)(1+pchpop)}{(1+pchoutpw_i)\ ISC_i} - 1 \right] \qquad (2.2)$$

$$CH_i = ISC_i \left[\frac{(aesc')}{(iesc_i)} \ (1q_i') - 1 \right] \qquad (2.3)$$

where, e_i = expenditure elasticity coefficient for personal consumption expenditures on i-th industry output in region

pchpcpce = annual rate of change in per capita personal consumption expenditures for i-th industry output in region

pchpcepi = annual rate of change in ratio of personal consumption expenditures to personal income in region

pchpcpi = annual rate of change in per capita personal income in region

pchpop = annual rate of change in total population in region

$poutpw_i$ = annual rate of change in i-th industry output per worker in region

ISC_i = U.S. industry shift coefficient, EMP'_i/EMP_i (i.e., ratio of i-th industry employment in forecast year t+1 to i-th industry employment in base year t)

$aesc'$ = area employment share coefficient in forecast year t+1 (i.e., ratio of total area employment in year t+1 to total U.S. employment in year t_1)

$iesc_i$ = industry employment share in base year t (i.e., ratio of i-th industry employment in region in base year t to i-th industry employment in U.S. base year, t)

lq'_i = industry location quotient in forecast year, t+1 (i.e., aesc'/iesc')

For location quotients less than 1 (i.e., negative values of $demp_i$), the differential effect is derived by use of the homothetic regional-share coefficient, CH_i, in place of the differential homothetic coefficient, CD_i. A negative differential effect denotes lack of industry output to meet local requirements and, hence, the Region is, in effect, dependent on imports to satisfy deficit demand. Each parameter series is listed in Tables 2.2, 2.3 and 2.4.

A special computational procedure is required for the derivation of the homothetic regional-share coefficient, CH_i, for the forecast year. This procedure makes use of previously forecast values of the regional-share coefficient. A correction term, ct_i, is introduced into this procedure for the purpose of accounting for any difference between the regional-share coefficients and the sum of the weighted values of the homothetic and different components of the regional-share coefficient. This difference is then assigned to one or more of the three rates of change in homothetic-regional-share coefficient. Thus,

$$DIFF_i = C_i - \left[CH_i \left(\frac{1}{lq_i}\right) + CD_i \left(1 - \frac{1}{lq_i}\right) \right] \qquad (2.4)$$

and,

Table 7.2. Expenditure elasticity, annual change in output per worker and industry shift coefficients for modified regional shift-and-share analysis, Minnesota, 1970-2000. 1/

Industry No.	Title	Expenditure Elasticity Coefficient	Annual Change in Output per Worker	Industry Shift Coefficient				
				Estimated	Projected			
				1970-1975	1975-1980	1980-1985	1985-1990	1990-2000 2/
1.	Agr., for., fish.	.70	.055	1.0295	.9621	.8607	.9174	.9334
2.	Mining	1.18	.047	1.2069	1.1327	1.0099	1.0000	1.0103
3.	Construction	.77	.020	.9895	1.1765	1.0558	1.0359	1.0464
4.	Food prod.	.83	.025	.9289	1.0467	.9754	.9690	.9721
5.	Textile prod.	1.07	.028	.8810	1.243	.8916	.9750	.977-
6.	Apparel	1.07	.028	.9086	1.0200	1.0619	.9978	.9967
7.	Lumber & furn.	1.04	.030	.9952	1.1644	.9852	.9867	.9890
8.	Paper prod.	.93	.024	.9151	1.2643	1.0376	1.0283	1.0305
9.	Print. & publ.	1.67	.022	.9723	1.1148	1.0791	1.0504	1.0430
10.	Chemicals	.83	.044	.9690	1.2493	1.0411	1.0410	1.0676
11.	Petro. rel.	.86	.022	.9845	1.1421	.9677	.9810	.9853
12.	Primary metals	.72	.024	.8688	1.2023	.9993	.9523	.9597
13.	Fabr. metals	.94	.020	1.0537	1.2223	1.0768	1.0269	1.0266
14.	Mach., exc. elec.	.46	.029	1.0369	1.2239	1.0531	1.0213	1.0181
15.	Elect. mach.	.54	.039	.8844	1.2981	1.0688	1.0664	1.0688
16.	Motor veh.	1.07	.028	.9647	1.6465	.9762	1.0220	1.0251
17.	Trans. eq., exc. mot.	1.07	.028	.7310	1.2671	.9832	.9800	.9775
18.	Misc. mfg.	1.07	.028	.9961	1.320	1.0682	1.0448	1.0432
19.	Trans., comm., util.	.92	.040	.9994	1.1277	1.0094	1.0466	1.0480
20.	Trade	1.01	.022	1.1118	1.0944	1.0315	1.0399	1.0348
21.	Fin., ins., real est.	1.10	.015	1.1315	1.1431	1.1090	1.0842	1.0791
22.	Services	1.40	.015	1.1446	1.0838	1.1023	1.1236	1.0813
23.	Fed. civ. govt.	1.00	.015	1.0049	1.0146	1.0182	1.0677	1.0279
24.	State & local govt.	1.00	.015	1.2026	1.1660	1.1016	1.0190	1.0225
25.	Military	0	.015	.7918	.9795	1.0000	1.0000	1.0000

1/ Derived from alternate baseline series for Minnesota and U.S.

