Journal of Economic and Social Measurement 24 (1998) 249–264
IOS Press

In defense of the net migrant*

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Net migration has been widely criticized as a theoretical concept and as a measure of population movement. Many of these criticisms are valid: net migration reflects a residual rather than a true migration process, it often masks large gross migration flows, it cannot account for differences in the characteristics of origin and destination populations, it cannot be used for rates in a probabilistic sense, and it can lead to misspecified causal models and unrealistic population projections. However, we believe there are purposes for which net migration is very useful, especially for analyses of small areas: 1) It provides a summary measure of one component of population change, 2) It can be used when gross migration data are unavailable or unreliable, and 3) It provides a low-cost alternative to the use of gross migration data. In this paper we discuss the strengths and weaknesses of net migration and provide several examples of how it can be useful for population estimation, forecasting, and analysis.

Keywords: Applied demography, migration data, net migration, population estimates and projections, small area analysis

1. Introduction

Gross migration is the movement of people into or out of a region during a particular period of time; net migration is the difference between these two countervailing movements. Although it is not a direct measure of population change, net migration has been used for many types of demographic analysis. For example, it has been used in economic studies of the determinants of interregional migration [4,8,12,20], human ecological studies of population redistribution [9,29,32], analyses of the components of population growth [6,36], and for the construction of population estimates and projections [5,18,43].

In spite of its long history and widespread use, however, net migration has been strongly criticized, both as a theoretical concept and as a measure of population mobility [see, for example, 15,17,21,25,28]. Although many of these criticisms

*An earlier version of this paper was presented at the annual meeting of the Population Association of America, New Orleans, May 9–11, 1996. The authors would like to thank an anonymous referee for a number of useful comments and suggestions.

are valid, we believe there are a number of purposes for which net migration can be usefully employed Indeed, there are circumstances in which net migration is the only available indicator of population mobility. In this article we review the conceptual and methodological problems of net migration as a measure of population mobility, but go beyond those problems to consider the important role net migration can play in population estimation, forecasting, and analysis. To paraphrase Mark Twain, we believe rumors of the death of the net migrant have been greatly exaggerated.[1]

2. Estimating net migration

There are two basic approaches to estimating net migration Under the first, net migration is calculated as the difference between the number of in-migrants and the number of out-migrants for a geographic area during a particular period of time:

$$\mathrm{NM} = \mathrm{IM} - \mathrm{OM} \tag{1}$$

where NM is net migration, IM is the number of in-migrants, and OM is the number of out-migrants. For example, Florida had 2,130,613 in-migrants from other states and 1,058,931 out-migrants to other states between 1985 and 1990, producing a net interstate migration inflow of 1,071,682 (Table 1). During the same time period New York had 727,621 in-migrants from other states and 1,548,507 out-migrants to other states, producing a net interstate migration outflow of 820,886 These were the largest positive and negative net migration flows of any state between 1985 and 1990. Twenty-two states had more interstate in-migrants than out-migrants during this time period, while twenty-nine had more interstate out-migrants than in-migrants [2]

The second approach to estimating net migration is based on the demographic balancing equation, in which population change is defined as:

$$P_1 - P_0 = B - D + \mathrm{IM} - \mathrm{OM} \tag{2}$$

where P_1 is the population at time 1, P_0 is the population at time 0, B is births between times 0 and 1, D is deaths between times 0 and 1, IM is in-migrants between times 0 and 1, and OM is out-migrants between times 0 and 1. By rearranging the terms of this equation, we can calculate net migration as.

$$\mathrm{NM} = \mathrm{IM} - \mathrm{OM} = P_1 - P_0 - B + D \tag{3}$$

[1] We use the term "net migrant" to refer to the net migration balance, or the difference between in-migrants and out-migrants for a particular area during a particular period of time Clearly, there is no specific category of persons that can be classified as "net migrants"

[2] These numbers refer solely to interstate migrants, or migrants from one state to another within the United States Although the decennial census collects data on immigration from abroad, it does not collect information on emigration to foreign countries In fact, no agency in the United States collects comprehensive data on foreign emigration

There are two common methods for estimating net migration in this manner. In the vital statistics method, net migration is estimated using population estimates (or counts) from two points in time and birth and death data for the intervening time period. When birth and death data are not available, the survival rate method can be used; this method uses indirect estimates of mortality and fertility rather than direct

