MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963-1
A Guide to the Use of the
IWR Interactive Ratio
Forecasting Program

March 1984

Research Report 84-R-3
This report provides instruction for using an interactive ratio forecasting program which can be used for developing forecasts of socioeconomic variables for small areas. Four commonly used methods are available in the program: basic ratio, average annual ratio, ratio difference, and shift share. These methods and their appropriate uses are described in the report.
A Guide to the Use of the IWR Interactive Ratio Forecasting Program

by

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I. Introduction

This user manual describes a ratio forecasting program developed at IWR. Several common ratio forecasting methods are available to the analyst in the program. These methods and their appropriate uses are described in section 2 of this manual. A presentation of the procedures involved in running the program is provided in section 3.

The development of this program proceeded from the observation that many Corps study areas are too small to have forecasts available for them. Since many plan formulation and evaluation tasks require forecasts of study area variables such as population, income, and employment the Corps analyst often faces a dilemma in obtaining or generating such forecasts for small study areas.

The ratio methods described in this manual and available in the program offer a means to generate forecasts of socio-economic variables for small areas. The methods are widely used to generate population and employment forecasts (see for example, Shyrock, et al 1972; Hammond, 1973; Greenberg, et al, 1978; U.S. Bureau of the Census, 1972). It should be noted that other variables of interest to Corps planners (e.g. income, price levels, etc.) can be forecast using the ratio methods described in this manual. Essentially, these methods produce forecasts for small areas by allocating an independently derived forecast of the variable(s) for a larger area (state, SMSA) among smaller subcomponent areas on the basis of past ratios of these smaller areas to the larger area for the variable being forecast.
These methods can thus be used to "step-down" forecasts for larger areas to study areas using a definable analytic structure and framework. Ratio techniques are premised on the assumption that a small area will continue to have a similar relationship to a larger area. The methods, thus, are wholly "top-down" in the way in which small area forecasts are derived. They do not take into account plans, expectations and developments in the small area which may affect the historical relationship between small and large areas combined in the ratio(s) being used to generate forecasts. Judgment, on the part of the analyst, is thus necessary in using these techniques to generate forecasts just as it is necessary in adequately using any other forecasting method.

The central focuses of this manual are on the description of the ratio methods and on providing instruction on the use of a forecasting program. The manual is not intended to address the issue of the use and misuse of forecasts. Several sources provide detailed discussion of this topic (see for example, Armstrong, 1978; Pittenger, 1978; Robinson, 1982; Delli Priscoli, 1979; Oak Ridge Associated Universities, 1977). Nevertheless, it is important to emphasize that judgments on the analysts' part are important. In the case of ratio methods assumptions are important in reaching decisions about the change in the ratio of a smaller area to the larger area -- is the recent past likely to be more important than the distant past, are there major changes occurring in the small area which may affect the past trend? These and other issues must be addressed, and assumptions shaping the small area forecast clearly stated in the projection.
Appendix A of manual describes the operation of the program on the Harris 500 minicomputer. The listing of the program in FORTRAN IV is provided in Appendix B. A revision of this program for the IBM personal computer is planned.

2. Ratio Methods

The IWR Program offers four ratio forecasting methods: basic ratio, average annual ratio, ratio trend, and OBERs shift share. These methods are described in greater detail below.

2.1 Basic Ratio. This method uses the relationship between a small area and a larger parent area at one point in time to generate forecasts for the smaller area. This relationship is expressed as the ratio of the small area to the larger area:

\[ r_t = \frac{S_t}{P_t} \]

where:

- \( S \) = small area population
- \( P \) = parent area population
- \( t \) = time
- \( r \) = ratio

Generally, the ratio is computed for the most recent time period for which data for the small area and parent area are available. However, more distant data can be employed, if the analyst judges that the ratio from the most recent data available is not suitable.
Forecasts for the small area are computed by applying the ratio obtained in equation (1) to a forecast of the parent area:

\[ S_{t+j} = r_t \cdot P_{t+j} \]

As noted previously the parent area forecast is externally derived. This forecast is obtained from other forecasting procedures at the local or national level (e.g. state or local planning agencies, OBERs).

The chief advantage of the basic ratio method is its ease of use. Only one data value for the small area and parent area is needed in combination with the parent area forecast in order to obtain a small area forecast. The primary potential disadvantage of the basic ratio method in comparison with the other methods described in this manual, however, is that it permits no use of information concerning how the relationship between the small area and parent area has changed over time. In periods of rapid change, when fundamental changes may be occurring in the small area, historical patterns of relationship may not be important. However, as a general rule, historical information about the past relationship of small to large areas can aid the analyst in making judgments about the future of the small area.
Example: Computation for population St. Clair County, Illinois using Basic Ratio Method

\[ r_{80} = S_{80}/P_{80} \]

\[ S_{80} = \text{St. Clair County, 1980 (265,469)} \]

\[ P_{80} = \text{Illinois, 1980 (11,418,461)} \]

\[ r_{80} = 0.02325 \]

\[ S_{90} = r_{80} * P_{90} \]

\[ = 0.02325 * 11,804,539 \]

\[ = 274,456 \]

2.2 Average Annual Ratio. The concept of an annual average rate of change is frequently used by Corps economists in computing benefits and costs. In the average annual ratio method for deriving small area forecasts, information about the ratio of the small to large area at two points of time is used to create an annual average change in the ratio. In this way a greater amount of information is employed in the forecasting process. The average annual method used in the IWR program has been derived from a method presented in White, et al 1953. The process is presented below:

\[ (3) \quad y = \frac{r_t}{r_{t-n}} \]

where:

\[ y = \text{ratio of ratios} \]
\( r_t = \text{ratio of small to large area at time } t \)
\( r_{t-n} = \text{ratio of small to large area at some previous time} \)
(4) \( i = t-(t-n) \) time interval between data points