2/ Five-year rate for 1990-2000 period.

Table 2.3. Area and industry employment share coefficients and location quotients for specified industry, Minnesota, 1975-2000.[1/]

Industry No.	Industry Title	Industry Employment Share Coefficient						Location Quotient					
		Estimated		Projected				Estimated		Projected			
		1970	1975	1980	1985	1990	2000	1970	1975	1980	1985	1990	2000
1.	Agr., for., fish.	.0331	.0374	.0268	.0276	.0273	.0276	1.780	1.903	1.406	1.408	1.413	1.434
2.	Mining	.0235	.0188	.0144	.0132	.0122	.0107	1.257	.958	.754	.687	.630	.555
3.	Construction	.0179	.0181	.0184	.0184	.0183	.0182	.964	.919	.963	.955	.948	.944
4.	Food prod.	.0306	.0287	.0311	.0302	.0294	.0285	1.644	1.460	1.629	1.573	1.522	1.480
5.	Textile prod.	.0027	.0030	.0029	.0030	.0030	.0031	.146	.155	.154	.155	.158	.162
6.	Apparel	.0061	.0060	.0058	.0056	.0053	.0050	.326	.304	.306	.289	.274	.258
7.	Lumber & furn.	.0103	.0119	.0116	.0119	.0122	.0125	.555	.606	.609	.618	.628	.648
8.	Paper prod.	.0445	.0478	.0460	.0459	.0463	.0466	2.391	2.430	2.390	2.388	2.392	2.416
9.	Print. & publ.	.0216	.0244	.0218	.0219	.0222	.0224	1.159	1.240	1.141	1.142	1.145	1.161
10.	Chemicals	.0062	.0061	.0069	.0066	.0062	.0061	.333	.309	.360	.341	.323	.315
11.	Petrol. rel.	.0105	.0087	.0113	.0117	.0122	.0127	.566	.443	.591	.610	.630	.660
12.	Primary metals	.0055	.0047	.0054	.0054	.0054	.0054	.290	.241	.282	.280	.279	.280
13.	Fabr. metals	.0234	.0215	.0231	.0230	.0229	.0228	1.257	1.092	1.209	1.195	1.184	1.181
14.	Mach., exc. elec.	.0324	.0315	.0379	.0400	.0421	.0445	1.743	1.602	1.988	2.078	2.176	2.308
15.	Elect. mach.	.0146	.0162	.0150	.0153	.0157	.0160	.787	.826	.785	.797	.810	.831
16.	Motor veh.	.0059	.0073	.0057	.0057	.0058	.0058	.315	.372	.297	.297	.297	.302
17.	Trans. eq., exc. mot.	.0046	.0065	.0077	.0084	.0090	.0097	.248	.331	.405	.433	.463	.504
18.	Misc. mfg.	.0148	.0151	.0172	.0172	.0172	.0171	.795	.769	.900	.894	.890	.885
19.	Trans., comm., util.	.0188	.0198	.0186	.0186	.0185	.0182	.998	1.006	.977	.969	.958	.947
20.	Trade	.0203	.0216	.0203	.0206	.0208	.0210	1.091	1.099	1.066	1.069	1.074	1.091
21.	Fin., inc., real est.	.0170	.0178	.0172	.0172	.0173	.0174	.917	.906	.900	.896	.894	.900
22.	Services	.0176	.0190	.0188	.0190	.0189	.0187	.947	.969	.988	.991	.978	.973
23.	Fed. civ. govt.	.0111	.0104	.0116	.0117	.0119	.0121	.598	.529	.608	.611	.615	.626
24.	State & local govt.	.0207	.0202	.0214	.0214	.0219	.0212	1.114	1.025	1.123	1.114	1.131	1.102
25.	Military	.0020	.0016	.0021	.0021	.0021	.0021	.114	.082	.111	.109	.108	.106
	Total	.0186[2/]	.0197[2/]	.0191[2/]	.0192[2/]	.0193[2/]	.0193[2/]	1.000	1.000	1.000	1.000	1.000	1.000

1/ Based on Alternate Baseline projection series for Minnesota and U.S.

2/ Area share coefficients.

Table 2.4. Estimated and projected industry-mix and regional-share coefficients for specified industry, Minnesota, 1970-2000: Alternate Baseline Series.