Table 1
In, out and net migration for states, 1985–1990*

	In-migrants	Out-migrants	Net Migration
Northeast			
Connecticut	291,140	342,983	–51,843
Maine	132,006	98,688	33,318
Massachusetts	444,040	540,772	–96,732
New Hampshire	191,130	129,070	62,060
New Jersey	569,590	763,123	–193,533
New York	727,621	1,548,507	–820,886
Pennsylvania	694,020	771,709	–77,689
Rhode Island	105,917	93,649	12,268
Vermont	74,955	57,970	16,985
Midwest			
Illinois	667,778	1,009,922	–342,144
Indiana	433,678	430,550	3,128
Iowa	194,298	288,670	–94,372
Kansas	272,213	295,663	–23,450
Michigan	473,473	606,472	–132,999
Minnesota	320,725	316,363	4,362
Missouri	448,280	420,223	28 057
Nebraska	141,712	181,662	–39,950
North Dakota	56,071	107,018	–50,947
Ohio	622,446	763,625	–141,179
South Dakota	69,036	91,479	–22,443
Wisconsin	307,168	343,022	–35,854
South			
Alabama	328,120	292,251	35,869
Arkansas	240,497	216,250	24,247
Delaware	94,129	68,248	25,881
District of Columbia	109,107	163,518	–54,411
Florida	2,130,613	1,058,931	1,071,682
Georgia	804,566	501,969	302,597
Kentucky	278,273	298,397	–20,124
Louisiana	225,352	476,006	–250,654
Maryland	531,803	430,913	100,890
Mississippi	193,148	220,278	–27,130
North Carolina	748,767	467,885	280,882
Oklahoma	279,889	407,649	–127,760
South Carolina	398,448	289,107	109,341
Tennessee	500,006	368,544	131,462
Texas	1,164,106	1,495,475	–331,369
Virginia	863,567	635,695	227,872
West Virginia	123,978	197,633	–73,655

West			
Alaska	105,605	154,090	−48,485
Arizona	649,821	433,644	216,177
California	1,974,833	1,801,247	173,586
Colorado	465,714	543,712	−77,998
Hawaii	166,953	187,209	−20,256
Idaho	137,542	157,121	−19,579
Montana	84,523	137,127	−52,604
Nevada	326,919	154,067	172,852
New Mexico	192,761	204,218	−11,457
Oregon	363,447	280,875	82,572
Utah	177,071	213,233	−36,162
Washington	626,156	409,886	216,270
Wyoming	62,286	118,979	−56,693

Source [41]
* Interstate migrants only, excluding international migration

birth and death data [31, pp 625–635]. Both the vital statistics and survival rate methods can be used to produce estimates not only of total net migration, but of the age, sex, race, and other characteristics of the net migration flow as well

Net migration can thus be calculated directly as the difference between the number of in-migrants and the number of out-migrants or indirectly using the demographic balancing equation. The major advantage of the second approach, of course, is that estimates can be made even when gross migration data are not available. As we will describe in this article, that is typically the case for subcounty areas in the United States [3]

3. Conceptual and methodological problems

Net migration as a measure of population mobility is subject to a number of well-known conceptual and methodological problems First of all, gross (i e., unidirectional) migration is closer to the true migration process than is net migration. Some people move into an area, some move out, and others stay put. People may thus be classified as movers or non-movers and as in-migrants or out-migrants, but there is no such thing as a "net migrant" Net migration is not a process in itself, but is rather the difference between the outcomes of two migration processes.

Second, focusing on net migration may mask the existence of large gross migration flows. Indiana, for example, had net interstate migration of 3,128 between 1985 and

[3]Demographers often distinguish between migration and local mobility Migration refers to moves which cross some type of political or administrative boundaries, whereas local mobility refers to moves within those boundaries [31, p 617] This article focuses on moves from one geographic region to another, we therefore refer to all moves from one region to another as migration, regardless of the size of the region or the distance of the move

1990 (Table 1). Does this mean that only a few people were moving into or out of Indiana during this time period? Absolutely not, Indiana had 433,678 in-migrants and 430,550 out-migrants between 1985 and 1990 Gross migration data illuminate these population movements, whereas net migration data obscure them.

Third, with net migration there is no true "population at risk" for calculating migration rates. A rate may be defined as the number of events occurring during a given time period divided by the population at risk to the occurrence of those events [31, p. 7]. For out-migration, the population at risk is the population living in the region; for in-migration, the population at risk is the population living in other regions. For net migration, however, there is no true population at risk Net migration "rates" are therefore not rates in a probabilistic sense because they do not represent the frequency of an event in relation to the population at risk to its occurrence Rather, they are simply ratios showing the relationship between net migration and population size.