(5) \( A = \frac{1}{y-1} \) average annual rate of change in ratio of small to large area

(6) \( r_{t+j} = r_t \times (I+j(A)) \) ratio extrapolated \( j \) years into future on basis of annual average change

(7) \( S_{t+j} = r_{t+j} \times P_{t+j} \) forecast for small area at \( t+j \)

Example: Computation for St. Clair County, Illinois using average annual ratio method

\( y = \frac{r_{80}}{r_{50}} \)
\( r_{80} = 0.02325 \)
\( r_{50} = 0.02357 \)
\( = 0.98642 \)

\( i = t-(t-n) \)
\( = 80-50 \)
\( = 30 \)
\[ A = \frac{1}{.98642^{30} - 1} \]
\[ = \text{(antilog (log } .98642)/30) - 1 \]
\[ = -.000456 \text{ (average annual change } = (-0.0456 \text{ percent}) \]

\[ r_{0:1} = r_{0:0} (1 + 10 (-.000456)) \]
\[ = .02325 (.999544) \]
\[ = .02314 \]

\[ S_{0:1} = r_{0:0} * P_{0:0} \]
\[ = .02314 * 11,804,539 \]
\[ = 273,204 \]

2.3. Ratio Difference Method. The ratio difference method inspects the change in ratios over time expressed as differences in ratios and projects on the basis of these changes. Thus, like the average annual method, this method offers the advantage of incorporating historical information. However, where the average annual change method assumes a continuous slope in the historical change in ratios, the ratio difference method allows the use of information about fluctuations in the ratios over time. The ratio difference method presented in the IWR program was developed on the basis of a description of this technique in Pickard (1980).

The method allows past ratios to be weighted according to the judgment of the analyst. In the IWR program the user has two choices for weighing past ratios. In the first option the most recent ratios are weighted more heavily.
as an inverse proportion of this time from the period to be forecast. The second option allows the user to choose weighting factors (e.g., weight all ratios equally, weight past more heavily, etc.).

The ratio difference method is presented below:

(8) \( D_t = r_t - r_{t-i} \) Difference of ratios where 
\( r_{t-i} = \) ratio at some previous interval

(9) \( \bar{D} = \sum_{t} W(D) \) Weighted average of differences;  
where weighting factors \( (w) \) are chosen by the user or are computed as below

(10) \( w_j = \frac{1}{t+n - t_j} \) * 100 factors weighted in inverse proportions to their distance in time from the period to be forecast.

(11) \( S_{t+n} = (r_t + N(D)) * P_{t+n} \) Forecast for small area.
For example, for St. Clair County, Illinois:

\[ r_{50} = .02357 \]
\[ r_{60} = .02553 \]
\[ r_{70} = .02561 \]
\[ r_{80} = .02325 \]

\[ D_t = r_t - r_{t-1} \]
\[ D_{50-60} = .00196 \]
\[ D_{60-70} = .00008 \]
\[ D_{70-80} = -0.00236 \]

**Weighting Factors:**

For 1990 forecast

\[ W_{50-60} = \frac{1}{1990-1960} \times 100 = 3.3 \]
\[ W_{60-70} = \frac{1}{1990-1970} \times 100 = 5 \]
\[ W_{70-80} = \frac{1}{1990-1980} \times 100 = 10 \]

\[ W_{50-60}/EW = .18 \]
\[ W_{60-70}/EW = .27 \]
\[ W_{70-80}/EW = .54 \]
\[
\bar{D} = w_{70-80} (D_{70-80}) + w_{60-70} (D_{60-70}) + w_{50-60} (D_{50-60}) \\
= .54 (-.236) + .27 (.008) + .18 (.196) \\
= -.09
\]

\[
S_{90} = r_t + 1 (\bar{D}) * P_{90} \\
= .02325 - .0009 * 11,804,539 \\
= 263,831
\]

As can be seen in this example, a significantly lower forecast was derived using the ratio difference method than was obtained using either the basic ratio or average annual method. This lower forecast occurs because information from the most recent difference in ratios (1970-1980 period) was preserved by this method, and was weighted most heavily. In contrast, the average annual ratio method used information only from 1950 and 1980 to generate its forecast.

2.4. OBERS Shift Share. This procedure was developed by the Bureau of Economic Analysis. It combines a ratio component with a trend extrapolation of historical changes in the small area. This latter component is termed a shift factor and measures the difference in the small area's change accounted for by the simple ratio between the small area and the parent area, and the actual change observed. The method presented below was derived from Greenberg, et al, 1978.
The approach is presented as follows:

\( S_{t+m} = (r_t + b (t+m)) * P_{t+m} \)

In equation 12, the term \( r_t \) represents the ratio factor, while the \( b \) coefficient represents the "shift" component, showing how the relationship between small and parent areas has changed over time. This information is used to modify the current ratio (or an average ratio) \( r_t \). The approach uses logarithms to compute the shift factor. Logarithms smooth the curve when rapid fluctuations in ratios have occurred. The computation of the shift factor \( b \) is shown below.

\[
(13) \quad b = \frac{N \sum (\log t) * (\log r_t) - \sum (\log t) * \sum (\log r_t)}{N \sum (\log t)^2 - (\sum (\log t))^2}
\]

As can be seen, equation 13 is the familiar ordinary least squares formula for computing the slope of a regression. This approach requires the use of a series of historical data. Generally, at least 10 historical data points should be used.

For example: for St. Clair County, Illinois:
**Summary.** Four methods employing ratios to derive forecasts have been described in this section. It has been established that each method has different data requirements, makes different assumptions about the distribution of historical information used to derive forecasts, and employs
different mathematical procedures to generate forecasts. These differences in the methods are summarized in the table below. Having discussed the ratio methods in detail, the next section describes how to use the IWR ratio forecast program.