Industry No.	Title	Industry-Mix Coefficient[1] Estimated 1970-1975	Industry-Mix Coefficient[1] Projected 1975-1980	1980-1985	1985-1990	1990-2000	Homothetic Regional-Share Coefficient[2] Estimated 1970-1975	Homothetic Regional-Share Coefficient[2] Projected 1975-1980	1980-1985	1985-1990	1990-2000	Differential Regional-Share Coefficient[3] Estimated 1970-1975	Differential Regional-Share Coefficient[3] Projected 1975-1980	1980-1985	1985-1990	1990-2000
1.	Agr., for., fish.	-.0347	-.1540	-.1889	-.1295	-.2110	.0745	-.1431	.0057	.0060	.0068	.0581	-.1292	.0023	.0025	.0028
2.	Mining	.1428	.0166	-.0397	-.0469	-.0614	-.1871	-.2686	-.0823	-.0768	-.1260	-.0482	0	0	0	0
3.	Construction	-.0747	.0604	.0062	-.0110	.0128	.0070	.0196	-.0011	-.0010	-.0084	0	0	0	0	0
4.	Food prod.	-.1353	-.0694	-.0742	-.0779	-.1372	-.0347	.0587	-.0100	-.0164	-.0195	-.0224	.0270	-.0101	-.0094	-.0102
5.	Textile prod.	-.1831	.0132	-.1580	-.0719	-.1277	.1108	-.0461	.0182	.0201	.0218	0	0	0	0	0
6.	Apparel	-.1556	-.0961	.0123	-.0491	-.0889	-.0132	-.0253	-.0510	-.0466	-.0606	0	0	0	0	0
7.	Lumber & furn.	-.0689	.0483	-.0644	-.0602	-.1042	.1526	-.0280	.0220	.0244	.0272	0	0	0	0	0
8.	Paper prod.	-.1490	.1482	-.0129	-.0186	-.0203	.0281	-.0239	.0031	.0033	.0028	.0391	-.0341	.0043	.0046	.0039
9.	Print. & publ.	-.0919	-.0013	.0295	.0035	.0057	.1093	-.0967	.0083	.0082	.0096	.0174	-.0233	.0012	.0012	.0014
10.	Chemicals	-.0952	.1332	-.0085	-.0059	.0575	-.0181	.0867	.0082	-.0510	-.0306	0	0	0	0	0
11.	Petro. rel.	-.0797	.0260	-.0819	-.0659	-.1113	-.1705	.3379	.0392	.0381	.0415	0	0	0	0	0
12.	Primary metals	-.1954	.0862	-.0503	-.0046	-.1611	-.1056	.1616	.0019	-.0002	-.0002	0	0	0	0	0
13.	Fabr. metals	-.0104	.1062	.0272	-.0200	-.0284	-.0689	.0826	-.0033	-.0029	-.0057	-.0177	.0076	-.0007	-.0006	-.0010
14.	Mach., exc. elec.	-.0272	.1078	.0035	-.0256	-.0456	-.0174	.1559	.0284	.0263	.0270	-.0129	.0938	.0280	.0284	.0317
15.	Elect. mach.	-.1798	.1820	.0192	.0195	.0601	.0971	-.1016	.0241	.0237	.0252	0	0	0	0	0
16.	Motor veh.	-.0995	.5304	-.0734	-.0249	-.0315	.2403	-.3729	.0073	.0081	.0102	0	0	0	0	0
17.	Trans. eq., exc. mot.	-.3332	.1510	-.0659	-.0669	-.1266	.2961	.2375	.0748	.0750	.0812	0	0	0	0	0
18.	Misc. mfg.	-.0681	-.0841	.0185	-.0021	.0060	.0211	.1402	.0003	.0016	-.0091	0	0	0	0	0
19.	Trans., comm., util.	-.0648	.0116	-.0402	-.0003	.0161	.0648	-.0651	-.0004	-.0056	-.0173	0	-.0004	0	0	0
20.	Trade	.0476	-.0217	.0181	-.0007	-.0115	.0653	-.0589	.0104	.0104	.0121	.0059	-.0058	.0007	.0007	.0009
21.	Fin., ins., real est.	.0673	.0270	.0594	.0373	.0830	.0491	-.0413	.0039	.0039	.0043	0	0	0	0	0
22.	Services	.0804	-.0323	.0527	.0767	.0869	.0924	-.0117	.0116	-.0081	-.0099	0	0	0	0	0
23.	Fed. civ. govt.	-.0593	-.1015	-.0314	.0208	-.0257	-.0654	.1160	.0128	.0131	.0160	0	0	0	0	0
24.	State & local govt.	.1384	.0499	.0520	-.0279	-.0368	-.0303	.0712	-.0004	.0201	-.0273	-.0035	.0018	0	.0023	-.0036
25.	Military	-.2723	-.1366	-.0496	-.0469	-.0822	-.1897	.3156	-.0105	-.0091	-.0155	0	0	0	0	0
TOTAL[4]		.0642	.1161	.0496	.0469	.0822	--	--	--	--	--	--	--	--	--	--

1/ $B_i = \frac{EMP_i'}{EMP_i} - \frac{EMPN'}{EMPN}$

2/ $CH_i = ISC_i \left[\frac{(1 + e_i \text{ pchpcpce})(1 + \text{pchpcpi})(1 + \text{pchpcpce})(1 + \text{pchpop})}{ISC_i (1+\text{outpw}_i)} - 1 \right]$

3/ $CD_i = ISC_i \left[\frac{aec'}{iec_i} lq_i' - 1 \right]$

4/ National-growth coefficient.

$$Ct_i = \left(\frac{lq_i}{ISC_i}\right) DIFF_i \qquad (2.5)$$

where, $DIFF_i$ = difference between regional-share coefficient and weighted sum of homothetic regional-share and differential regional-share coefficients in i-th industry employment in region

C_i = regional share coefficient derived in conventional shift-and-share method for i-th industry in region

CH_i = homothetic component of regional-share coefficient derived by modified shift-and-share method in i-th industry in region.

CD_i = differential component of regional-share coefficient derived by modified shift-and-share method for i-th industry in region

ct_i = correction term for homothetic regional-share coefficient in i-th industry in region

The correction term thus provides the model operator with a numerical measure of the "error" due to use of the given rates of change in personal consumption expenditures and output per worker.

