

► CASE STUDY (continued)

Although Nevada and Arizona led the nation in net migration with rates of 15 and 7 percent respectively, the largest regional concentration of positive migration rates occurred in the Southeast, where Florida, Georgia, and North Carolina were among the top destination states (Figure 4.10). Positive net migration also occurred in Nevada, Arizona, Colorado, Oregon, and Idaho, where Californians and others were attracted by affordable housing, healthy job growth, and high-amenity lifestyles. The same forces created positive net migration to the upper New England states of Maine, Vermont, and New Hampshire. Alaska, Hawaii, and New York State registered the highest negative net migration rates. The urban Northeast fared poorly in general, as did some parts of the Midwest, particularly Illinois. Great Plains states had difficulty retaining population, as did Louisiana in the South and New Mexico in the Southwest. Overall, the map of regional desirability reveals the strong preference among domestic migrants for high-amenity

regions with warm climates, picturesque seashores, striking mountain views, and outdoor lifestyle.

Today's migration patterns reflect the location of states relative to one another (nearby states tend to exchange migrants), historical patterns of movement (i.e., longtime linkages between Florida and New York and between California and Texas), the changing geography of economic opportunity in the nation, and the public's perceptions about the attractiveness of places, including intangibles such as an agreeable climate, being near family and friends, and an ocean view. You are asked in this exercise to examine recent migration flows between your state (or Canadian province) and all others in the nation in 2002–2003 and to hypothesize about why your state or province is more connected to some than to others. Use your basic knowledge of migration trends in the nation and your knowledge of the circumstances of your particular state or province.

Name: _____ Instructor: _____

Newton's First Law of Migration: The Gravity Model

► ACTIVITY 1: PREDICTING MIGRATION WITH THE GRAVITY MODEL

Use the simplified format of the following gravity model to estimate migration flows to your state or province in 2003. The destination population term, P_j , has been left out because you will be looking at a single destination j —your state or province—that is the same for all origins. The distance exponent also has been left out for simplicity.

$$M_{ij} = k \frac{P_i}{d_{ij}}$$

where:

M_{ij} = gravity model prediction of migration between origin i and destination j

P_i = population of origin state i

d_{ij} = distance from origin i to destination j

k = a constant that adjusts the gravity model estimates so that the total numbers of actual and estimated migrants are approximately equal

You will obtain the data you need and perform calculations using a spreadsheet. If you've never used a spreadsheet, you will learn a valuable skill here. Just follow the step-by-step instructions.

- To start your activity, log onto the *Human Geography in Action* Web site or insert your CD into your computer.
- Select this chapter from the drop-down list, and then click on *Computerized Chapter Activities*
- Click on *Activity 1: Predicting Migration with the Gravity Model*.
- Choose your country, USA or Canada.
- Choose the destination state or province to which you wish to measure migration. As you move the mouse over the names, the location on the map is highlighted. Click on your state or province.

You now will be looking at a spreadsheet with all the information you need. You can scroll down the spreadsheet to look at all the values by using the scroll bar. The columns are as follows:

Column A	State	State or province abbreviations.
Column B	P_i	Population of each state or province in 2002.
Column C	d_{ij}	Distance in miles from the geographic center of that state to the geographic center of the state you selected. Notice that your state has a value of 0 because it is zero miles away from itself.
Column D	P_i/d_{ij}	State or province population divided by the distance to your state or province.
Column E	Predicted Migration	The number of migrants, M_{ij} , predicted by the gravity model.
Column F	Actual Migration	The actual number of migrants from that state or province to your state or province from 2002 to 2003. The U.S. data come from the Internal Revenue Service (IRS), which tracks where claimants filed their returns in 2002 as opposed to where they filed in 2003. Any claimant crossing a state line between those years is considered an interstate migrant. Canadian data are estimated in the same way and are obtained from Statistics Canada for 2002 to 2003. Notice that your own state or province has a value of 0, because we are not concerned here with movements within a state or province.
Column G	Residual %	Actual migration minus the predicted migration, divided by the actual migration, and multiplied by 100. These residuals show the percentage error in your predictions.

Note: At the top of the screen, you are provided with the k coefficient that has already been calculated for your particular state or province.¹

The spreadsheet software will compute values much like a calculator if you give it a formula to use. In a spreadsheet, the letter of the column and the number of the row identify a cell. For instance, the population (Column B) of California (row 6) is in cell B6. Multiplying or dividing a number by cell B6 is the same as multiplying or dividing by the population of California.