Table 1. Summary of Ratio Forecast Methods

<table>
<thead>
<tr>
<th>Basic Method</th>
<th>Average Annual Differences</th>
<th>Ratio Differences</th>
<th>Shift Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum No. of Historical Data Needed</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Mathematical procedure to forecast</td>
<td>Simple ratio</td>
<td>Rate of Change</td>
<td>Weighted Average OLS</td>
</tr>
<tr>
<td>Weight of Historical Data</td>
<td>NA</td>
<td>Equal</td>
<td>Variable</td>
</tr>
</tbody>
</table>

3. Using the Ratio Forecast Program.

The ratio forecast program performs the following functions:

- generates forecasts for small areas using any of the four ratio methods
- generates forecasts for multiple small areas which are subcomponents of the same parent area.
o reconciles forecasts of multiple small areas so that they sum to the value of parent forecast.

3.1. Operation of main program. The operation of the program is shown below. User supplied inputs are underlined.

3.1.1. Initial Data Entry. On first accessing the program, the user is prompted to enter data:

<table>
<thead>
<tr>
<th>Computer Prompts</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTER YEARS FOR WHICH YOU HAVE DATA</td>
<td></td>
</tr>
<tr>
<td>Enter 0 to Stop</td>
<td>Enter years for which you have both a value for the parent area, and a value for the small area. To stop enter a 0.</td>
</tr>
<tr>
<td>1: 1950</td>
<td></td>
</tr>
<tr>
<td>2: 1960</td>
<td></td>
</tr>
<tr>
<td>3: 1970</td>
<td></td>
</tr>
<tr>
<td>4: 1980</td>
<td></td>
</tr>
<tr>
<td>5: 0</td>
<td></td>
</tr>
<tr>
<td>ENTER NAME OF PARENT AREA: ILLINOIS</td>
<td>Enter name or other identification for parent area (up to 10 characters)</td>
</tr>
<tr>
<td>ENTER DATA FOR ILLINOIS FOR</td>
<td></td>
</tr>
<tr>
<td>1950: 8738000</td>
<td></td>
</tr>
<tr>
<td>1960: 10280000</td>
<td></td>
</tr>
<tr>
<td>1970: 11137000</td>
<td></td>
</tr>
<tr>
<td>1980: 11418461</td>
<td></td>
</tr>
<tr>
<td>ENTER NAME OF SMALL AREA: ST. CLAIR</td>
<td>Enter name of other identification for small area (up to 10 characters)</td>
</tr>
<tr>
<td>ENTER DATA FOR ST. CLAIR FOR</td>
<td></td>
</tr>
<tr>
<td>1950: 205995</td>
<td></td>
</tr>
<tr>
<td>1960: 262509</td>
<td></td>
</tr>
<tr>
<td>1970: 285176</td>
<td></td>
</tr>
<tr>
<td>1980: 265469</td>
<td></td>
</tr>
</tbody>
</table>
Enter Years To Be Forecast: Enter years for which forecast is desired, and for which a parent area forecast is available.
Enter 0 to STOP:
1: 1990
2: 2000
3: 0

Enter Forecast for Illinois for 1990: 11804539
Data entry is now complete, program exits to main menu.

2000: 12263810

3.1.2. Main Menu. Seven options are provided in the main menu. The main menu is displayed in full once, and in an abbreviated form thereafter. The full menu can be displayed by entering a number other than 1 through 7 in response to the menu prompt.

<table>
<thead>
<tr>
<th>Computer Prompts</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN MENU CHOICES:</td>
<td></td>
</tr>
<tr>
<td>(1) ENTER NEW PARENT AREA DATA</td>
<td>See Section 3.1.3</td>
</tr>
<tr>
<td>(2) ENTER NEW SMALL AREA DATA</td>
<td>See Section 3.1.4</td>
</tr>
<tr>
<td>(3) ENTER NEW PARENT AREA FORECAST</td>
<td>See Section 3.1.5</td>
</tr>
<tr>
<td>(4) EXAMINE/CHANGE INPUT VALUES</td>
<td>See Section 3.1.6</td>
</tr>
<tr>
<td>(5) ACCESS FORECAST MENU</td>
<td>See Section 3.1.7</td>
</tr>
<tr>
<td>(6) RECONCILE SMALL AREA FORECASTS</td>
<td>See Section 3.1.8</td>
</tr>
<tr>
<td>(7) END</td>
<td></td>
</tr>
</tbody>
</table>

or MAIN MENU CHOICE (1-7)

3.1.3. Enter New Parent Area Data. If the user decides to test the sensitivity of forecasts using a different parent area (e.g. substituting SMSA data for state data) choosing option 1 on the main menu will put the user back into the data entry mode described in 3.1.1 for parent area data. After entering new parent area data the program returns to the main menu.
3.1.4. **Enter New Small Area Data.** Choosing option 2 of the main menu enables the user to enter data for a different small area. Prompts are the same as described in 3.1.1.

3.1.5. **Enter New Parent Area Forecast.** Selecting option 3 of the main menu enables the user to substitute different forecasts for the parent area. This option can be useful if the analyst would like to compare the small area forecasts among several competing parent area forecasts embodying different assumptions, etc.

3.1.6. **Examine/Change Input Values (option 4).** Option 4 of the main menu enables users to correct individual data entries which were incorrectly entered.