This new formulation of the conventional shift-and-share model thus introduces several verifiable numerical relationships of economic significance in understanding regional growth and change. The well-known concepts of income elasticity of demand, labor productivity, and population and income growth affect one part of the regional-share component in the shift-and-share model. This is the always positive homothetic regional-share effect which is derived for each industry in each region. The second component -- the differential regional-share effect -- also is derived for each industry in each region, but this effect may be positive or negative (or zero, if the industry employment-share coefficient in the Region is the same as in the Nation).

The new formulation of a shift-and-share forecasting model is an improvement over the conventional model on empirical and conceptual grounds. Empirical conformation of period-to-period changes in the

regional-share effects is readily achieved by the use of the new location quotient and the industry employment share forecasts for the study area. The industry employment share coefficient is more stable over time than the conventional regional-share coefficient and, hence, is more accurately forecast. The location quotient forecast is readily derived as a ratio of the industry employment and total regional employment share coefficients. All other ratios are lagged, one period, or obtained from external forecasts for the Nation and, hence, pre-determined in the regional forecasting equation.

The reformulation of the shift-and-share model is conceptually atractive with its melding of the location quotient, economic base and shift-and-share approaches. In addition, it provides for a separation of the influence of the homothetic (i.e., residentiary) and differenital (i.e., export-producing) components on the total regional-share effect. If no differential employment were present and if no change occured in the location quotient, then the regional share effect would equal zero. With a positive or a negative differential employment, or a change in the location quotient, the excess employment would show as a measurable regional-share effect. This effect would be positive only if the location quotient times the total employment share ratio were greater than 1, given a lagged industry employment share ratio equal to, or less than 1.

Model Implementation

Model implementation requires derivation of two sets of coefficients -- one shift, to show period-to-period change, and the other share, to show relative importance of Region to Nation. The coefficients are derived from historical data series and related economic assumptions. The combined set of coefficients is needed in the final forecasting model.

Deriving Coefficients

Conventional shift-and-share coefficients are derived from historical national and regional data series and projected national data series. Only the regional-share coefficient is forecast for each industry.

For the 30-year period from 1970 to 2000, the total shift coefficient ($1+A+B_i+C_i$) for Minnesota industries is generally more than 1 because of the employment increases -- estimated and projected (see, Table 2.4). A shift coefficient of less than 1 is derived only for those industries with below-average growth in demand and/or above-average growth in output per worker. Values of each of the three shift coefficients and the total shift coefficient were derived from the baseline projection series for Minnesota.

The industry-mix coefficient presents the differential growth rate of each industry in the Nation. An industry with a growth rate greater than the overall industry employment growth rate (i.e., the national growth coefficient) is an above-average growth industry. It has a positive industry-mix coefficient. An industry with a growth rate less than the overall industry employment growth rate is a below-average growth industry and it has negative industry-mix coefficient.

The regional-share coefficients may be of the same sign as the industry-share coefficients as a result, partly, of the spread effect of industry-mix and, partly, of the changing competitive positive of both export-producing and residentiary industries in the Region. A positive regional-share coefficient denotes a geographical concentration of the industry in the Region while a negative regional-share coefficient denotes a dispersion of the industry to other regions and/or below-average local requirements for the industry output.

The reformulated shift-and-share model partitions the regional-share coefficient into the coefficients shown earlier in Equations 2.2, 2.3, 2.4, and 2.5. Several of the key coefficients are used in deriving the homothetic and differential effects listed in Table 2.5. Both the U.S. employment-shift and the Regional employment-share coefficients are shown for five-year forecast periods while the expenditure elasticity and output per worker coefficients are shown only for the base year, 1970. Annual rates of change are used with all coefficients, except expenditure elasticities. The industry employment-share coefficient (when used to derive excess employment and location quotients) produce an indirect method of delineating the export-producing industries in the Region.

Deriving Employment Changes

The second step is the derivation of the shift-and-share effects -- national-growth, industry-mix and regional-share. Each coefficient is multiplied by the base-year industry employment to obtain the forecast target-year effect due to the given source of employment change (Table 2.6).

The regional-share effects, when partitioned into the two components, show the importance of the State's industry mix in accounting for its employment growth. The differential employment effects shows the contribution of the difference between the total regional employment and its homothetic component to the regional-share effect. Thus, the occurrence of an above-average employment share for a declining industry or a below-average employment share for a growing industry is noted and its share of the regional-share effect is derived for each industry. The homothetic employment, insofar as it represents the employment in the region based on the industry mix for the Nation, provides a reference employment distri-

Table 2.5 Estimated and projected employment in specified industry, by source of employment change, Minnesota 1970-2000; Alternate Baseline Series