F. Your first step is to divide the population of the first origin state (or province) by the distance between that origin and your state. Click on cell D2, the first empty cell, where you will calculate P_i/d_{ij} . Because the population of the first origin is in B2 and its distance from your state is in C2, you can calculate P_i/d_{ij} by entering the following formula:

$$= B2 / C2$$

¹ For you math mavens, we estimated k by doing a least-squares linear regression of M_{ij} on P_i/d_{ij} with the constant term forced to zero (that is, using the functional form $Y = kX$, where $Y = M_{ij}$ and $X = P_i/d_{ij}$).

The "=" is a code that tells the spreadsheet you are entering a formula, not a number. The formula simply says divide cell B2 by cell C2 and store the answer in D2. You can type this formula directly in cell D2 using the keyboard or create it using the formula buttons at the top right. Click the "=" button, then type B2, then click on the "÷" button, and then type C2. Whichever way you enter the formula into the cell, click out of the cell (on any other cell) to see the calculated value. If you make a mistake, you will get an error message telling you the formula you have entered is incorrect and asking you to try again. Click *Try again*, and edit the formula. If at any time you wish to return to the original blank spreadsheet, go to the browser's *View* menu and select *Refresh*.

G. Now comes one of the best features of spreadsheets—you can transfer this formula to the entire Column D. First, click back into cell D2 to highlight the formula. Second, click on *Copy* in the upper left. This copies the formula from cell D2 into a buffer, which the computer remembers. Third, click on the Column D header to highlight the entire column. Fourth, click on the word *Paste* in the upper left. The computer has now copied the formula from cell D2 into each of the cells below it and has modified each formula to divide by the B and C column cells immediately to the left, rather than always dividing cell B2 by C2. You have just saved yourself much time compared with typing this formula 50 times.

Notice that the value for your state or province—infinity—is not a valid result. This is so because you tried to divide by zero (the distance), and zero can go into anything an infinite number of times. This is okay; you will not need a value from your own state, so ignore it.

H. Finish calculating the predicted migration to your state by multiplying the P_i/d_{ij} value in Column D by the coefficient k , which we have calculated and provided to you for each state and province. Because the *Human Geography in Action* software checks to make sure that you complete the spreadsheet correctly, k must be entered into the formula *exactly* as it appears at the top of the spreadsheet. The easiest and safest way to do this is to use the k button in the upper right to enter the value. **Whatever you do, don't type the letter k .** Click on cell E2 and type "=D2*" and then click on the k button (* means multiply in computer language). Your formula should look something like:

$$\begin{aligned} &= D2 * 2.6183 \text{ (for Alberta)} \\ &= D2 * 0.1974 \text{ (for Alabama)} \end{aligned}$$

Click out to see the result. Then follow the *Copy* and *Paste* commands from the previous step to copy this formula into all the cells for Column E. Column E is the predicted migration to your state or province based on the gravity model. Think about what these numbers mean. Based on the population of each state or province and its distance from your state or province, you have *predicted* the number of migrants in 2003.

I. Your final step in completing the spreadsheet is to calculate residuals in Column G. You will learn more about residuals and how to use them in Activity 3, but you must calculate them now while the spreadsheet is still active.

A **residual** is the difference between the actual migration and the predicted migration. Residuals indicate how well the gravity model predicted the actual migrant flow. To calculate the residuals, simply subtract your predicted migration, Column E, from the actual migration, Column F. Then, to put the residuals in percentage terms, divide the result by the actual migration (Column F) and multiply by 100. In cell G2, enter this formula exactly as shown here, and then click out of the cell:

$$= 100 * (F2 - E2) / F2$$

Again, use the *Copy* and *Paste* commands you learned in the previous steps to copy the formula from cell G2 to all cells in column G. If this step is done correctly, you will receive a message on the screen that says you have completed the spreadsheet. Click *OK*.

The numbers in Column G are interpreted as percentage errors. For instance, a -2.6 means that the actual migration was 2.6 percent less than the predicted migration, as a percentage of the actual migration. Putting the residuals into percentage terms allows you to compare, on an equal footing, how well the gravity model predicts migration from states of different sizes.

- J. Click the *Print* button.
- K. Click on *Activity 2: Scatter Diagram*. Do not close the spreadsheet window; you will need to return to it later.