Fourth, the use of net migration as a dependent variable can lead to misspecified causal models. The construction of net migration rates mixes together changing migration propensities and changing population stocks [28] In addition, some explanatory variables may have opposite effects on in- and out-migration, reinforcing their overall impact on net migration, whereas others have similar effects, which tend to cancel each other out Studies of the determinants of net migration may therefore produce misleading results and faulty conclusions regarding the factors that drive the migration process. In particular, it is not valid to view net migration either as a measure of individual mobility or of uni-directional migration flows

Fifth, when net migration is calculated indirectly (i e , total population change minus births plus deaths), it captures all the measurement errors found in the underlying birth, death, and population data These errors may be substantial [16]

Finally, the use of net migration may create problems for cohort-component population projection models When in- and out-migration are projected separately, the model can account for differences in the population sizes, growth rates, and other characteristics of the origin and destination populations When in- and out-migration are combined to form net migration, however, the model cannot account for these differences. As noted by Isserman [15], Plane [25], and Smith [33], projections based on net migration rates can differ considerably from projections based on gross migration rates. The further into the future the projections extend, the greater the differences are likely to be. Population projections based on net migration models may therefore lead to unrealistic forecasts of future population Although little empirical research has addressed this issue, the likelihood of large forecast errors would seem to be greater for net migration models than for gross migration models, at least for projections covering long time horizons

4. Benefits of net migration

These are all valid criticisms There are undoubtedly circumstances in which net migration is not a useful concept and analyses based on net migration values will produce misleading results or faulty conclusions. However, we also believe there are circumstances in which net migration is a valid concept, and there are purposes for which it can be very usefully employed.

Summary Measure. One benefit of net migration is that it provides a summary measure of one component of population change. As shown in Equation 2, population change ($P_1 - P_0$) can be viewed as having two parts. Natural increase ($B - D$) describes the changes that occur as a result of the mortality and fertility processes operating within a region Net migration (IM – OM) describes the changes that occur as a result of population movements into and out of the region Natural increase thus reflects the population growth (or decline) coming from within a region, whereas net migration reflects the effects of interregional population movements Technical issues regarding the measurement of natural increase and net migration–and their effects on each other– are discussed in detail in Shryock and Siegel [31, chapters 20 and 21] [4]

Natural increase is the major component of population growth for most countries and the sole component for the world as a whole. For states, counties, and cities, however, net migration is often the major contributor to population change For subnational regions, net migration is generally more volatile than natural increase; in the United States it contributes substantially more to state-to-state differences in rates of population growth than does natural increase [6,36] As a general rule, the smaller the area, the greater the share of total population change accounted for by net migration [5].

Net migration and natural increase are roughly analogous concepts Each is a residual measuring the difference between two countervailing forces and each provides a summary measure of one component of population growth. Although net migration provides no information on the size of gross migration flows or the origins and destinations of migrants, it does show whether a region is growing or declining as a result of migration, and by how much This information may be of particular importance to policy makers, who are often more interested in the overall outcome of the migration process than its individual components [10]

Many studies have focused on net migration as a summary measure of population change. Human ecological theory, for example, views migration in aggregate rather than individual terms. From this perspective, migration is one response through which a population can attempt to maintain a balance between its size and its ability to support itself. Studies from this perspective have frequently used net migration as an indicator of how a population responds to changes in organizational, technological, and environmental factors [9,29,32].

[4] Natural increase and net migration are only two of the "net" summary measures that have found widespread use Measures of net undercount error have been widely used by demographers in evaluations of census enumeration accuracy in Australia, Canada, the United Kingdom, and the United States [1] Profit, the difference between revenue and expenditure, is even more widely used as a net summary measure

Many economists have used net migration as a measure of a region's relative attractiveness with respect to economic opportunities, costs of living, government services, and recreational, cultural, and climatic amenities [4,20,22]. It has also been used as an indicator of the presence or absence of a regional labor market equilibrium [7,13, 14]. As long as the empirical results are interpreted as reflecting aggregate population change rather than individual mobility or uni-directional migration flows, net migration is an appropriate measure for use in causal analysis [11].