Industry No.	Title	Estimated 1970	Change, 1970 - 1975					Estimated 1975	Change, 1975 - 2000					Projected 2000
			Relative Change		Regional Share				Relative Change					
			National Growth	Industry Mix	Homothetic	Differential	Total		National Growth	Industry Mix	Homothetic	Differential	Total	
							(number)							
1.	Agr., for., fish.	152,992	9,818	-5,309	11,398	8,890	20,288	177,789	58,169	-118,292	-6,471	-24,302	30,773	86,893
2.	Mining	15,496	994	2,213	2,899	746	-3,645	15,058	4,927	- 2,401	-7,614	0	7,614	9,970
3.	Construction	78,490	5,037	-5,863	550	0	550	78,214	25,590	6,397	749	0	749	110,950
4.	Food prod.	55,082	3,535	-7,453	1,911	-1,234	-3,145	48,019	15,711	- 18,841	- 174	- 156	174	44,559
5.	Textile prod.	2,692	173	- 493	298	0	298	2,670	874	- 1,042	54	0	54	2,556
6.	Apparel	8,370	537	-1,302	- 111	0	- 111	7,494	2,452	- 1,901	-1,360	0	-1,360	6,685
7.	Lumber & furn.	10,855	697	- 748	1,656	0	1,656	12,460	4,077	- 2,742	671	0	671	14,466
8.	Paper prod.	31,468	2,019	-4,689	884	1,230	2,115	30,913	10,114	3,216	- 694	- 432	-1,126	43,117
9.	Print. & publ.	24,173	1,551	-2,221	2,642	421	3,062	26,566	8,692	1,261	- 624	- 2,395	-3,019	33,500
10.	Chemicals	6,599	423	- 628	- 119	0	- 119	6,275	2,053	1,355	- 17	0	-17	9,666
11.	Petro. rel.	2,032	130	- 162	- 346	0	- 346	1,654	541	- 454	802	0	802	2,543
12.	Primary metals	7,156	459	-1,398	- 756	0	- 756	5,461	1,787	- 1,493	783	0	783	6,538
13.	Fabr. metals	32,676	2,097	- 340	-2,255	- 578	-2,833	31,600	10,389	3,067	141	2,486	2,627	47,683
14.	Mach., exc. elec.	64,990	4,171	-1,768	-1,183	- 838	-1,976	65,417	21,403	2,439	13,700	23,083	36,783	126,042
15.	Elect. mach.	28,382	1,821	-5,103	2,756	0	2,756	27,856	9,114	10,112	- 717	0	717	46,365
16.	Motor veh.	4,814	309	- 479	1,157	0	1,157	5,801	1,898	2,314	-2,072	0	-2,072	7,941
17.	Trans. eq., exc.mot.	5,839	375	-1,946	1,729	0	1,729	5,997	1,962	- 959	3,446	0	3,446	10,446
18.	Misc. mfg.	37,610	2,414	-2,561	791	0	791	38,254	12,516	- 2,824	6,153	0	6,153	54,099
19.	Trans., comm., util.	87,942	5,643	-5,699	5,698	0	5,698	93,584	30,619	- 1,746	-9,586	0	-9,586	112,871
20.	Trade	363,399	23,320	17,298	23,739	2,144	25,883	429,898	140,653	- 30,224	-2,250	-12,467	-14,717	525,610
21.	Fin., inc., real est.	70,078	4,497	4,716	3,446	0	3,446	82,737	27,070	22,704	-3,401	0	-3,401	129,110
22.	Services	281,130	18,041	22,603	25,975	0	25,975	347,749	113,776	84,184	-8,733	0	8,733	536,976
23.	Fed. civ. govt.	31,823	2,042	-1,887	2,080	0	2,080	29,898	9,782	- 4,839	5,557	0	5,557	40,398
24.	State & local govt.	209,708	13,457	29,024	-6,349	- 734	-7,083	245,106	80,193	27	10,624	17,339	27,963	353,289
25.	Military	4,295	276	-1,170	0	815	- 815	2,586	846	- 899	0	700	709	3,233
	Total	1,618,089	103,837	24,635	68,855	3,580	72,495	1,819,056	595,208	- 51,581	-1,087	3,856	2,823	365,506

Table 2.6. Estimated and projected total employment in specified industry, Minnesota and United States, 1970-2000.

