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A REEXAMINATION OF MIGRATION, ECONOMIC OPPORTUNITY, AND THE QUALITY OF LIFE*

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In a recent article in this journal Cebula and Vedder [1] (hereafter C-V) attempted to relate net migration to environmental factors as well as the more usual economic variables. Unfortunately, their reported results are marred by one empirical error and by several errors of a more judgmental character. In Section 1, the C-V model is presented in abbreviated form with an explanation of the nature of the empirical error. In Section 2, a corrected version of the C-V regression and other suggested alterations are given which tell a very different migration story.

The relevance of the basic C-V approach is questioned briefly in Section 3. It is argued that the principal interest in studying migration lies in improving our predictive ability, rather than merely providing historical explanations. C-V employ explanatory variables whose values can only be known ex post (e.g., using 1968 income to explain 1960 to 1968 net migration). Their migration equation is, then, of little value in those areas of urban study (such as transportation planning, provision of municipal services, tax base predictions and so on) where an understanding of present factors influencing future migration is vital.

1. THE C-V MODEL

The C-V migration model, with expected partial derivative signs in parentheses below the respective arguments, is as follows:

$$M_i = M(\underset{(+)}{Y_i}, \underset{(-)}{U_i}, \underset{(+)}{G_i}, \underset{(+)}{D_i}, \underset{(-)}{C_i}, \underset{(-)}{N_i}, \underset{(-)}{T_i}, \underset{(-)}{P_i}) \quad (i = 1, \cdots, 39)$$

where

M_i = net migration into the ith SMSA from 1960 to 1968,
Y_i = level of per capita income in the ith SMSA in 1968,
U_i = average (of 1963, 1966 and 1968) annual rate of unemployment in the ith SMSA,
G_i = annual average percentage rate of growth in personal income per capita in the ith SMSA over the 1959–1968 period,

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D_i = number of physicians per 100,000 population in the ith SMSA in 1969,
C_i = number of major crimes per 100,000 population in the ith SMSA in 1969,
N_i = proportion of the ith SMSA's 1960 population that was nonwhite,
T_i = average number of days per year that the ith SMSA's temperature is below freezing and
P_i = average number of micrograms of suspended particulate matter per cubic meter of air in the ith SMSA in the 1960 to 1968 period.

The intuition suggesting most of the a priori sign expectations is quite straightforward and need not be repeated at this point.

While sufficiently close for present purposes, replicating the sample employed by C-V was an elusive goal.[1] The comparison of C-V's regression results with my own is found in Equations (1) and (2) respectively in Table 1.

However, Equations (1) and (2) are both incorrect. With respect to the G variable, C-V [1, p. 209] note:

> By itself, change in per capita income can explain more than 44 percent of the total variation in net migration rates. This equation [reproduced as my equation (1)] suggests that for each one percent change in the rate of growth in per capita income over the nine-year period 1960–1968, population changed, because of changes in net migration, by 3.21 percent, other factors held constant.

This is a striking and implausible result. Analysis revealed that this finding derived from C-V's usage of "growth of (aggregate) personal income," rather than the intended "*per capita* personal income growth" for each SMSA. The error is somewhat understandable given the layout of the data in the *Statistical Abstract* [2]. Thus, the results quoted above follow from the fact that areas experiencing rapid in-migration have, for that reason, higher personal income growth in the aggregate.

2. A CORRECTED MODEL

When the correct G variable replaces the erroneous one in the regression, very different results obtain, as seen in Equation (3).[2] Unemployment and temperature are seen to have larger and more significant impacts on migration relative to the reported findings of C-V. The G variable, relied on so heavily in C-V's discussion, is seen as insignificantly different from zero, the estimated coefficient actually having a negative sign.

From an economist's perspective, the only big theoretical disappointment remaining in Equation (3) is that income has no significant effect. But, is *per capita* income the appropriate measure of income? There is a great deal of variation in the percentage of children, retired, and other nonworkers across SMSA's. A

[1] The difficulties involved, in spite of a helpful communication from Professor Vedder, are outlined in the Appendix to this paper.