**Computer Prompts**

**INPUT VALUES ARE AS FOLLOWS**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ILLINOIS</th>
<th>CALHOUN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>8738000.</td>
<td>5600.</td>
</tr>
<tr>
<td>1960</td>
<td>10280000.</td>
<td>6500.</td>
</tr>
<tr>
<td>1970</td>
<td>11137000.</td>
<td>6700.</td>
</tr>
<tr>
<td>1980</td>
<td>11418461.</td>
<td>8000.</td>
</tr>
</tbody>
</table>

**FORECAST DATA**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ILLINOIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>12090000.</td>
</tr>
<tr>
<td>2000</td>
<td>13877000.</td>
</tr>
<tr>
<td>2010</td>
<td>15380000.</td>
</tr>
<tr>
<td>2020</td>
<td>17500000.</td>
</tr>
</tbody>
</table>

Do you want to make changes in data? (Y or N): **Y**

Select category of item to be changed
(1) YEAR FOR WHICH YOU HAVE DATA
(2) PARENT AREA DATA
(3) SMALL AREA DATA
(4) YEARS TO BE FORECAST
(5) PARENT AREA FORECAST

The "Y" entered indicates that small area data is to be changed.

Program lists data entries with an identification number.

ENTER NUMBER OF ITEM TO BE CHANGED: 3


MORE CHANGES? (Y or N) If there are more data changes to be made enter Y.

DO YOU WANT TO PRINT DATA AGAIN? To inspect data enter "Y", a "N" response returns to the menu for selecting ratio approaches.

(Y or N) N

3.1.7. Access Forecast Menu (Option 5). The operation of the Forecast Menu is described more fully in section 3.2. After accessing the forecast menu the program returns to the main menu.

3.1.8. Reconcile Small Area Forecasts (Option 6). This portion of the program can be called into operation when the analyst has generated forecasts for several small areas which encompass a parent area. Examples include forecasts for SIC categories comprising a parent area employment forecast, forecasts for townships comprising a county for which an external forecast is available. It is unlikely that the small area forecasts will exactly total the value of the parent area. The reconciliation subroutine scales the small area forecasts so that they sum to the value of the parent area forecast. The scaling factor used is the ratio of the summed small area forecasts to the
parent area forecast. Each small area forecast is then multiplied by this scaling factor to generate the reconciled small area forecasts. If the small areas do not entirely encompass the parent area a "Balance" is automatically computed representing that portion of the parent area not included in the small areas. A forecasted "Balance" is computed on the basis of the most recent ratio of the "Balance" to the parent area. This balance is then treated just like a small area in the scaling routine.

MAIN MENU CHOICE (1-7): 6
RECONCILED FORECAST FOR SMALL AREAS
PARENT AREA= ILLINOIS

<table>
<thead>
<tr>
<th>SMALL AREA</th>
<th>1990</th>
<th>2000</th>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST. CLAIR</td>
<td>273595.</td>
<td>283802.</td>
<td>320717.</td>
<td>3550023.</td>
</tr>
<tr>
<td>CALHOUN</td>
<td>9121.</td>
<td>9913.</td>
<td>11633.</td>
<td>13324.</td>
</tr>
<tr>
<td>BALANCE</td>
<td>11521824.</td>
<td>11970095.</td>
<td>13544650.</td>
<td>15011653.</td>
</tr>
</tbody>
</table>

| TOTAL       | 11804539. | 12263810. | 13877000. | 15380000. |

MAIN MENU CHOICE (1-7):
In the above example, the program has adjusted the forecast values of two small areas which do not entirely encompass their parent area.

3.1.9. END (Option 7). This option ends the program.

3.2. Forecast Menu. As noted above selecting option 5 on the main menu accesses the forecast menu. Like the main menu, after the user has viewed the full menu once an abbreviated form is shown. If the user wants to see the entire menu it can be accessed by entering any number besides the choices shown.
### Computer Prompts

(1) **BASIC RATIO METHOD**  
(2) **ANNUAL AVERAGE RATIO**  
(3) **RATIO DIFFERENCE METHOD**  
(4) **SHIFT SHARE**  
(5) **COMBINATION TABLE**  
(6) **EXIT TO MAIN MENU**

or

**FORECAST MENU CHOICE (1-6):**

#### 3.2.1. Basic Ratio Method (Option 1)

**Computer Prompts**

SELECT ONE OF THE FOLLOWING RATIOS:

<table>
<thead>
<tr>
<th>Year</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>.02357</td>
</tr>
<tr>
<td>1960</td>
<td>.02554</td>
</tr>
<tr>
<td>1970</td>
<td>.02561</td>
</tr>
<tr>
<td>1980</td>
<td>.02325</td>
</tr>
</tbody>
</table>

**FORECAST FOR ST. CLAIR**

RATIO = **.02325**

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>274445.</td>
</tr>
<tr>
<td>2000</td>
<td>285123.</td>
</tr>
<tr>
<td>2010</td>
<td>322628.</td>
</tr>
<tr>
<td>2020</td>
<td>357571.</td>
</tr>
</tbody>
</table>

**DO YOU WANT TO RECONCILE THIS FORECAST?**

(Y OR N): N

**DO YOU WANT TO TRY ANOTHER RATIO?**

(Y OR N): N

### 3.2.2. Average Annual Ratio (Option 2)

**Computer Output**

**FORECAST USING AVERAGE ANNUAL FACTOR OF - .00046**

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>273173.</td>
</tr>
<tr>
<td>2000</td>
<td>282480.</td>
</tr>
</tbody>
</table>
3.2.3 Ratio Difference (Option 3).