Industry No.	Title	Minnesota Estimated[1] 1970	1975	Minnesota Projected[2] 1980	1985	1990	2000	United States Estimated[1] 1970	1975	United States Projected[2] 1980	1985	1990	2000
		(thousand)											
1.	Agr., for., fish.[3]	153.0	177.8	122.6	106.5	98.7	86.9	4,616	4,752	4,572	3,935	3,610	3,145
2.	Mining[4]	15.5	15.1	13.0	12.1	11.1	10.0	662	799	905	914	914	933
3.	Construction	78.5	78.2	93.6	98.7	102.1	111.0	4,373	4,328	5,092	5,376	5,569	6,098
4.	Food prod.	55.1	48.0	54.4	51.6	48.7	44.6	11,800	1,672	1,750	1,707	1,654	1,563
5.	Textile prod.	2.7	2.7	2.9	2.6	2.6	2.6	992	874	987	880	858	819
6.	Apparel	8.4	7.5	7.5	7.5	7.2	6.7	1,378	1,252	1,277	1,356	1,353	1,344
7.	Lumber & furn.	10.9	12.5	14.2	14.3	14.4	14.5	1,051	1,046	1,218	1,200	1,184	1,158
8.	Paper prod.	31.5	30.9	37.3	38.9	40.3	43.1	707	647	818	848	872	926
9.	Print. & publ.	24.2	26.6	26.4	28.8	30.5	33.5	1,120	1,089	1,214	1,310	1,376	1,497
10.	Chemicals	6.6	6.3	8.4	8.8	8.7	9.7	1,064	1,031	1,288	1,341	1,396	1,591
11.	Petro. rel.	2.0	1.7	2.4	2.5	2.5	2.5	193	190	217	210	206	200
12.	Primary metals	7.2	5.5	7.4	7.5	7.1	6.5	1,326	1,152	1,385	1,384	1,318	1,214
13.	Fabr. metals	32.7	31.6	41.5	44.5	45.5	47.7	1,396	1,471	1,798	1,936	1,988	2,095
14.	Mach., exc. elec.	65.0	65.4	96.4	107.0	115.1	126.0	2,003	2,077	2,542	2,677	2,734	2,834
15.	Elect. mach.	28.4	27.9	33.3	36.4	39.7	46.4	1,938	1,714	2,225	2,378	2,536	2,897
16.	Motor veh.	4.8	5.8	7.4	7.3	7.5	7.9	821	792	1,304	1,273	1,301	1,367
17.	Trans. eq., exc. mot.	5.8	6.0	9.0	9.6	10.1	10.4	1,260	921	1,167	1,148	1,125	1,075
18.	Misc. mfg.	37.6	38.3	44.8	47.9	50.1	54.1	2,540	2,530	2,611	2,789	2,914	3,171
19.	Trans., comm., util.	87.9	93.6	99.4	100.3	104.4	112.9	4,732	4,729	5,333	5,383	5,634	6,188
20.	Trade	363.4	429.9	442.6	461.5	485.0	525.6	17,896	19,897	21,775	22,460	23,356	25,008
21.	Fin., ins., real est.	70.1	82.7	91.2	101.5	110.4	129.1	4,106	4,646	5,311	5,890	6,386	7,441
22.	Services[5]	281.1	347.7	372.8	415.3	463.2	537.0	15,945	18,250	19,779	21,802	24,496	28,639
23.	Fed. civ. govt.[6]	31.8	29.9	33.8	34.9	37.7	40.4	2,859	2,873	2,915	2,968	3,169	3,348
24.	State & local govt.[7]	209.7	245.1	303.7	334.4	348.2	353.3	10,111	12,159	14,178	15,618	15,914	16,637
25.	Military	4.3	2.6	3.3	3.3	3.3	3.2	2,032	1,609	1,576	1,576	1,576	1,576
TOTAL[8]		1,618.8	1,819.1	1,969.4	2,083.4	2,194.1	2,365.5	86,922	92,500	103,237	108,359	113,439	122,764

1/ Based on employment estimates from U.S. Department of Commerce, Regional Economic Information System, Minnesota Department of Employment Security and Survey of Current Business.

2/ Based on total earnings projections from U.S Water Resource Council 1972 OBERS-E projections except for employment in agriculture, mining, services, federal government, state and local government, which is adjusted to control totals indicated below.

3/ Specified industry earnings adjusted to constant share of all industry total earnings.

4/ Specified industry earnings adjusted to an increasing share of all industry total earnings.

5/ Specified industry earnings adjusted to an increasing share of all industry total earnings.

6/ Specified industry earnings adjusted to constant share of all industry total earnings.

7/ Specified industry earnings adjusted to constant share of all industry total earnings.

8/ Individual entries may not sum to totals because of rounding.

bution for deriving the specific-industry effects of the region's differential employment levels.

Forecast Validation

Forecast validation procedures used with the shift-and-share models depend on time series of estimated industry employment (e.g., 1940, 1950, 1960 and 1970 or 1970, 1971, 1973, 1974, 1975). Because of the limited number of years for which comparable industry employment data are available, the historical-based validation procedures are less useful now than they will be in later years.

Two modifications of forecast validation procedures are, namely, the use of both the 10-year series from 1940 to 1970 and the annual series from 1970 to 1975 and the comparison of several forecast series based on alternative sets of regional-share coefficients. This procedure makes possible immediate validation of the values used for the critical regional-share coefficients. However, this requires a "splicing" of the two historical series -- the employed labor force and the employed work force (9, 13).

The most recent set of U.S. employment projections prepared by the U.S. Bureau of Labor Statistics include a baseline and a high employment series (Table 2.7). The two series differ in their assumptions regarding the rate of unemployment in 1980, 1985 and 1990. The modified OBERS-E projections presented in this study are generally within the range of the two most recent projection series for 1980, but below the most projections for 1985 and 1990.

Table 2.7. Estimated and projected employment in specified industry, United States, 1977-1990[1/]