[2] The desired per capita personal income growth variable was constructed by subtracting, for each SMSA, the average annual population growth rate from the average annual personal income growth rate. This assumes the migrants to an SMSA are like those already there, although employing growth of median family income produced essentially the same results.

TABLE 1: Regression Analysis of Net Migration Rates

Equation	Constant	Y^a	U	N	T^b	G^c	C	P	D	D.F.	F	R^2
(1)	−14.9268	+.00237	− .91527	−.09472	−.05950	+3.2064	−.00127	−.00571	+.00544	30	6.871	.647
		(1.20)	(2.04)	(1.29)	(2.51)	(3.69)	(1.57)	(.27)	(2.40)			
(2)	−4.5744	+.00028	−3.2223	−.20146	−.06894	+2.8906	−.00142	+.00573	+.06112	30	6.827	.645
		(.143)	(2.51)	(2.12)	(2.75)	(3.03)	(1.16)	(.203)	(2.64)			
(3)	35.4644	−.00124	−5.2359	−.22357	−.10758	−1.3698	+.00049	+.00586	+.04774	30	4.544	.548
		(.583)	(4.21)	(2.07)	(4.29)	(.845)	(.366)	(.183)	(1.78)			
(4)	21.9902	+.00114	−4.7606	−.17080	−.11760	−1.2912	−.00026	+.00032	+.03577	30	4.911	.567
		(1.30)	(3.80)	(1.61)	(4.69)	(.814)	(.201)	(.010)	(1.36)			
(5)	24.4218	+.00143	−4.4696	−.16060	−.11623	−1.8218	+.00047	−.00021		31	5.209	.541
		(1.66)	(3.57)	(1.49)	(4.58)	(1.17)	(.395)	(.007)				
(6)	9.1922	+.00281	−4.2591	−.27269	−.00369					34	12.84	.602
		(3.84)	(4.04)	(2.80)	(6.71)							

Note: *t*-values are given in parentheses below the respective coefficients.

[a] Variable *Y* in Equations (1) through (3) is per capita personal income, while in Equations (4) through (6) it is median family income.

[b] Variable *T* in Equations (1) through (5) is average number of days per year during which the temperature is less than or equal to 32°, while in Equation (6) it is degree days, 65° base.

[c] Variable *G* in Equations (1) and (2) is average annual rate of growth of personal income, 1959–1968, while in Equations (3) through (6) it is this variable minus average annual change in population, 1960–1968.

city with more nonworkers would, even if all wage and salary incomes were the same for those employed, have a much smaller per capita income than would other cities. A migrant would be indifferent between these cities, ceteris paribus, since his income would be the same in either. In Equation (4) the theoretically preferred median family income measure (for 1969) is substituted for the less satisfactory per capita income measure, with the proper sign and expected gain in precision becoming apparent.

The *D* variable (physicians per 100,000 population) was presumed to be a proxy for abundance of health services, although it is difficult to envision the typical migrant knowing, or behaving as if he knew, the values this variable (or any that it would be correlated with) might take on across SMSA's. A moment's reflection indicates that what is probably happening is that doctors, upon coming out of medical school, tend to accumulate in those areas expected to grow rapidly in population and those having many high-income potential patients. Indeed, dropping *D* from the regression does result in increased significance for the income coefficient, it now being significant at the 95 percent level with the appropriate one-tailed test.

While crime and pollution levels might, a priori, be thought to affect migration, it must be understood that these variables are essentially local in their impact.[3] Most high pollution or high crime SMSA's will have many areas with low values for these variables. That is, pollution and crime would be much more likely to affect intra-SMSA migration than inter-SMSA migration. These variables are dropped from the regression in Equation (6) of the Table.

The final alteration, in arriving at the powerful results in Equation (6), was to substitute the number of degree days, 65° base for *T* (the average number of days per year temperature is below freezing). The former measure is more in keeping with people's notions about temperature. Few would regard Phoenix as colder than San Francisco, even though Phoenix has, on average, 17 days in which the thermometer falls below 32°, compared to San Francisco's 4. Phoenix can be below freezing in the early morning and have shirt-sleeve weather by afternoon, and the "degree days" measure captures this sort of climatic variation.[4]

Summarizing this section, we have arrived, in Equation (6), at a regression which explains more of the variation of migration than the corrected C-V version. Further, this is accomplished by using fewer, more theoretically acceptable, variables, each of which is highly significant (as is the regression as a whole) when compared to C-V's findings.