**Computer Output**

**DIFFERENCE IN RATIOS ARE AS FOLLOWS:**

<table>
<thead>
<tr>
<th>Period</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1960</td>
<td>.0019613</td>
</tr>
<tr>
<td>1960-1970</td>
<td>.0000703</td>
</tr>
<tr>
<td>1970-1980</td>
<td>-.0023571</td>
</tr>
</tbody>
</table>

**WHICH DIFFERENCE METHOD WOULD YOU LIKE TO USE:**

1. Proportional Weights
2. Weighted Average

**WEIGHTS FOR 1990 ARE:**

<table>
<thead>
<tr>
<th>Period</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1960</td>
<td>.182</td>
</tr>
<tr>
<td>1960-1970</td>
<td>.273</td>
</tr>
<tr>
<td>1970-1980</td>
<td>.545</td>
</tr>
</tbody>
</table>

**FORECAST FOR 1990 = 263704.**

**WEIGHTS FOR 2000 ARE:**

<table>
<thead>
<tr>
<th>Period</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1960</td>
<td>.231</td>
</tr>
<tr>
<td>1960-1970</td>
<td>.308</td>
</tr>
<tr>
<td>1970-1980</td>
<td>.462</td>
</tr>
</tbody>
</table>

**FORECAST FOR 2000 = 270071.**

**DO YOU WANT TO RECONCILE THIS FORECAST? (Y or N)**

See comment in section 3.3.2 concerning this question.

3.2.4 Shift Share (Option 4).

**IMPLICIT SHIFT FACTOR IS 1.00769**

**SELECT RATIO FOR USE: 1**

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) .023 (1980)</td>
<td>Program offers users opportunity to use most recent ratio or an average ratio computed over the historical time period.</td>
</tr>
<tr>
<td>(2) AVERAGE RATIO = .024</td>
<td></td>
</tr>
</tbody>
</table>

**YEAR**

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>279332.</td>
</tr>
<tr>
<td>2000</td>
<td>291746.</td>
</tr>
</tbody>
</table>

**DO YOU WANT TO RECONCILE THIS FORECAST? (Y or N)**

See comment in section 3.2.1 concerning this question.
3.2.5. Combination Table (Option 5). In many cases an analyst might like to compare the forecasts generated by each of the ratio methods presented in this manual. Option 5 presents a comparative table for the small area containing basic ratio, average annual, ratio difference, and shift share forecasts. The basic ratio forecast uses the most recent ratio, the ratio difference forecast uses the proportional weights method, and the shift share forecast employs the most recent ratio to serve as share factor.

Computer Output

COMPARATIVE FORECASTS FOR ST. CLAIR

HISTORICAL DATA

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ILLINOIS</th>
<th>ST. CLAIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>8738000.</td>
<td>205995.</td>
</tr>
<tr>
<td>1960</td>
<td>10280000.</td>
<td>262509.</td>
</tr>
<tr>
<td>1970</td>
<td>11137000.</td>
<td>285176.</td>
</tr>
<tr>
<td>1980</td>
<td>11418461.</td>
<td>265469.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>YEAR</th>
<th>ILLINOIS</th>
<th>ST. CLAIR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>11804539.</td>
<td>274445.</td>
</tr>
<tr>
<td>2000</td>
<td>12263810.</td>
<td>285123.</td>
</tr>
<tr>
<td>2010</td>
<td>13877000.</td>
<td>322628.</td>
</tr>
<tr>
<td>2020</td>
<td>15380800.</td>
<td>357571.</td>
</tr>
</tbody>
</table>

After printing the comparative table, the program returns to the main menu.

If the user chooses, individual forecast approaches can be accessed and various sub-options in the approaches (e.g., use of different share factor, different basic ratio, different weighting factors) explored. Similarly, if the user wants to use a forecast in the comparative table in a reconciliation, the particular forecast must be reproduced by accessing the relevant ratio forecast option (1-4) in the forecast menu.
4. Summary

This user manual has described four ratio methods which can be used to generate forecasts for socio-economic variables in small areas. It is felt that these methods offer a means for providing Corps planners with a way to generate forecasts of population, income, and employment for small study areas. The IWR program presented offers a way to relieve the computational tedium associated with using these methods. While the methods are easy to use and conceptually straightforward, it should again be emphasized that the role of professional judgment on the part of the analyst is just as essential in the use of these methods as it is in using any other forecasting techniques.
References


APPENDIX A

Using the Ratio Forecasting Program
on the Harris Computer
Appendix A
Using the Ratio Forecasting Program
on the Harris Computer

To use the RFP enter the following statements after logging onto the Harris:

```
FORTRAN, IRFP
FR,5
ASSIGN, 5=FORDATA
VEXECUTE
```

NOTE: In this instance name of RFP is IRFP

Note that the ASSIGN, 5=FORDATA creates an output file (FORDATA) which can be stored and accessed at a later date. In this way RFP can be run on a CRT and the output retrieved and printed later. The output can be retrieved by bringing it into Editor and listing it.
APPENDIX B

FORTRAN 66 listing of RFP
COMMON ALPHA, 10 NAME(3), 10 IY(10), 10 ICOUNT
COMMON JCOUNT, J4, IA(10)