Industry No.	Title	Estimated 1977	Baseline Projection[2/] 1980	1985	1990	High Employment Projection[2/] 1980	1985	1990
			(thousand)					
1.	Agr., for., fish.	3,219	3,306	3,301	3,046	3,306	3,310	3,065
2.	Mining	867	1,002	1,055	1,073	1,008	1,082	1,122
3.	Construction	4,672	5,087	5,557	5,748	5,107	5,714	6,065
4.	Food prod.	1,757	1,796	1,815	1,795	1,805	1,869	1,886
5.	Textile prod.	987	1,000	1,034	1,069	1,004	1,069	1,130
6.	Apparel	1,301	1,428	1,514	1,571	1,433	1,564	1,658
7.	Lumber & furn.	1,241	1,279	1,391	1,454	1,285	1,435	1,533
8.	Paper prod.	700	723	766	802	726	791	851
9.	Print. & publ.	1,141	1,266	1,305	1,315	1,271	1,346	1,394
10.	Chemicals	1,063	1,110	1,222	1,355	1,112	1,261	1,439
11.	Petro. rel.	209	190	184	180	191	187	184
12.	Primary metals	1,206	1,331	1,383	1,358	1,338	1,430	1,441
13.	Fabr. metals	1,627	1,810	1,973	2,051	1,821	2,039	2,174
14.	Mach., exc. elec.	2,211	2,466	2,793	3,021	2,469	2,881	3,205
15.	Elect. mach.	1,941	2,192	2,404	2,530	2,200	2,480	2,665
16.	Motor veh.	893	1,006	1,108	1,156	1,014	1,146	1,227
17.	Trans. eq., exc. mot.	919	1,060	1,139	1,191	1,065	1,179	1,257
18.	Misc. mfg.	2,648	2,830	2,982	3,034	2,842	3,074	3,200
19.	Trans., comm., util.	4,838	5,210	5,515	5,658	5,232	5,654	5,946
20.	Trade	20,908	23,351	25,907	27,370	23,403	26,636	28,720
21.	Fin., ins., real est.	4,888	5,313	6,113	6,696	5,328	6,306	7,089
22.	Services	18,570	21,131	24,525	27,639	21,226	25,210	29,087
23.	Fed. civ. govt.[3/]	2,120	2,152	2,226	2,300	2,152	2,226	2,300
24.	State & local govt.[3/]	11,890	12,514	13,232	13,677	13,700	15,679	15,513
25.	Military[3/]	2,133	2,089	2,089	2,089	2,089	2,089	2,089
TOTAL		93,949	102,642	112,532	119,178	104,127	117,651	126,240

1/ Valerie A. Personick, Industry output and employment: BLS projection to 1990, Monthly Labor Review, 102:3-14, April, 1979.

2/ Projected labor force levels and unemployment rates are as follows:

Projection	Labor Force (thous.) 1980	1985	1990	Unemployment Rate (pct.) 1980	1985	1990
Baseline	106,099	115,041	121,456	5.5	4.7	4.5
High Employment	107,554	119,095	127,692	5.5	4.0	4.0

3/ Norman C. Saunders, The U.S. economy to 1990: two projections for growth, Monthly Labor Review, 101: 36-46, December 1978.

FORECASTING SYSTEM

The modified shift-and-share model is the central part of the regional economic forecasting system developed for this study (Figure 3.1). Earnings, income and population, as well as employment, forecasts are produced by this system for substate planning regions.

In this chapter, the several system components are presented under three topical headings, starting with industry employment and extending to labor force, population, total earnings and income. Place of work and place of residence differences in the measurement of employment and income are accounted for in the forecast procedures. Thus, while the employment forecasts are usually presented by place of work, they may be presented, also, by place of residence, given the so-called "residence adjustment" (for commuting). These and other attributes of the forecasting system are discussed under the three topical headings.

Industry Employment

The forecasting for given industry employment in a region is accomplished by the modified shift-and-share model of the form represented in Chapter 2, Equations 2.1, 2.2 and 2.3. This model is a central part of the forecasting system, which prepares, first, an initial forecast of industry employment from the input data specified in the three equations.

Each of the three elements in the basic shift-and-share model can be viewed as additive rates of change in employment in a particular industry. Variations in industry growth rates are unique to the industry while variations in regional growth rates are unique to the region, given the industry mix in the region. The unique regional variations in employment change patterns are accounted for by the individual change