3. PREDICTION

A predictive equation, in the spirit of the C-V approach followed in the previous section, is constructed by using as income and unemployment variables

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[3] Alternatively, if migration were in equilibrium with respect to these variables (through compensating income differentials) in 1960, only relative changes in pollution and crime levels across SMSA's would matter, and these would be small over the period 1960–1968.

[4] "Heating degree days are the number of degrees the daily average temperature is below 65°. . . . Heating degree days are determined by subtracting the average daily temperature [if] below 65° from the base 65°. A day with an average temperature of 50° has 15 heating degree days while one with an average temperature of 65° or higher has none" (U.S. Department of

Y_{60} = median family income in 1960 in the ith SMSA, and U_{60-63} = an average of the annual unemployment rates for the years 1960 through 1963 for the ith SMSA.[5] In Equation (7), making these substitutions with T and N as before, we obtain the predictive equivalent of Equation (6):

$$\text{(7)}\quad \text{Net Migration} = \underset{}{4.487} + \underset{(2.417)}{.00361(Y_{60})} - \underset{(2.954)}{1.924(U_{60-63})} - \underset{(4.615)}{.00275(T)}$$

$$- \underset{(1.241)}{.14515(N)} \quad \text{D.F.} = 34 \quad F = 6.505 \quad R^2 = .434$$

In broad outline, the results displayed in Equation (7) are as expected. When compared to Equation (6), the significance is lower for the coefficients singly and collectively, and we observe a lower R^2. Note, however, that the coefficients are somewhat different, with the income effect being larger while the other variables have reduced impacts. The coefficients of Equation (7) are the ones that are appropriate for prediction purposes.

In conclusion, this analysis shows, as did C-V, that environmental considerations are important in the migration decision—but only those that are global with respect to a particular city (e.g., climate, but not pollution or crime). At the same time, the importance of the more usual economic variables is confirmed.

APPENDIX

Professor Vedder was unable to provide the list of SMSA's making up the C-V sample. However, following his suggestions, only those SMSA's were included which had (1) at least 7 of 9 annual pollution averages and (2) a population of 250,000 or more in 1960. Data for San Francisco-Oakland and Minneapolis-St. Paul were combined and Honolulu was excluded as being atypical since U-haulers could not migrate there. Finally, omitting observations for which only SEA data were available, the following set of SMSA's made up the data used in the regressions of this paper:

Birmingham	Minneapolis-St. Paul	Philadelphia
Phoenix	Baltimore	Oklahoma City
Los Angeles	Detroit	Portland
San Francisco-Oakland	Kansas City	Pittsburgh
San Diego	St. Louis	Memphis
Denver	Omaha	Nashville
Wilmington	Newark	Dallas
Washington	New York	Houston
Atlanta	Rochester	San Antonio
Chicago	Charlotte	Salt Lake City
Indianapolis	Cincinnati	Norfolk-Portsmouth
Wichita	Cleveland	Seattle-Everett
New Orleans	Columbus	Milwaukee

Commerce [3, p. 36]). Phoenix has 1765 annual degree days compared to San Francisco's 3012, hence this measure more accurately captures temperature perceptions.

[5] It would have been preferable to use only data for 1960 or earlier in predicting 1960–1968 migration. The use of 1960 through 1963 was dictated by data limitations in the various variables examined. Data for the unemployment variable used here came from U.S. Department of Labor, *Statistics on Manpower* [4, Table D-8] interpolating for a few observations as required, while U.S. Department of Commerce, *Statistical Abstracts* [2] were, following C-V, the source for remaining data.

REFERENCES

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[3] ———, Environmental Science Services Administration. *Climatic Atlas of the United States*. Washington, D.C.: U.S. Government Printing Office, 1968.

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