10 C  INPUT OF DATA
11 C
12 C
13 WRITE (3,12)
14 N 20
15 ICOUNT 0
16 JCOUNT 0
17 IT 0
18 12 FORMAT(5X,"ENTER YEARS FOR WHICH YOU WANT DATA")
19 ISX,"ENTER 0 TO STOP"
20 7 FORMAT(I8)
21 DO 10 IA=1, N
22 WRITE (3,5) IA
23 5 FORMAT(I15,I2,1X,"":",5X)
24 READ (3,9) IY(IA)
25 J=IA
26 IF(IY(IA) .EQ. 0) GO TO 11
27 10 CONTINUE
28 11 CONTINUE
29 9 FORMAT(I4)
30 J=J - 1
31 22 WRITE (3,6)
32 ICOUNT=ICOUNT + 1
33 6 FORMAT(/5X,"ENTER NAME OF PARENT AREA:"",5X)
34 READ (3,4) PA(IY(IA),1, I=1,2)
35 4 FORMAT(2A6)
36 WRITE (3,9) (PA(IY(IA),1, I=1,2)
37 23 FORMAT(/5X,"ENTER DATA FOR",1X,2A6,1X,"NOTE INCLUDE INCIEMA!""
38 DO 25 IA=1, J
39 WRITE (3,23) IY(IA)
40 24 FORMAT(I15,I4,2X,"":",5X)
41 READ (3,17) A(IA)
42 17 FORMAT(1E0)
43 25 CONTINUE
44 1A=0
45 IF(IT .EQ. 0) GO TO 26
46 GO TO 63
47 26 WRITE(3,18)
48 JCOUNT=JCOUNT + 1
49 8 FORMAT(/5X,"ENTER NAME OF SMALL AREA:"",5X)
50 READ (3,4000) (NN(IY(IA),1, I=1,4)
51 4000 FORMAT(4A3)
52 4001 FORMAT(/5X,"ENTER DATA FOR ",4A3," NOTE: INCLUDE DECMAL!",/)
53 4A3 JA=JA + 1
54 IT2=0
55 40 RA=0
56 DO 30 IA=1, J
57 WRITE (3,28) IY(IA)
58 28 FORMAT(I15,I4,2X,"":",5X)
59 21 READ (3,17) B(IA)
60 17 IF(B(IA) .LT. A(IA)) GO TO 29
61 WRITE (3,44)
62 44 FORMAT(I5,"SMALL AREA LARGER THAN PARENT AREA. RE ENTER!",/)
63 44 AN TO 21
**INPUT OF FORECAST DATA**

1. WRITE (3,12)
2. FORMAT//"ENTER YEARS TO BE FORECAST, ENTER & COUNT,"
3. DO 125 IN=1,N
4. WRITE (3,5) IN
5. READ (3,10) YLD(IN)
6. IF (YLD(IN).EQ.0) GO TO 125
7. 125 CONTINUE
8. GO TO 93
9. 93 WRITE (3,200) (PA(I),I=1,N),NH(I),HCOUNT(I),I=1,4)
10. 110 FORMAT//"INPUT VALUES ARE AS FOLLOWS:"
11. 115 "YEAR",6X,2A6,6X,4A3)
12. DO 55 IA=1,J
13. WRITE (3,34) YD(IA),A(IA),B(IA)
14. 160 FORMAT//"INPUT VALUES ARE AS FOLLOWS:"
15. 165 "YEAR",6X,2A6,6X,4A3)
16. DO 94 IA=1,K2
17. WRITE (3,92) PA(I),I=1,2)
18. 190 FORMAT//"THE PERIOD",1X,1I2,",
19. DO 32 IA=1,J
20. WRITE (3,96) YD(IA),A(IA)
21. 230 FORMAT//"THE PERIOD",1X,1I2,",
22. DO 32 IA=1,J
23. 260 CALL CHANGE
24. CONTINUE
25. 290 CALL FILEIN
26. 320 CALL FILEEX
27. 350 IYE-IYD(J)
28. 380 IX-IYE YD
29. 410 FORMAT//"THE PERIOD",1X,1I2,",
30. DO 32 IA=1,J
31. WRITE (3,90) A(IA)
32. 350 CONTINUE
33. 380 AV=R(J)/R(1)
34. 410 AA=EXP(ALOG(AV)/IX) - 1
35. GO TO 197

---

*Note: The above code appears to be a segment of a FORTRAN program, possibly for data input and processing.*
DO YOU WANT TO TRY ANOTHER RATIO (Y OR N)?:",5X)
177 READ (3,82) IAN
178 IF (IAN .NE. "H") GO TO 151
179 CALL PRECON
180 GO TO 197
175 151 WRITE (3,701)
176 701 FORMAT("DO YOU WANT TO TRY ANOTHER RATIO (Y OR N)?:",5X)
177 READ (3,82) IAN
178 IF (IAN .NE. "H") GO TO 187
179 GO TO 26
180 191 CALL COMP
181 GO TO 187
182 142 CALL DIFF
183 GO TO 187
184 144 CALL SHIFT
185 GO TO 187
186 C
187 C *** ANNUAL AVERAGE RATIO ***
188 C
189 145 WRITE (3,150) (NN(JCOUNT,I),I=1,4),AA
190 WRITE (5,150) (NN(JCOUNT,I),I=1,4),AA
191 150 FORMAT(5X,"FORECAST FOR",1X,4A3,/,5X,"USING AVERAGE ANNUAL",
192 @/
193 193 \7/5."
194 DO 160 IB=1,K2
195 X12=FLOT(IYB(IB) - IYE)
196 CONTINUE
F(I) = (R(J) × (1 + X12 × A0)) × P(I0)

WRITE (3,157) IYB(IB),F(IB)
WRITE (5,157) IYB(IB),F(IB)
FORMAT(15X,4,6X,F9.0)
CONTINUE
WRITE (3,700)
READ (3,82) IAN
IF(IAN .NE. 111) GO TO 187
CALL PRCOG
FORMAT(7.0)
CONTINUE
IF(110 .EQ. 0) GO TO 182
WRITE (3,705)
FORMAT(/5X,"MAIN MENU CHOICE (1-7): OR 0 TO SEE MENU",5X)
GO TO 706
CONTINUE
IF(110 .EQ. 3) WRITE (3,100)
FORMAT(/5X,"MAIN MENU CHOICE: ");
ITIS." 1 ENTER NEW PARENT AREA DATA","/
ITIS." 2 ENTER NEW SMALL AREA DATA","/
ITIS." 3 ENTER NEW PARENT AREA FORECAST","/
ITIS." 4 EXAMINE/CHANGE INPUT VALUES","/
ITIS." 5 ACCESS FORECAST MENU","/
ITIS." 6 RECONCILE SMALL AREA FORECASTS","/
ITIS." 7 END"/
READ (3,105) IPLY
IF(IPLY .GT. 7 .OR. IPLY .LT. 1:60 TO 182
FORMAT(11)
GO TO (22,26,201,34,73,184,183,184,184),IPLY
CALL PRCOG
GO TO 187
STOP
END