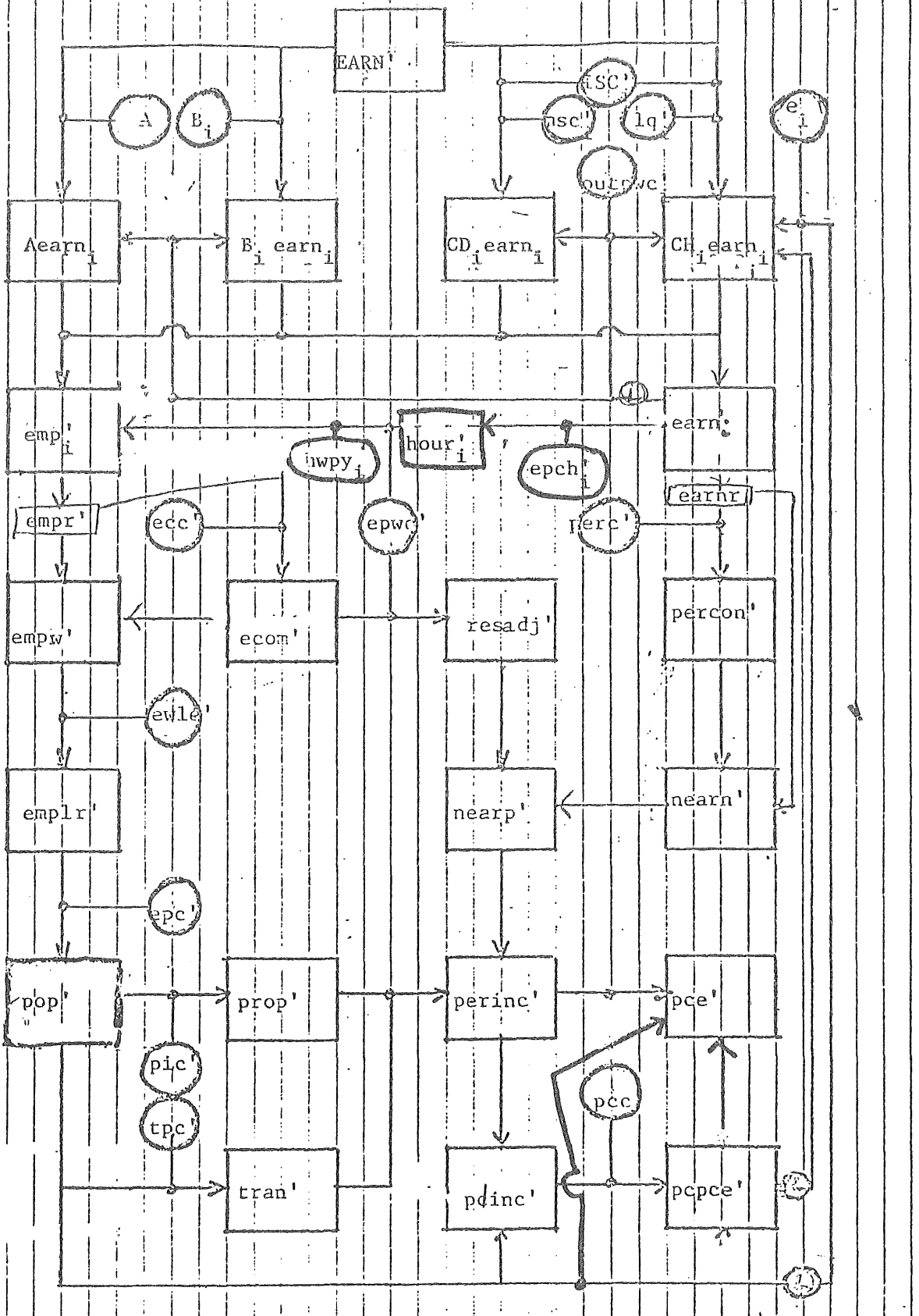

Fig. 3.1. Nationally-Linked Regional Employment, Income and Population Forecasting System.

components in the regional-share homothetic effect and the regional-share differential effect. The new shift-and-share model is now represented by the form,

$$emp_i' = \left[1 + A + B_i + CH_i\left(\frac{1}{1q_i}\right) + CH_i\left(1 - \frac{1}{1q_i}\right) \right] emp_i, \qquad (3.1)$$

where each model element is defined the same as it was in Chapter 2.

Labor Force and Population

Additional forecast system components are represented by the labor force and population relationships. These relationships are given by the forms,

$$ecom' = ecc' * empr' \qquad (3.2)$$

$$empw' = empr' + ecom' \qquad (3.3)$$

$$empl' = ewlc' * empw' \qquad (3.4)$$

$$pop' = epc' * empl' \qquad (3.5)$$

where, ecom' = total employed work force commuting to place of work in year (t+1)

ecc' = employed work force commuting ratio in year (t+1)

empr' = total employed work force by place of work in year (t+1)

empw' = total employed work force by place of residence in year (t+1)

empl' = total employed labor force by place of residence in year (t+1)

ewlc' = employed work force to employed labor force ratio in year (t+1)

pop' = total population by place of residence in year (t+1)

epc' = employed labor force to total population ratio in year (t+1)

Employment is represented also in total hours worked in each industry by the form,

$$hour'_i = hpwc'_i * emp'_i \quad (3.6)$$

where, $hour_i$ = total hours worked annually in i-th industry in year (t+1)

$hpwe_i$ = average hours worked annually by employed work force in i-th industry in year (t+1)

The series of five equations thus convert output of the shift-and-share model into a set of intervening variables for deriving the total earnings and the total personal income of the resident population.

Total Earnings and Income

The total earnings and income of the resident population is derived with the use of earnings and income equations, as follows:

$$earnr' = \sum_i ephc'_i * hour'_i \quad (3.7)$$

$$percon' = perc' * earnr' \quad (3.8)$$

$$nearn' = earn' - percon' \quad (3.9)$$

$$resadj' = ecc' * earn' \quad (3.10)$$

$$nearp' = nearp' + readj' \quad (3.11)$$

$$prop' = pcpc' * pop' \quad (3.12)$$

$$tran' = tppc' * pop' \quad (3.13)$$

$$perinc' = nearp' + prop' + tran' \quad (3.14)$$

$$pcinc' = perinc' \div pop' \quad (3.15)$$

$$pcpce' = pceb' + pcc' * pcinc' \quad (3.16)$$

$$pce' = pcepc' * perinc' \quad (3.17)$$

where,

earnr' = total earnings of employed labor force by place of work in year (t+1)

percon' = total personal contributions of employed work force in year (t+1)

perc' = personal contribution ratio in year (t+1)

nearn' = net earnings of employed work force by place of work in year (t+1)

resadj' = residence adjustment in year (t+1)

nearp' = net earnings of employed work by place of residence in year (t+1)

prop' = total property income by place of residence in year (t+1)

pipc' = property income per capita in year (t+1)

tran' = total transfer payments by place of residence in year (t+1)

tppc' = transfer payments per capita in year (t+1)

perinc' = total personal income by place of residence in year (t+1)

pcinc' = personal income per capita in year (t+1)

pcpce' = personal consumption expenditures per capita in year (t+1)

pce = total personal consumtpion expenditures by place of residence in year (t+1)

This completes the equation series for the expanded shift-and-share forecasting model. The forecast values from the model operation become the lagged values of the next forecast cycle.

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