Gross Migration Data Not Available. A second benefit of net migration is that it provides a measure of population mobility when gross migration data are not available. To understand why gross migration data may not exist for particular geographic regions or periods of time, it is necessary to consider the primary sources of migration data in the United States.

The first is the decennial census of population and housing, in which migration data have been collected in every census year since 1940. These data are based on the respondent's current place of residence compared to his/her place of residence five years earlier (migration data from the 1950 census were based on place of residence one year earlier). The decennial census is by far the most comprehensive source of gross migration data, providing information not only on the numbers of in- and out-migrants, but their origins, destinations, age, sex, race, ethnicity, and other characteristics as well. Decennial census data have been widely used for analyses of the determinants of migration [22,30] and for population projections [3,33].

There are a number of problems with the migration data collected in the decennial census, however. Questions regarding place of residence five years earlier are asked only of a one-in-six sample of census respondents, this raises questions about data reliability, especially for small places [42]. Data are available only once every ten years and are not released to the public until 3–5 years after the census is completed. They cover migration only for the last half of the decade and do not pick up the effects of multiple moves. The data account for the entry of immigrants from abroad, but not for the exit of emigrants to foreign countries. All these problems limit the usefulness of the migration data collected in the decennial census.

The most serious problem for small area analyses, however, is that complete migration data are not available below the county level. Data on the number of in-migrants are tabulated down to the census tract level, but data on the characteristics of those in-migrants are not tabulated. Out-migration data present an even bigger problem, as the number of out-migrants from an area must be tabulated from questionnaires filled out by residents throughout the United States. This requires a colossal effort. The Census Bureau currently tabulates data on in- and out-migration by age, sex, and race for states and counties, but not for subcounty areas. Migration data from the decennial census are therefore inadequate for estimates, projections, and many other types of demographic analysis below the county level.

A second source of gross migration data is administrative records kept by various agencies of the federal government. The records most commonly used for migration estimates come from the Internal Revenue Service (IRS). By matching addresses on income tax returns and adjusting for the number of exemptions claimed, the Census Bureau has created a set of annual state- and county-level gross migration flows [37] These data have several advantages over decennial census migration data: they are available every year, they cover single-year intervals, and they become available more quickly (within 2–3 years instead of 3–5 years).

The IRS migration data also have several shortcomings, however. Not everyone files a tax return, especially people with low incomes. The address listed on a tax return may refer to a bank, law office, accounting firm, or post office box rather than to the home address of the filer. Data on exemptions may be inaccurate or refer to persons living in other areas. Coverage is not as complete as for the decennial census and data on population characteristics are not available. Although the Census Bureau uses IRS migration data to produce population estimates and projections, the data themselves are not made available to the general public. These disadvantages severely limit the usefulness of IRS migration data for many purposes.

A final source of gross migration data is various sample surveys conducted by the federal government One of the most commonly used is the Current Population Survey, conducted monthly by the Census Bureau. This survey is designed primarily to collect labor force information, but every March interviewers ask additional questions regarding geographic mobility. The resulting data provide valuable migration information for the nation as a whole and for some states and large metropolitan areas, but provide no information for most substate areas

This brief review of data sources makes it clear that there are many circumstances in which gross migration data are incomplete, outdated, or simply nonexistent. These shortcomings are particularly severe for subcounty areas. When gross migration data are unavailable or otherwise inadequate, net migration estimates can be developed by comparing an area's population at two points in time, determining the change that would be expected on the basis of natural increase, and attributing the residual to net migration, as shown in Equation 3. This is an important benefit of net migration as a measure of population mobility.

Gross Migration Data Not Reliable. The question regarding place of residence five years earlier is found only on the long form of the decennial census, a form filled out by about one in six households in the United States. Although sample size is generally not a problem for states and large substate areas, it can create data reliability problems for small areas, especially when migration data are broken down into age, sex, race, or other population subgroups. This problem was exacerbated in 1980 when only half the long forms were processed due to budgetary restrictions

An example from Hardee County, Florida illustrates the data reliability problem Hardee County is a small, largely rural county is southwest Florida. Its 1990 population was 19,499, with 23.4% Hispanic, 5 3% black, and 15.2% age 65 and older. Table 2 shows the number of in- and out-migrants from 1985 to 1990 for five-year age groups for persons age 65 and above.