*** RATIO DIFFERENCE SUBROUTINE ***

SUBROUTINE DIFF
COMMON /ONE/ J,B(15),R(15),IY(15),K2,IIYB(15),P(15),
M(15).M2.RC20,290,291.M15,MT1T5,F(15),NN(15,4),
R(15),X(15),R(15),X2
DON: DON = D(I0)
FORMAT(/5X,"DO YOU WANT TO RECONCILE THIS FORECAST",/
1110 OR N")/
IF(3 .EQ. 3) FORMAT(A1)
XNN = FLOAT(IY(2))
XNN = FLOAT(IY(1))
K = 1
DO 250 IB = 1,K5
R(0B) = R(IB + 1) - R(I0)
DON: DON = D(I0)
CONTINUE
250 D = XNN XNN2
D2 = 0
DO 255 IB = 1,K5
255 (IY(IB) + 1) = IY(IB) / D4
D0 D2 + D2
CONTINUE
IF(ITZ .GT. 0) GO TO 273
WRITE (3,260)
WRITE (5,260)
FORMAT(/5X,"DIFFERENCES IN RATIOS ARE AS FOLLOWS: ";)
DO 270 IB = 1,K5
WRITE (3,265) IY(IB),IY(IB) + 1,D(IB)
WRITE (5,265) IY(IB),IY(IB) + 1,D(IB)
CONTINUE
READ (3,105) IPLY
IF(IPLY .GT. 7 .OR. IPLY .LT. 1:60 TO 182
FORMAT(11)
GO TO (22,26,201,34,73,184,183,184,184),IPLY
CALL PRCOG
GO TO 187
STOP
END

(8-4)
F7 C-

I'I'I'I'I'I'I'I

PR PF TF'

E2'

I-I-

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J

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W11

NH

7

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325 320

FORMAT(F4.3)

F3A<-WF(113)

F4A- F4A

+ F7ZA-

A2

V

rflMTTfllr-~--
WRITE (3,320)
FORMAT(12X,"DO YOU WANT TO RECONCILE THIS FORECAST",/)
400 IE:::I,J
AVE=RA/J
409 DNUM=(J/SIX) - SX*SY
410 DENOM=(J/SIX)*SIX**2
411 B=DNUM/DENOM
412 BA=EXP(B)
413 WRITE (3,405) BA
414 WRITE (5,405) RA
CONTINUE
DO 440 IA=1,K2
F(IA)=0
B(IA)=B2I/D1
F(IA)=F(AUC)=B(IA)*D2I
AUC=1/(B*7)
SUM=SUM-AUC
AUC=1/(B*7)
SUM=SUM-AUC
CONTINUE
IFIAN(IY,1HY)GO TO 445
CALL PRECON
GO TO 445
CONTINUE
DO 440 IA=1,K2
F(IA)=0
B(IA)=B2I/D1
F(IA)=F(AUC)=B(IA)*D2I
AUC=1/(B*7)
SUM=SUM-AUC
AUC=1/(B*7)
SUM=SUM-AUC
CONTINUE
IFIAN(IY,1HY)GO TO 445
CALL PRECON
RETURN
END

*** RECONCILIATION SUBROUTINE ***

SUBROUTINE RECON

COMMON /ONE/ J,D(15),B(15),IY(15),K2,IB(15),P(15),SA(15)
COMMON /TWO/ ICOUNT,PA(15,2),SUMB,PB(15),IBP(15),NB(15)

DIMENSION SA(20,20),BF(15)

RBAL=(A(1,J)-SUM)/A(J)
IC=ICOUNT
DO 510 IB=1,K2
BF(IB)=P(IB)/RBAL
CONTINUE
DO 550 IB=1,K2
XSUM=0
N=0
SUM=0
CONTINUE
00 CONTINUE
440 CONTINUE
470 CONTINUE
545 CONTINUE
585 CONTINUE
625 CONTINUE
665 CONTINUE
705 CONTINUE
745 CONTINUE
785 CONTINUE
825 CONTINUE
865 CONTINUE
905 CONTINUE
945 CONTINUE
985 CONTINUE
1025 CONTINUE
1065 CONTINUE
1105 CONTINUE
1145 CONTINUE
1185 CONTINUE
1225 CONTINUE
1265 CONTINUE