The numbers appear to be quite reasonable for ages 65–69, with a net in-migration flow of 65 for males and 77 for females. They still appear to be fairly reasonable for

Table 2
Number of in- and out-migrants Age 65+, 1985–1990, Hardee County, Florida

Age	Males In	Males Out	Males Net	Females In	Females Out	Females Net
65–69	116	51	65	105	28	77
70–74	67	27	40	50	45	5
75–79	4	47	−43	39	19	20
80–84	77	0	77	12	29	−17
85+	22	11	11	8	31	−23

Source [41]

ages 70–74, although the net in-migration flow is only five for females, compared to 40 for males. For the three oldest groups, however, the numbers are of doubtful reliability. Males age 75–79 are reported as having four in-migrants and 47 out-migrants, while males age 80–84 are reported as having 77 in-migrants and no out-migrants These numbers are not only wildly inconsistent with each other, but with the numbers reported for females as well. If no adjustments were made, migration rates based on these data would almost certainly lead to some very unlikely population estimates and projections.

Discrepancies such as these are not unique to Hardee County, Florida. They are found in many other states and counties and are even more glaring when the data are further subdivided by race or ethnicity. Reliability problems characterize gross migration data from other data sources as well. In these instances net migration data may prove to be more reliable than gross migration data for performing demographic applications. Although net migration data also contain errors, those errors are often offsetting and can be further reduced by making adjustments for census undercount and vital statistics underregistration [31, pp. 628–636]

At the very least, net migration data provide an additional criterion for evaluating the reliability of gross migration data Suppose, for example, that 1985–1990 gross migration data showed some very unusual migration patterns for several age groups in a particular area. Those patterns could be evaluated by comparing them with those found in 1980–1990 net migration data. If the same patterns were found in both sets of data, the net migration data would support the validity of the gross migration data If the same patterns were not found in both sets of data, the net migration data would suggest that the gross migration data might in fact be unreliable. This information would help the analyst decide whether to adjust the gross migration data, or even to replace it with another data set.

5. Small-area estimates and projections

Migration data are widely used for analytic purposes, or for explaining the determinants and consequences of individual mobility decisions and aggregate migration trends. For many of these purposes, gross migration data are more useful than net migration data. However, migration data are also widely used for demographic applications such as the construction of population estimates and projections. For these purposes, net migration data can be very useful This is especially true for estimates and projections of subcounty areas such as cities, census tracts, traffic zones, and zip code areas, for which complete gross migration data are rarely if ever available. It is in the field of applied demography that the benefits of net migration become most apparent

Population Estimates. The Census Bureau, state demographic centers, local governmental agencies, and a number of private companies make post-censal population estimates. These estimates are used for planning, budgeting, and the allocation of resources at the national, state, and local levels In terms of federally-produced estimates, Prevost and McKibben [26] found that population estimates affected the allocation of $40 billion in federal grants in 1988. Typical of many state programs, Oregon distributed $155 million in state funds to local governments in 1994 based on population estimates produced by its demographic center [38]. Florida distributed $1.4 billion to city and county governments in 1994–1995 based on state-produced population estimates [35]. Post-censal population estimates clearly have an important impact on the distribution of public revenues, as well as on planning and budget decisions.

The Census Bureau has traditionally used three primary methods for producing state and local population estimates· Component Method II, Administrative Records, and Ratio Correlation [18]. The first two are component methods based on birth and death data and estimates of net migration. Component Method II (CM II) utilizes a "residual" estimate of net migration derived from changes in school enrollment data. This method has been used by the Census Bureau and other demographic agencies since the 1950s and was the most widely used of the complex component methods during the 1960s, 1970s, and 1980s [2] Although no longer used by the Census Bureau, it is still used by a number of state demographic agencies.

In the early 1970s the Census Bureau developed the Administrative Records (AR) Method (now called the Tax Returns Method). This is a component method similar to CM II, but it uses change-of-address data from income tax returns rather than school enrollment data to develop estimates of net migration. It is the method currently used by the Census Bureau for state and county estimates; until very recently, it was the sole method used for subcounty estimates It is interesting to note that although place-to-place migration data are available from federal income tax returns, the Census Bureau uses net rather than gross migration rates in applying the AR method at the substate level, apparently because of the difficulty of developing appropriate denominators for in-migration rates [37].

Although both methods are subject to certain problems, evaluations of the CM II and AR methods have been generally favorable [18,23]. They are conceptually straightforward and easy to describe to data users, utilize data that are available for all areas in the United States, and provide estimates of the components of population growth as well as of total population. Furthermore, they produce reasonably accurate population estimates. Estimates of net migration clearly play a critical role in the production of post-censal population estimates

Population Projections. Population projections have been used for a wide variety of purposes at the national and state levels for many years; they are increasingly being used for many types of decision-making at the local level as well. Examples include regulating the expansion of hospitals, nursing homes, and automobile dealerships; determining optimal locations for new elementary schools or fast food franchises, evaluating the need to increase the capacity of sewer systems or electric power plants; and forecasting the demand for new residential housing. For many purposes, projections of demographic characteristics (e g , age, sex, race) are needed in addition to projections of the total population

Some variant of the cohort-component method is typically used for these projections [24]. Conceptually, multiregional models incorporating place-to-place migration flows are superior to single-region models because small areas form part of a larger interrelated system, migrants to an area do not simply appear, but are drawn from some other area [27]. Other advantages of gross migration models were discussed earlier in this article However, the data required by multiregional models are rarely available for small areas in the United States. Even when available and reliable, the sheer volume of data may be so large as to be virtually intractable In these instances, net migration models provide a viable alternative [5]

When projections are used for planning and budgeting decisions, questions regarding forecast accuracy become paramount. Do the theoretical advantages of gross migration models lead to more accurate projections than can be obtained from simpler net migration models? Few studies have addressed this question Isserman [15] used 1975–1980 migration data to project the population in 1990 for 55 counties in West Virginia. He employed two migration models, one using net migration and the other projecting in- and out-migration separately He calculated forecast errors by comparing the projections with 1990 census counts. He found mean absolute percent errors of 18 percent for projections based on the gross migration model and 21 percent for projections based on the net migration model.

The Isserman study did not report results by size of place, rate of growth, or any other demographic characteristic. It covered only one state (West Virginia), one launch year (1980), and a single projection horizon (1980–1990) Furthermore, West Virginia was somewhat unique in that 52 counties gained population during the 1970s but only ten gained during the 1980s. It is therefore impossible to draw more than the most tentative of conclusions from these results What they suggest, however, is that average forecast errors may not be too much different for net than gross migration models, at least for relatively short time horizons (e.g , ten years)

[5]Large multiregional models are difficult to apply even at the state level Recent Census Bureau projections required the construction of a "synthetic" data set based on three different migration sources before the multiregional approach could be applied This data set contained 2,550 state-to-state migration flows, each broken down into separate age, sex, and race categories [3]

We can conduct another empirical test using a set of projections constructed for ten states [33]. This study focused on the choice of the base population used for constructing migration rates and the impact of that choice on the resultant population projections. Three different migration models were used. Model I used gross in- and out-migration data by age and constructed separate in- and out-migration rates for each age group. Out-migration rates were based on the population of the state being projected and in-migration rates were based on the population of the rest of the United States. Model II used the same gross migration data as Model I, but combined them to form net migration data. Net migration rates were constructed by dividing net migration for each age group by the state population in that age group. Model III used the same net migration data as Model II, but used the national population instead of the state population as the denominator in constructing age-specific migration rates.[6]

All three models used migration data from 1975–1980 and identical mortality and fertility assumptions; the only difference was in the construction of the migration rates. Projections were made for four states that grew rapidly between 1975 and 1980, three states that grew slowly, and three states that grew at about the same rate as the United States population as a whole. Projections were made in five-year intervals from 1980 to 2030. Table 3 summarizes the forecast errors for 1990, defined as the difference between the projections and the census counts The error measures are the Mean Absolute Percent Error (MAPE) and Mean Algebraic Percent Error (MALPE) The MAPE ignores the direction of error, providing a measure of accuracy; the MALPE accounts for the direction of the error, providing a measure of bias.

In terms of accuracy, differences among the three models were fairly small. Model I had the smallest MAPE for low- and medium-growth states, while Model III had the smallest for high-growth states. Model II had the largest MAPE for high- and medium-growth states and Model III had the largest for low-growth states. Overall, MAPEs were 9.9 percent for Model I, 11.1 percent for Model II, and 10.2 percent for Model III

In terms of bias, differences in errors were considerably larger. Model I had the smallest MALPE (i.e , the least bias) in all three growth-rate categories. The differences were fairly small for low- and medium-growth states, but were very large for high-growth states. Errors were particularly large for Model II in high-growth states. This is not surprising because Model II uses net migration rates based on the population of the state itself; consequently, net migration rates in Model II are highly correlated with population growth rates. Since high growth rates tend to decline