END

*** CHANGES IN INPUT DATA SUBROUTINE ***

SUBROUTINE CHANGE

COMMON (ONE, I4(I)) WHERE I4(I) TYPED AS INTEGER

(B-8)
I ~
If

J
(1 + Q)
669  WRITE (3,1099) IB,YA,F(IA)  
670  1099  FORMAT(15,15,A X,F10.0)  
671  CONTINUE  
672  GO TO 1080  
673  1080  RETURN  
674  END  
675  C  
676  C*** PRE RECONCILIATION SUBROUTINE ***  
677  C  
678  SUBROUTINE PRECON  
679  C  
680  COMMON /ONE/ J,D(15),IY(15),R(15),K2,IB(15),IA(15),  
681  1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,4),JCOUNT,  
682  SX(15),B(15),RA  
683  C  
684  DO 1001=1,4  
685  NN(JA,1)=NN(JCOUNT,1)  
686  100 CONTINUE  
687  DO 735 IB=1,K2  
688  RC(JA,IB)=0  
689  RC(JA,IB)=F(IB)  
690  735 CONTINUE  
691  RETURN  
692  END  
693  C  
694  *** COMPARATIVE FORECAST SUBROUTINE ***  
695  C  
696  SUBROUTINE COMP  
697  C  
698  COMMON /ONE/ J,D(15),IY(15),R(15),K2,IB(15),IA(15),  
699  1WF(15),JA,RC(20,20),WT1(15),WT(15),F(15),NN(15,4),  
700  JCOUNT,IA(15),B(15),RA  
701  COMMON /TWO/ ICOUNT,FA(15,2),SUMB,RA(15),IYE,NN,F(15),SC(15)  
702  C  
703  XY=0  
704  SXY=0  
705  SX=0  
706  SY=0  
707  KS=1  
708  DO 709 I=1,J  
709  D1=FLOAT(IY(2) - IY(1))  
710  DO 1300 IE=1,J  
711  DT=FLOAT(IE)  
712  DXY=ALOG(DT)  
713  SIX=SIX + DXY**2  
714  RY=ALOG(R(IE))  
715  XY=DXY * RY  
716  SXY=SXY + XY  
717  SX=SX + DXY  
718  SY=SY + RY  
719  1300 CONTINUE  
720  DNUM=(J * SXY)  
721  DENOM=DNUM/DENOM  
722  DO 1305 IB=1,K2  
723  SC(IB)=0  
724  F2A=FLOAT(IB,IB)  
725  SS(IB)=EXP(ALOG(YC(J)) + (EV + ALOG(F2A)) + D(IB))  
726  1305 CONTINUE  
727  DO 1313 IA=1,J  
728  DO 1312 IB=1,K2  
729  WT1(IB)=0  
730  W(T(IB))=0  
731  D(IB)*R(IB)+1, R(IB)  
732  1313 CONTINUE  
733  SUM=0  
734  (B-11)
DO 1315 IB = 1, K2
   WRITE (3, 1300) (NN(JCOUNT, I), I = 1, 4), (PA(I, COUNT, I), I = 1, 2),
   1(NN(JCOUNT, I), I = 1, 4)
   WRITE (5, 1300) (NN(JCOUNT, I), I = 1, 4), (PA(I, COUNT, I), I = 1, 2),
   1(NN(JCOUNT, I), I = 1, 4)
1200 FORMAT(5X, 'COMPARATIVE FORECASTS FOR', 1X, A3, //)
   15X, 'HISTORICAL DATA', //5X, 'YEAR', 3X, 2A6, 4X, 1A3)
   DO 1205 IA = 1, J
54   WRITE (3, 1204) IY(IA), A(IA), B(IA)
   WRITE (5, 1204) IY(IA), A(IA), B(IA)
1204 FORMAT(5X, I4, 3X, F10.0, 4X, F10.0)
1205 CONTINUE
   WRITE (3, 1207) (PA(I, COUNT, I), I = 1, 2), (NN(JCOUNT, I), I = 1, 4)
   WRITE (5, 1207) (PA(I, COUNT, I), I = 1, 2), (NN(JCOUNT, I), I = 1, 4)
1207 FORMAT(5X, 'FORECAST', //12X, 2A6, 2X, 1A3, '.00',
   1'BASIC',
   2132, 'RATIO', 7X, 'ANNUAL', 2X, 'DIFFERENCE', 7X, 'SHARE')
   DO 1209 IB = 1, K2
56   XI2 = FLOAT(IY(IA) - IYE)
   TEMP1 = R(J) * P(IB)
   TEMP2 = XI2 * AA1
   TEMP3 = TEMP2 * R(J)
   TEMP4 = TEMP3 * P(IB)
   WRITE (3, 1208) IY(IA), P(IB), TEMPl,
   ITEM4, P(WIB), SS(IB)
   WRITE (5, 1208) IY(IA), P(IB), TEMPl,
   ITEM4, P(WIB), SS(IB)
1208 FORMAT(5X, I4, 3X, F10.0, 4X, F10.0, 3X, F10.0, 2X, F10.0,
   12X, F10.0)
1209 CONTINUE
   RETURN
1209 END
*** WRITE DATA TO FILE SUBROUTINE ***
SUBROUTINE FILEIN
    COMMON /ONE/ J, D(15), R(15), IY(15), K2, IY(15), F(15),
    1WF(15), JA, RC(20, 20), WT(15), WT(15), F(15), NN(15, 4),
    2JCOUNTA(15), B(15), RA
    WRITE(5, 900)
700 FORMAT(1X, 'IWR RATIO FORECAST PROGRAM. WRITTEN FOR THE', //)
701 'HARRIS 120 SYSTEM BY MARK DUNNING AND KEVIN ALEXANDER.', //
702 'VERSION 1.1 JANUARY 1984', //)
703 WRITE(5, 935)
735 FORMAT(//, 5X, 'INPUT VALUES ARE AS FOLLOWS:', //)
735 'YEAR', 5X, 'PARENT AREA', 5X, 'SMALL AREA')
736 DO 955 IA = 1, J
740 WRITE(5, 940) IY(IA), A(IA), B(IA)
734 FORMAT(15, I4, 4X, F10.0, 4X, F10.0)
735 CONTINUE
736 WRITE(5, 950)
900 WRITE(5, 960)
791 992 FORMAT(//, T23, "FORECAST DATA", // T15, "YEAR", 5X, "PARENT AREA", //)
792 DO 994 Ia=1, K2
793 WRITE(5,996) IYB(Ia), P(Ia)
794 996 FORMAT(T15, I4, 6X, F10.0)
795 994 CONTINUE
796 RETURN
797 END
END...
END
DATE FILMED
7 - 84
DTIC