[6]Out-migrants from any state are drawn from that state's population, but in-migrants are drawn from the rest of the United States (or the world) Consequently, state and national populations both represent potential populations at risk to migration For states with net out-migration, the state is the source for the majority of total migrants, for states with net in-migration, the rest of the nation is the source for the majority of total migrants Most analysts simply use the population of the area under consideration as the denominator for constructing net migration rates [19], but we believe the national population is a useful alternative, especially when net migration rates are to be used for population projections of rapidly growing areas Models II and III reflect these two possibilities

Table 3

Population forecast errors for selected states, by rate of growth, for three projection models (ten year horizon)

Error/Growth Rate	N	Model I	Model II	Model III
MAPE				
High	4	15 4	17 2	14 7
Medium	3	8 2	8 8	8 7
Low	3	4 1	5 2	5 6
Total	10	9 9	11 1	10 2
MALPE				
High	4	2 0	14 6	8 1
Medium	3	8 2	8 8	8 7
Low	3	−4 1	−5 2	−5 6
Total	10	2 0	6 9	4 2

N = number of states

Notes Model I Gross in- and out-migration rates
Model II Net migration rates based on state population
Model III Net migration rates based on national population

High growth states Arizona, Florida, Nevada, Wyoming
Medium growth states Arkansas, Kentucky, Montana
Low growth states Massachusetts, New York, Pennsylvania

over time [34], projections based on the application of constant net migration rates are likely to have an upward bias for rapidly growing places, especially for long projection horizons. That is exactly what is shown in the bottom panel of Table 3.

Again, these results are merely suggestive. More empirical evidence is required before any general conclusions can be drawn What the results suggest, however, is that projections based on gross and net migration models are likely to be quite similar when growth rates are slow or moderate, or when projection horizons are relatively short (10 years or less). When growth rates are very high or projection horizons are long, however, differences in projections from different migration models may turn out to be fairly large. In these instances, it may be advisable to adjust the projected net migration rates over time. Alternatively, the net migration model could be used only for projecting the age, sex, and race characteristics of the population, with other techniques used for projecting total population (e g., mathematical extrapolation, shift-share).

6. Conclusion

Net migration is not dead, either as a theoretical concept or as a measure of population mobility. Although it suffers from a number of well-known problems, there are purposes for which it is very useful: measuring and analyzing the components of growth; developing post-censal population estimates; and constructing population projections when gross migration data are unavailable, unreliable, or too expensive to be feasible. We believe it is important to recognize both the strengths and the weaknesses of net migration and to take full advantage of the benefits it has to offer, particularly in the area of small-area demographic analysis.

Even when gross migration data are available and appear to be reliable, one must ask whether the large resource expenditures required by gross migration models are justified by their benefits Large multiregional models require a tremendous amount of time for data collection, verification, and adjustment, as well as for constructing and running the models themselves. Even relatively simple migrant pool and two-region models are more time-consuming to construct and apply than net migration models. Do the extra benefits of gross migration models justify their higher costs?

Swanson, Burch, and Tedrow [39] have drawn a distinction between the objectives of applied demography and those of academic (or basic) demography. According to these analysts, the primary objective of academic demography is to develop convincing explanations of demographic phenomena, whereas the primary objective of applied demography is to use the methods and materials of demography to guide practical decision-making In both fields, researchers seek to achieve a certain level of performance subject to time and money constraints, but their perspectives differ. Academic demographers generally attempt to maximize performance given their time and money constraints, whereas applied demographers often attempt to minimize time and money costs while achieving a level of performance that can adequately support the decision-making process.

From the perspective of an applied demographer, then, there may be circumstances in which a net migration model is preferable to a gross migration model even though the latter is theoretically superior and perhaps somewhat more accurate as a forecasting tool If a net migration model is much less expensive than a gross migration model in terms of time and money costs, and almost as accurate as a predictor of future migration flows, it may be the optimal choice even when the data required by gross migration models are available. We believe that the choice of the "best" model for any particular purpose cannot be made independently of a cost-benefit analysis of the alternatives. As noted by Swanson and Tayman [40], cost, timeliness, and "value-added" are all important criteria for judging the adequacy of a population model. The simplicity and relatively low costs of net migration models make them a potentially valuable alternative for many types of demographic applications, especially for subcounty areas

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